ICAO COMMITTEE ON AVIATION ENVIRONMENTAL PROTECTION

CAEP/7 WG2 – Aircraft Operations and Modelling

TG2 Meeting – Sixth Meeting

Tucson, AZ, USA, 7-8 February 2006

Aviation Environmental Portfolio Management Tool (APMT) Prototype

(Prepared by U.S. Representative)

SUMMARY

The U.S. Federal Aviation Administration (FAA) Office of Environment and Energy is developing a comprehensive suite of software tools that will allow for thorough assessment of the environmental effects of aviation. The main goal of the effort is to develop a new capability to assess the interdependencies between aviation-related noise and emissions effects, and to provide comprehensive cost analyses of aviation environmental impacts. The economic analysis function of this suite of software tools has been given the rubric Aviation Environmental Portfolio Management Tool (APMT).

This paper contains an overview of the APMT Requirements Document and Architecture Study. It also outlines the recently initiated APMT prototyping effort. Additional information is available in the full reports, which can be accessed at http://spacestation.mit.edu/partner (login=iaw, password=partnerweb).

CAEP members are invited to comment on this effort by following the instructions provided on the website. CAEP is further invited to consider the proposed APMT process during its evaluation of interdependencies tools.

1. BACKGROUND

1.1 The Federal Aviation Administration's Office of Environment and Energy (FAA-AEE) is developing a comprehensive suite of software tools that will allow for thorough assessment of the environmental effects of aviation. The main goal of the effort is to develop a new capability to assess the interdependencies between aviation-related noise and emissions effects, and to provide comprehensive cost analyses of aviation environmental impacts. The economic analysis function of this suite of software tools has been given the rubric Aviation Environmental Portfolio Management Tool (APMT). This function will be derived from existing tools, tools currently under development, and new tools to be developed.

1.2 FAA-AEE provided a grant to the Partnership for AiR Transportation Noise and Emissions Reduction (PARTNER), an FAA/NASA/Transport Canada-sponsored Center of Excellence, to conduct a scoping study of APMT. The results of the study were reported in three documents describing APMT requirements, APMT architecture, and an APMT prototype work plan. The three documents have been accepted by the FAA; and, are undergoing formal review by international stakeholders. Below is a brief overview of the APMT Requirements Document and Architecture Study. More details are available in the full reports, which can be accessed at http://spacestation.mit.edu/partner (login=iaw, password=partnerweb).

2. APMT REQUIREMENTS

2.1 The Requirements Document provides a detailed list of the functional requirements and guidance on implementation of APMT with supporting background discussions to help place these requirements within the broader context of current practice. The Requirements Document also defines the recommended time frames for development and use as well as the geographical and economic scope for analyses performed using APMT.

2.2 Environmental economic analyses[1] can be divided into three categories: cost-effectiveness analysis[2] (CEA), benefit-cost analysis[3] (BCA), and distributional analysis[4] (DA). Each of these three types of analysis is designed to answer a different question. Across these three categories and within these three categories, tools of different levels of scope and fidelity are required depending on the scope of the analysis and data availability. The types of analyses and the tools within each category are outlined in Table 1. Also referenced in Table 1 are categories of potentially impacted entities including:

a) Producers in the primary market (Airlines, airports and manufacturers); producers in secondary and related markets (e.g. travel and tourism, aerospace suppliers, etc.); producers in other markets (anything else);
b) Consumers of goods and recipients of environmental harm as characterized by different geographical and other qualities such as airline customers, local communities, global communities, and specially-defined subpopulations for equity analyses (e.g. children, small businesses, Native Americans, etc.); and

[1] Throughout this document, as is typical in environmental economic analysis, changes in monetary flows in the aviation markets and the general economy are labeled as "costs" although it is recognized that they may be positive or negative. Similarly, changes in health and welfare that occur through environmental pathways are labeled as "benefits" although they may be positive or negative.

[2] Cost-Effectiveness Analysis (CEA) is used to determine the outcome or impact of alternative regulatory choices. It is useful for answering the question: "Given several options for addressing an environmental problem through regulation—each (ideally) with similar benefits, which choice has the lowest costs?" Typically the benefits are defined using some surrogate for the ultimate environmental effect (e.g. kg NOx vs. incidence of adverse health effects).

[3] Benefit-Cost Analysis (BCA) seeks to determine the extent to which a policy option will produce a net benefit to society (independent of distributional aspects such as who wins and who loses). By estimating the net present value of benefits less costs relative to a well-defined baseline scenario, BCA can be used to determine the degree to which a policy scenario improves economic efficiency. BCA requires that benefits and costs be expressed in the same units (typically monetary). It is the recommended basis in North America and Europe for assessing policy alternatives.

[4] Distributional analyses seek to determine what segments of the economy will gain or lose as a result of a policy option. The segments of the economy may be defined by markets, components of markets, or specific parts of the population as defined by demographic information or geographical location.

c) Governments, both as regulators of flows in the economy and as producers in the economy (through provision of services).

2.3 A timeline for development of APMT capabilities is presented in Table 2. It defines the recommended time frames for development and use as well as the geographical and economic scope for analyses performed using APMT. Broadly, the current practice within ICAO-CAEP focuses on cost-effectiveness analysis (CEA.1 and CEA.2). APMT must be capable of reproducing these capabilities and then expanding beyond them. The primary environmental impacts that must be addressed with these tools are local air quality, community noise, and climate change.

2.4 Because of the immediacy of upcoming global decisions and the need to adequately inform these decisions, the highest priority for the geographical and economic scope for all of these analyses should be global and regional (or national). Thereafter, focused studies over smaller geographical areas and economies may be pursued (e.g. within a single airport community).

2.5 To respond to the near-term needs, the FAA has initiated development of an expanded cost-effectiveness analysis capability that would be operational within 1-3 years. The analysis capability will be built to accept a range of environmental performance indicators from AEDT (e.g. number of people living within DNL 65dB, kg NOx, kg fuel burn, etc.) and enable a first assessment of indirect environmental effects that policy options in one domain may produce in another domain (e.g. the effects of noise stringency on NOx levels). Concurrently, development of a benefit-cost analysis capability is being initiated to include monetization of benefits (BCA.1.1) and quasi-equilibrium modeling of the consumers and producers in the primary market (BCA.2.1) – since this should ultimately supplant the near-term reliance on cost-effectiveness analysis. Due to present availability of data, it is expected that this capability would be developed first for application within the U.S. (within 1-3 years), and then expanded internationally through partnerships and collaborations (3-6 years).

Table 1 Outline of functional requirements

Types of Analysis	Question Answered	Tools of Analysis
Cost-Effectiveness Analysis (**CEA**)	"Given several options for addressing an environmental problem which option provide the greatest change in a surrogate for environmental impact per unit of cost?"	**CEA.1** Benefits Assessment: Requires some measure of system performance that serves as a surrogate for the full monetized environmental benefit value (e.g. lbs of NOx per year or # of people living in DNL 55dB).
		CEA.2 Costs evaluation: Considers the changes in capital and operating costs in primary markets and potentially enforcement costs (e.g. FESG spreadsheet that calculates manufacturer and airline marginal costs in response to a policy scenario) with appropriate discounting.
Benefit-Cost Analysis (**BCA**)	"Relative to a well-defined baseline scenario, to what degree does a policy scenario improve economic efficiency?"	**BCA.1** Social Benefits Assessment: Requires methods to convert system performance to both health and welfare impacts (e.g. # of asthma cases, premature mortality, etc.) and other benefits (e.g. operational efficiency) in comparable ways (usually monetary values since this is also comparable to the social costs metric) with appropriate discounting. **BCA.1.1** Revealed preference methods, stated preference methods and out-of-pocket expenditures—and hybrids thereof for assessing direct effects (e.g. hospitalization, lost wages, housing devaluation) **BCA.1.2** General economic models (e.g. input-output models for marginal sensitivities, and models for reaching a new optimization point) for assessing indirect (e.g. changes in household consumption patterns in response to environmental disbenefits) and induced (any multiplier effects after the consumption patterns change – e.g. people get sick more often and they buy less paper so it impacts the paper industry) benefits. These techniques are currently a research activity.

Table 1 Outline of functional requirements (*continued*)

		BCA.2 Social Costs Assessment: **BCA.2.1** Partial equilibrium models to evaluate costs in the primary market (e.g. supply = airlines and demand = travelers and freight). This allows consideration of market-based options, of command and control options, etc. **BCA.2.2** General equilibrium models to assess the indirect and induced effects (e.g. how do changes in production and consumption in the aviation industry, change production and consumption in other parts of the economy).
Distributional Analysis (**DA**)	"Which entities pay the costs and receive the benefits?"	**DA** General equilibrium models, national or global in scope, are required to assess who pays and who receives the benefits.
		DA.1 Economic Impacts Analysis: Determines the costs-and benefits that accrue to various potentially impacted entities.
		DA.2 Equity Assessments: Applies impacts assessments for specific subpopulations (e.g. for example those considered to be disadvantaged, such as small businesses, Native Americans, etc.)

Table 2 APMT Requirements Timeline

Development Time Frame	Title	Scope	Capabilities
Years 1-3	APMT v1 Enhanced Cost-Effectiveness Capability	National/ Global	Cost-effectiveness analysis which replicates existing CAEP practice, but uses inputs from AEDT to provide integrated assessment of noise, local air quality and climate variables (CEA.1 and CEA.2)
Years 1-6	APMT v2 Benefit-Cost Assessment Capability	National/ Global	Add monetized benefits and partial equilibrium modeling of the primary markets (BCA.1.1 and BCA.2.1) enabling limited distributional assessments (DA.1 and DA.2)
Years 3-8	APMT v3 Benefit-Cost Assessment Capability with Indirect and Induced Costs	National/ Global	Indirect and induced cost assessment using a general equilibrium model (BCA.2.2) to enable more complete distributional assessments (DA.1 and DA.2)
Years 6-8+	APMT v4 Benefit-Cost Assessment Capability with Indirect and Induced Costs and Benefits	National/ Global	Addition of indirect and induced benefits
Years 6-8+	APMT-Local v1	Local/ Regional	Perform benefit-cost assessment on local/regional scale

3. APMT ARCHITECTURE

3.1 The APMT Architecture Study report describes in detail the components of the APMT architecture, outlines the interfaces that will be required among those components, and establishes how APMT will interface with other tools that exist or are under development including the Environmental Design Space (EDS) and the Aviation Environmental Design Tool (AEDT). The Architecture Study also reviews existing tools available for economic analyses, assesses their suitability for use in APMT, and establishes what additional development will be necessary to achieve APMT requirements.

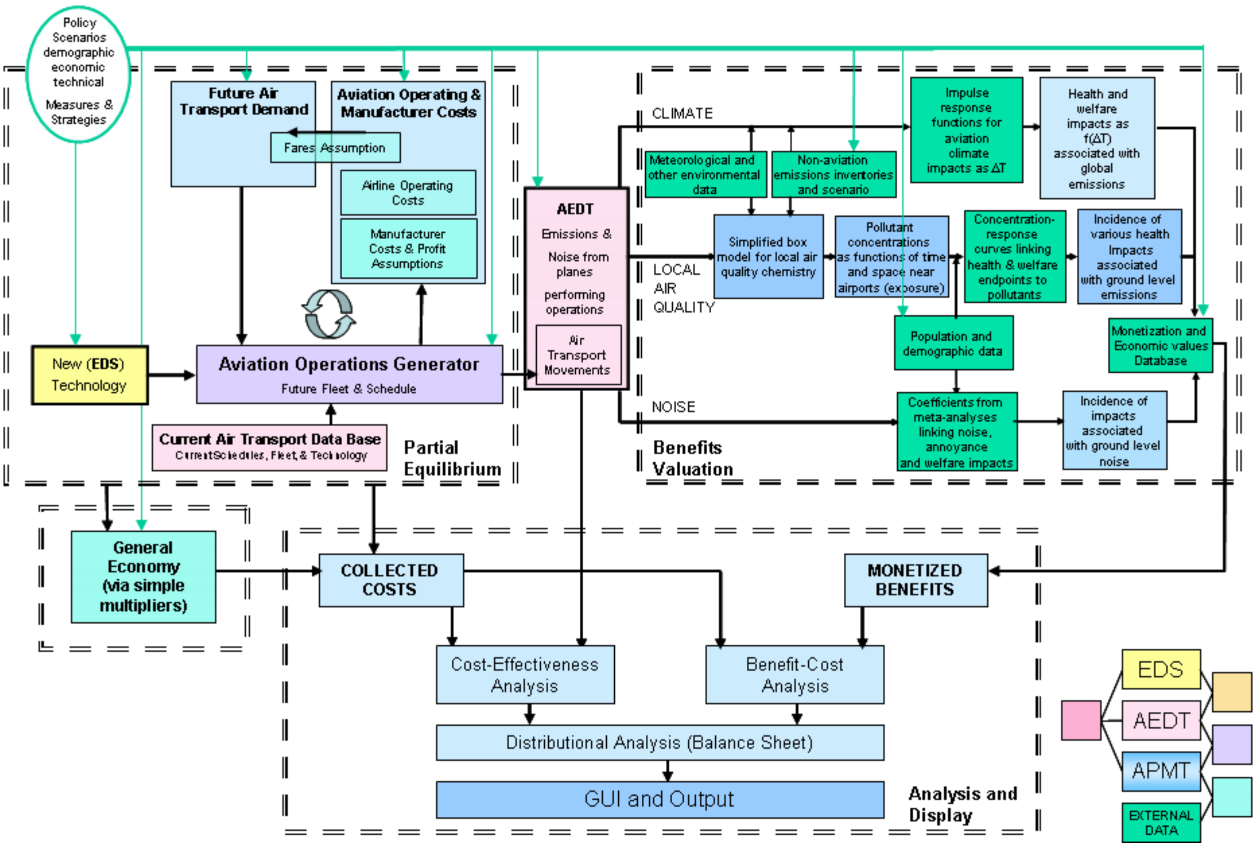

Figure 1: Overall APMT Structure

3.2 The recommended APMT architecture is composed of five functional blocks as shown in Figure 1: the Partial Equilibrium Block simulates economic flows in the aviation market; the Aviation Environmental Design Tool (AEDT) Block converts aviation activity into quantities of emissions and noise distributed in time and space; the Benefits Valuation Block converts the quantities of emissions and noise to monetized health and welfare impacts (including broader socioeconomic and ecological effects); the General Economy Block evaluates the changes in economic flows in other markets due to changes in the aviation market; and the Analysis and Display Block allows the results to be analyzed graphically and provides quantitative estimates of uncertainty. These five blocks are described in greater detail below.

a) The **Partial Equilibrium**[5] **Block** takes estimates of future aviation demand and other assumptions specific to various policy scenarios, establishes a future fleet and flight schedule for input to the AEDT Block, and assesses manufacturer costs, operator costs and consumer surplus. An assumption about the extent to which costs are passed-on to consumers, leading to a modification of the initial demand assumption, completes the partial-equilibrium loop. Airline costs, manufacturer costs and consumer surplus can be used directly for cost-effectiveness and benefit-cost assessments, or can be multiplied to reflect indirect and induced effects associated with broader effects in the

[5] Partial equilibrium refers to analysis of change in one market, here the market for air transport, without taking into consideration how changes in one market imply changes in other markets. In the context of APMT, this means capturing the new equilibrium in the market for air travel after a change in policy, and the impact of that change on the traveling public, air carriers and manufacturers.

general economy. The Partial Equilibrium Block includes a link to EDS to provide new technology aircraft that may be introduced as part of the policy scenario and to ensure that the future aircraft provided by EDS are synthesized using assumptions and requirements consistent with the APMT scenario. To develop this functionality, an Aviation Operations Generator module shall be developed in concert with AEDT. It shall be based upon methods used by the Wyle/FAA Model for Assessing Global Exposure from Noise of Transport Airplanes (MAGENTA), but modified to enable the introduction of new aircraft from EDS. Manufacturer cost and aircraft price estimates shall be based upon correlations drawn from regression analyses of historical price data with a range of assumptions for manufacturer profits. Uncertainty shall be addressed through parametrically varying the estimates. Higher fidelity modeling of manufacturing costs associated with technology trade-offs shall be accomplished using the NASA/GaTech Aircraft Life Cycle Cost Analysis code (ALCCA), but further assessment and development of ALCCA will be required. Airline operating costs shall be estimated using the Dutch Aviation Emission and Evaluation of Reduction Options Modeling System (AERO-MS) Aviation Operating Cost Model (ACOS) or similar modeling techniques. Airline cost pass-through to fares shall be modeled parametrically in a manner similar to AERO-MS, although work to improve these techniques is recommended for longer-term application within APMT.

b) The **Aviation Environmental Design Tool (WG2/TG-2-6-WP6 and WG2/TG-2-6-WP10) Block** represents the significant development efforts already underway within the FAA to integrate the existing noise and emissions modeling tools including the Integrated Noise Model (INM), MAGENTA, Emissions and Dispersion Modeling System (EDMS), and the System for Assessing Global Aviation Emissions (SAGE). In aggregate, AEDT will take as input the detailed schedule and fleet information from the Partial Equilibrium Block, and provide as output the noise and emissions inventories both locally and globally. These outputs may be used directly with the costs from the Partial Equilibrium Block to form cost-effectiveness assessments, or can be passed to the Benefits Valuation Block to enable benefit-cost assessments.

c) The **Benefits Valuation Block** takes noise and emissions inventory information from the AEDT Block, demographic and socioeconomic data, and background concentrations of pollutants (e.g. from the US EPA), and estimates of changes in health and welfare endpoints for climate, local air quality and noise. To a large extent this is accomplished through reliance on external sources of information (e.g. concentration-response curves established by other agencies for relating pollutants to mortality and morbidity incidences). Changes in health and welfare are then monetized to enable benefit-cost analyses. The monetization would draw heavily on a wide range of published studies within the U.S. and Europe that have focused on this topic. The block should be developed starting from the existing capabilities of the MIT Multi-Attribute Impact Pathway Analysis tool (MAIPA), but be augmented to include components of the US EPA Environmental Benefits Mapping and Analysis Program (BenMAP).

d) The **General Economy Block** is currently envisioned as a simplified mechanism for including multiplier effects associated with indirect and induced costs in markets beyond the primary aviation markets. These multiplier effects would be specified exogenously and drawn from the literature and from external general equilibrium[6] models. However, future versions of APMT may consider a more complete integration of a general equilibrium model with the other components of APMT.

e) The **Analysis and Display Block** will collect the costs and benefits, provide assessments of propagated uncertainty, and allow cost-effectiveness and benefit-cost analyses. Depending on the

[6] General equilibrium analysis explicitly models relationships and feedback amongst industries that are related as suppliers and demanders of intermediate goods.

level of maturity of the modeling tools and the specific assessment scenario being studied, varying types of distributional analyses will be available. For example, for the cost-effectiveness analysis it will be possible to understand the effects of policy scenarios on broad geographical regions and primary market categories. For the benefit-cost assessments, it will be possible to consider a variety of categories of impacted populations consistent with the level of detail present within the census data.

3.3 To meet near-term and mid-term analysis needs, work is being initiated on all of these blocks. It is anticipated that the first version (years 1-3) of APMT will include the Partial Equilibrium Block, the AEDT Block, and the Analysis and Display Block, which will enable only cost-effectiveness analyses. APMT Version 2 will incorporate the Benefits Estimation Block providing a first capability for benefit-cost assessment. However, it is expected that due to present data availability, the Benefits Estimation will be limited initially to application within the U.S. (years 1-3) with expansion to other parts of the world enabled later through international partnerships (years 4-6) where data are available. APMT Version 3 will incorporate the General Equilibrium Block and improvements to the other model components (years 3-8).

4. APMT PROTOTYPE

4.1 The APMT Prototype Work Plan document[7] delineates all of the elements necessary for the analyses, as well as their roles and data requirements, and provides a schedule of APMT development activities. In addition, the document provides a brief discussion of the steps required to move beyond the APMT Prototype to APMT Versions 1 through 3, as described in the Architecture Study.

4.2 The APMT Prototype will help to identify gaps or weaknesses in the APMT architecture and stimulate advancements in development of APMT. Therefore, the objective of the prototyping effort is to construct all of the functional modules of APMT, although with more limited capabilities than planned for the final versions. This will enable testing of the functionality of APMT for addressing various policy questions. It will also facilitate assessing and propagating uncertainties from the module level to the APMT system level to guide the determination of high priority areas for future development and refinement.

4.3 The APMT Prototype work is organized around the development of several blocks and modules. An overview of their functions is provided below, and in more detail in the APMT Architecture Study document.

4.3.1 <u>Aviation Operations Generator Module</u> – Within the APMT Partial Equilibrium Block, the Aviation Operations Generator module will use the MAGENTA "forecasting processor" module to generate a future fleet mix. This element makes use of recent work with MAGENTA for AEDT, which makes the "forecasting processor" module independent. However, in order to capture the economic decisions involved in choosing a fleet, a replacement mechanism beyond that available in MAGENTA will be developed (as described below), and some changes to the "forecasting processor" module process will also be needed. The external mechanism should be able to capture a selection process among replacement aircraft with different operating costs (e.g. fuel burn, speed) and price characteristics, thus establishing a link to the Airline Operating Costs module. In order to reflect the fact that not all airlines may choose the same fleet replacement strategies, the "forecasting processor" module will have to be modified to allow for multiple

[7] The full document can be accessed at http://spacestation.mit.edu/partner (login=iaw, password=partnerweb).

replacement curves and aircraft replacement databases, each applying only to a subset of the fleet, divided by airline or airline type (e.g. major, start-up, regional). The user-defined substitutions currently allowed by MAGENTA will not fulfill this role since they are applied prior to the replacement/retirement process.

4.3.2 Fleet Selection – As described above, modifications made to the Aviation Operations Generator module will not be sufficient to capture the decision-making involved in the selection of one aircraft over another by an airline under different policy, market, and technology scenarios. Therefore, a fleet selection mechanism will be developed as part of APMT. The details of this mechanism have not yet been determined; during the first year, we will research various options and develop an initial fleet selection capability for implementation in the APMT Prototype. At the end of the first year, a detailed definition of the fleet selection module will be provided for future versions of APMT. Since forecasting of future demand is taken as an input in this phase of APMT development, caution will be exercised to ensure that the assumptions under which a scenario fleet is generated do not conflict with the assumptions used in the input demand forecasts. It is essential to ensure consistency between the Future Air Transport Demand module, the Aviation Operations Generator module, and the input forecasts from the CAEP Forecasting and Emissions Support Group (FESG).

4.3.3 Manufacturer Costs/Aircraft Prices Module – The Manufacturer Costs/Aircraft Prices module must provide the prices of all aircraft to be considered in the Aviation Operations Generator module and the Airline Operating Costs modules, including estimates of prices for new technology aircraft. It must also provide estimates of the impacts on manufacturer costs. Prototype activities will focus on the following: (1) establishing a regression-based price model using existing database information; (2) carrying out a sample problem; (3) using results from the sample problem to establish the required level of fidelity for the module and make recommendations regarding development in subsequent years.

4.3.4 Airline Operating Costs Module – The primary objective of the Airline Operating Costs module is to estimate *aircraft* operating costs and how they might change under different policy scenarios. However, *airline* operating costs in this section are referred to more broadly to because APMT must have the capability to estimate cost impacts under alternative future airline network, fleet, and operating environments. As air travel demand, competitive conditions, and fuel prices change, characteristics of the air transportation system can change dramatically, including fleet composition (e.g. aircraft sizes), network characteristics (e.g., hub-and-spoke vs. point-to-point flights) and airline operations (e.g., stage length and daily aircraft utilization). These airline-related characteristics should be captured by APMT, in addition to the actual impacts on aircraft operating costs of new policies, regulations, and/or technologies. The air travel demand forecasts and airline supply responses generated by the Aviation Operations Generator module of APMT provide input to both the Airline Operating Costs module and the AEDT Block. For the purposes of calculating airline operating costs, the detailed capabilities of AERO-MS, specifically the Aviation Operating Cost Model (ACOS) module, are closely suited to the requirements of APMT. The ACOS performs detailed calculations of airline operating costs under different scenarios. The airline operating costs framework used by ACOS is quite detailed and compatible with the cost categorization schemes in US DOT Form 41. AERO-MS combines these cost components into measures of variable operating cost per unit of capacity, and these measures can be reported by flight stage, aircraft type, aircraft function (e.g., passenger, freighter), and aircraft technology level. Airline operating cost results can also be reported by spatial definitions of up to 14 world regions, in line with IATA regional definitions. The AERO-MS ACOS module will be the reference for prototyping the APMT Airline Operating Costs module. With the concurrence of the AERO-MS Program Manager (Hans Pulles), members of the AERO-MS development team are being brought into the APMT development team to assist in the development of the APMT prototype.

4.3.5 Fares Assumptions Module – The prototype of the Fares Assumptions module will operate by adjusting fares to maintain an existing rate of return. That is, if costs are predicted to increase by a certain percentage, fares will rise by the same percentage to maintain a proportional relationship. This percent change in fares will then be passed to the Future Air Transport Demand module. Because the Future Air Transport Demand module requires the percent change in fares, no data on average fares are necessary. Additionally, no assumptions need to be made about the magnitude of the existing return; proportional adjustments will maintain the level of return. This functionality will represent a placeholder for a future fare capability that will be capable of differentiating across market characteristics (including, pending further development, drawing on differentiated elasticities in an expanded Future Air Transport Demand module). Simultaneous to beginning work on fares for the prototype, as described above, research will begin to refine the Fares Assumptions module to offer a more realistic approach that takes into account the nature of competition. This work will build on a literature review focusing on the nature of competition and fares. It is expected that a model will be made up of structural equations that depend on segment elasticities, cross-carrier elasticities, segment concentration, and other market characteristics that can be empirically estimated using econometric techniques.

4.3.6 Future Air Transport Demand Module – The function of the Future Air Transport Demand module is to provide adjustment to the levels or growth rates in the Aviation Operations Generator module that represent the demand response to rising or falling fares. The forecast uptake and processing will be handled in the Aviation Operations Generator module, which will be based on the MAGENTA capability for processing FESG forecasts. The most straightforward way to reflect demand response to fares for the prototype is to use a single mean-own-price demand elasticity estimate based on estimates from AERO-MS and from the literature. This elasticity estimate will then be multiplied by the predicted percent-change in average fares from the Fares Assumptions module, and the resulting percent-change in passengers will be uniformly applied to the Aviation Operations Generator module. This will be sufficient to demonstrate how to connect the modules in the Partial Equilibrium Block, although a future capability should differentiate elasticities by segment length and other characteristics and possibly use an elasticity distribution to reflect uncertainty. To be capable of connecting with the general equilibrium module, the module will need to contain other elasticities, including income elasticity of air travel demand, in order to track the feedback effects from the general economy through the aviation market. Alternatively, the general equilibrium feedback can be passed directly to the Aviation Operations Generator module.

4.3.7 Benefits Valuation Block – For the Benefits Valuation Block prototype existing MIT Multi-Attribute Impact Pathway Analysis (MAIPA) capabilities for estimating damage costs related to noise, air quality, and climate impacts will be amended to handle AEDT flight-by-flight movement data and inventories. Improvements to MAIPA databases will also be executed, including the addition of alternative airport-by-airport operational data generated for use with MAGENTA. This will allow a fully-functional, basic valuation methodology to be operational within the first six months after initiation of the work plan.

Two follow-on activities will run in parallel. The first of these activities is to assess the U.S. EPA's BenMAP as a replacement for the concentration-response-valuation capability in MAIPA used for air quality evaluations. Use of BenMAP, which is also used in many parts of the world outside the U.S. would improve APMT by allowing the evaluation of health impacts using the latest epidemiological research assessed by the U.S. EPA for use in policy analyses. The process for incorporating BenMAP will initially require a thorough comparison of MAIPA and BenMAP data sources, followed by an assessment of how BenMAP could be used to accept emissions inventories provided by AEDT (including prototype runs). At the same time we will be evaluating alternative sources and methods for monetization including work supported by the European Union under the ExternE and UNITE programs. The second activity is to assess the mechanics of producing 2-D surface exposure maps detailing pollutant concentrations and noise contours for each of the MAGENTA Shell-1 airports. Use of 2-D maps would enhance APMT by improving the fidelity of the population exposure estimate and would potentially allow the inclusion of a wider range of BenMAP functionality within the APMT architecture. Incorporating higher fidelity surface exposure maps would require that population and land use maps for each airport be developed using GIS capabilities, and that modifications be made to the current assumptions in MAIPA for estimating pollutant concentrations as functions of time and space. For emissions, these modifications would include implementing a dispersion model accounting for average winds and pollutant chemistry. EDMS is the desired model through which to develop pollutant maps. However, some modification/augmentation of methods currently used within EDMS will be required.

4.3.8 General Economy Block – As described in the APMT Requirements Document, initial development of the General Economy Block will consist of the application of simple multiplier effects. The most basic form this can take is the application of a single economy-wide multiplier, but drawing on a more detailed input-output framework will allow for a greater degree of distributional analysis without significantly greater difficulty in development. This approach will use the output of the Partial Equilibrium Block (the change in output of carriers and manufacturers measured in dollars) as its primary input. It will be tied to the Future Air Transport Demand module using income elasticities. The scale of this work is comparable to that of the prototype Future Air Transport Demand and Fares Assumptions modules in that it primarily consists of application of carefully researched parameters. Work in the first year will also include steps toward the identification and/or development of a computable general equilibrium model calibrated to match the FESG growth rates as closely as possible. Over time, maturity of the General Economy Block may depend on treating the other components as "nested" within the general equilibrium framework.

5. CAEP REVIEW

5.1 CAEP members are invited to comment on this effort by accessing the APMT document website at http://spacestation.mit.edu/partner (login=iaw, password=partnerweb) and following the instructions provided. CAEP is further invited to consider the proposed APMT process during its evaluation and approval of interdependencies tools.