



Model and Data Management Tool for the Air Force Structure Analysis Model – User Guide

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Abstract

MDMT was created to provide a user-friendly wrapper for various versions of the Air Force Structure Analysis (ASTRA) model. Its primary function is to keep track of the model versions along with all input data, output data and associated meta-data for the models and for each execution of the model. This user guide contains all necessary instructions for a user to import, develop and manage models and data within the MDMT construct.

Résumé

Nous avons créé l'outil MDMT (Model and Data Management Tool) afin d'offrir une enveloppe conviviale pour diverses versions du modèle ASTRA (Air Force Structure Analysis). La fonction principale de l'outil est de faire le suivi des versions du modèle ainsi que des données d'entrée et des métadonnées associées aux modèles et à chaque exécution du modèle. Le présent guide de l'utilisateur décrit comment importer, élaborer et gérer des modèles et des données dans le cadre du schéma MDMT.

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**MODEL AND DATA MANAGEMENT TOOL FOR THE AIR FORCE
STRUCTURE ANALYSIS MODEL
USER GUIDE**

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FOR

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1 INTRODUCTION

This document represents a final deliverable for a project entitled “Model and Data Management Tool (MDMT) for the Air Force Structure Analysis Model (ASTRA)”. This report was completed by CAE Inc. under Task #137 for contract #W7714-083663/001/SV to Defence Research and Development Canada (DRDC) Centre for Operational Research and Analysis (CORA).

1.1 Background

The Directorate of Air Staff Operational Research (DASOR) created a number of force structure models over the past decade, in the form of various instances of the ASTRA model. Most of these instances were fleet-specific models designed in the Microsoft Access database software with a Visual Basic for Applications front-end. These versions capture much useful information and data concerning the organization and state of the applicable fleet at the time that they were created. The disadvantages of this format are manifold, the primary issues relating to data management, software development methods and its limited scope and lack for future growth.

In an attempt to rectify this situation, DASOR developed a new generic prototype version of ASTRA in 2005-2006, dubbed ASTRA Mark II. It was developed in MATLAB/Simulink for the following reasons:

- MATLAB has well-developed data structuring and graphic presentation capabilities;
- A simple graphical user interface (GUI) could be created to facilitate data entry;
- Simulink provides a visual development environment, allowing most operations performed on the data to be represented as nested graphic objects. This enables the developer to understand the model holistically and to view the model details.; and
- Ranges and steps can be entered for all input variables and all possible combinations of the variables can be generated for brute-force processing in a single step.

This approach alleviated some problems experienced with the first version of ASTRA, but made little headway in dealing with the problems of poor maintainability, limited personnel scope and the need for separate models for each platform.

Ideally, ASTRA Mark III will deal with all deficiencies by becoming a comprehensive Air Force structure model development tool. The analyst will be able to specify the input

data and rules as he or she sees fit. The ASTRA MDMT will enable this by providing the ability to manage the data and model versions in a comprehensive way.

1.2 Objective

The overall project objective was to design and implement the desired database (DB) and modelling object management tools for ASTRA, including a DB for the management of input and output data to the ASTRA models, and a type of version control and execution tool for the ASTRA model objects. The objective of this task was to develop and document the MDMT User Guide.

The current design of the MDMT includes the following capabilities:

- Management of models;
- Generation and management of scenarios;
- Optimization and output analysis;
- Handling of version control of the models; and
- Integration of the database and database management GUI.

The main functional modules in the MDMT software include:

- Perform Analysis;
- Scenario;
- Develop Model;
- Input;
- Output;
- Input/Output (IO) Metadata;
- Compatibility; and
- Raw Tables.

1.3 Outline

This User Guide is structured according to the functional modules:

- Section 1 - Introduction: Summarizes the project background, project and task objectives and organization of this document.
- Section 2 - Installation and Configuration: Describes the requirements of external software tools or libraries, installation and configuration of the software system.
- Section 3 - Main GUI: Describes the primary user interface of the MDMT.
- Section 4 - Perform Analysis: Describes the operation of the “Perform Analysis” tab that enables the user to execute models in MATLAB.
- Section 5 – Scenario: Describes the scenario development and management.
- Section 6 - Develop Model: Illustrates the steps taken to develop models.
- Section 7 – Input: Describes input development,
- Section 8 – Output: Describes output development.
- Section 9 - IO Metadata: Summarizes the IO metadata development.
- Section 10 – Compatibility: Illustrates the compatibility of models and inputs.
- Section 11 - Raw Tables: Shows the database tables.
- Section 12 – References: Provides reference links to all the external software components used in the MDMT.
- Section 13 – List of Acronyms and Abbreviations: Provides a definition to all acronyms and abbreviations used within this document.

2 INSTALLATION AND CONFIGURATION

This section describes the requirements of external software tools or libraries, installation and configuration of the MDMT software system.

2.1 Requirements of External Software Tools or Libraries

To build or run the MDMT software system, the following software tools or libraries on Windows XP/7 were required:

- Java: JRE 1.6 and up (Oracle, 2013);
- MySQL Server 5.6.10 (MySQL, 2013a);
- MySQL Workbench (5.2) (MySQL, 2013b);
- MATLAB R2012b (Mathworks, 2013);
- Simulink 8.0 (Mathworks, 2013);

2.2 Installation and Configuration

The installation instructions are described below:

1. Create the folders C:\mdmt\ C:\mdmt\model\ and C:\mdmt\output\
2. Put library\ and io_metadata\ into c:\mdmt\
3. Install MySQL Server
 - a. Download and install MySQL Server;
 - b. Set the root password as "foobarbaz";
 - c. Use port 3306;
 - d. For a development machine, it is recommended setting the service to manually start using the "mysqld -u -root -p" command with a Windows command prompt; and
4. Open the program "MySQL Workbench"
 - a. Download and install MySQL Workbench;
 - b. Execute create.sql:

- In the menu bar in MySQL Workbench, click the “Database” menu and select the “Query Database” menu item;
- Hit OK to the “Connect to Database” prompt;
- Hit File, Open SQL Script, create.sql in MDMT installation folder; and
- Click on the lightning bolt to execute the script.

5. Put config.xml into the home directory:

- On Windows XP, it is C:\Documents and Settings\UserName, and on Windows 7, it is C:\Users\UserName.

6. Double click on C:\mdmt\bin\MDMT2.jar.

Below are notes for programmers only:

7. Install Netbeans (NetBeans, 2013):

- a. Instruct it to add JUnit4 (JUnit, 2013) by right-clicking the “Libraries” in the Navigation Pane in NetBeans, selecting the “Add JAR/Folder...” popup menu item and then selecting the downloaded JUnit4 library.

8. Add the source code into NetBeans:

- a. Move the MDMT2 folder to the NetBeansProjects directory; and
- b. JAR files such as MATLABControl (Matlabcontrol, 2013), and Apache’s FileUnits (Apache, 2013) may need to be configured by right-clicking the “Libraries” in the Navigation Pane in NetBeans, selecting the “Add JAR/Folder...” popup menu item and then selecting the downloaded libraries.

9. Run the project:

- a. In NetBeans, select the project and hit F6; and
- b. In the main screen, select a model and input then hit “Execute”. This should invoke MATLAB and create a scenario (see the tables within resources) as well as output (see C:\mdmt\output\).

3 MAIN GUI

Figure 3-1 shows the main GUI of the MDMT software, which consists of the following functional module tabs:

- Perform Analysis;
- Scenario;
- Develop Model;
- Input;
- Output;
- IO Metadata;
- Compatibility; and
- Raw Tables.

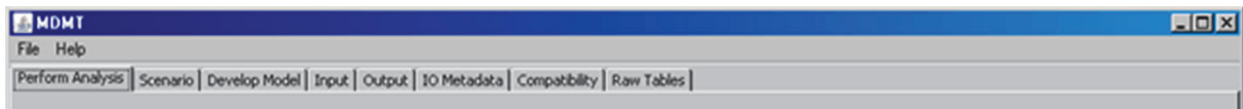


Figure 3-1: Main GUI of MDMT Software

Each module tab in the main GUI provides a group of visual components to perform relevant functionality.

Section 4 through Section 11 describes the steps to use these functional module tabs.

3.1 User Warning

WARNING: USERS OF THE MDMT MUST EXERCISE CAUTION WHEN EDITING DATA FIELDS IN THE SYSTEM'S FUNCTION TABS.

THE CHANGES ARE COMMITTED TO THE DATABASE INSTANTANEOUSLY. THERE IS NO UNDO BUTTON.

4 PERFORM ANALYSIS

The “Perform Analysis” tab (Figure 4-1) provides the functionality required for tasks related to user models, such as running and deploying models. The main functions completed within this tab include displaying, executing and deploying models.

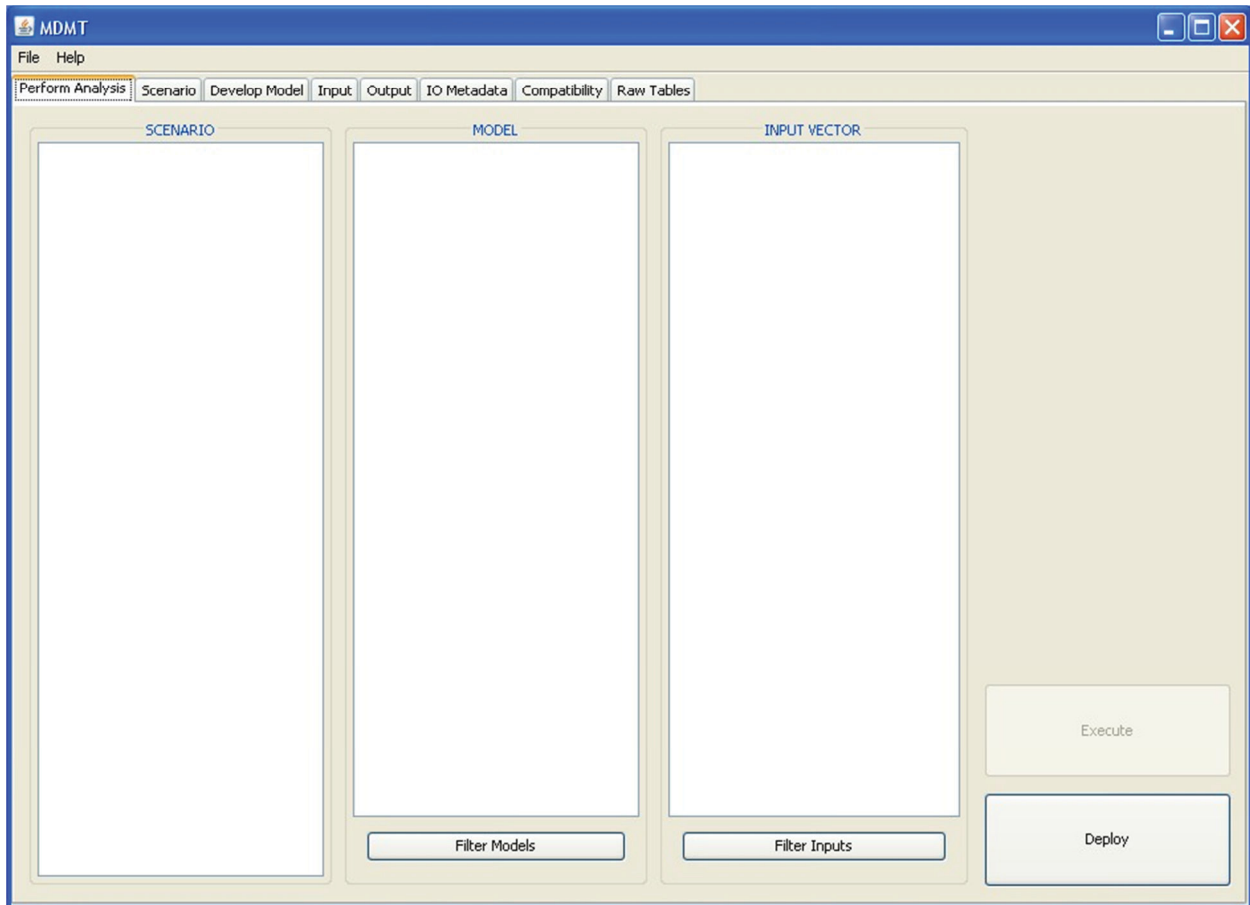


Figure 4-1: Perform Analysis Tab

4.1 Display Scenarios, Models and Inputs

When a user clicks the “Perform Analysis” tab, the system retrieves the database for all models, scenarios and compatible inputs, and displays them in the three lists.

The “Filter Models” and “Filter Inputs” buttons are a convenience option that will show only the compatible models/inputs. If the “Filter Inputs” button is clicked, when the user selects a model, only those inputs deemed compatible will be shown.

4.2 Execute a Model

When a user selects a model from the “Model” list and relevant inputs from the “Input Vector”, and then clicks the “Execute” button, the system starts a MATLAB instance to execute the model. The output of the execution is stored on the file system, connected to the DB in the output table that is in turn connected to the scenario.

4.3 Deploy a Model

If the user clicks the “Deploy” button, the model or input, or both, are passed into the MATLAB workspace. The “Deploy” injects the model or input (or both) into MATLAB, but it does not execute the model (making it a development mode).

5 SCENARIO

The Scenario tab, as shown in Figure 5-1, can be used to classify previous executions by renaming them or by adding notes. Displaying scenario files and exporting a scenario are the main functions completed in this tab.

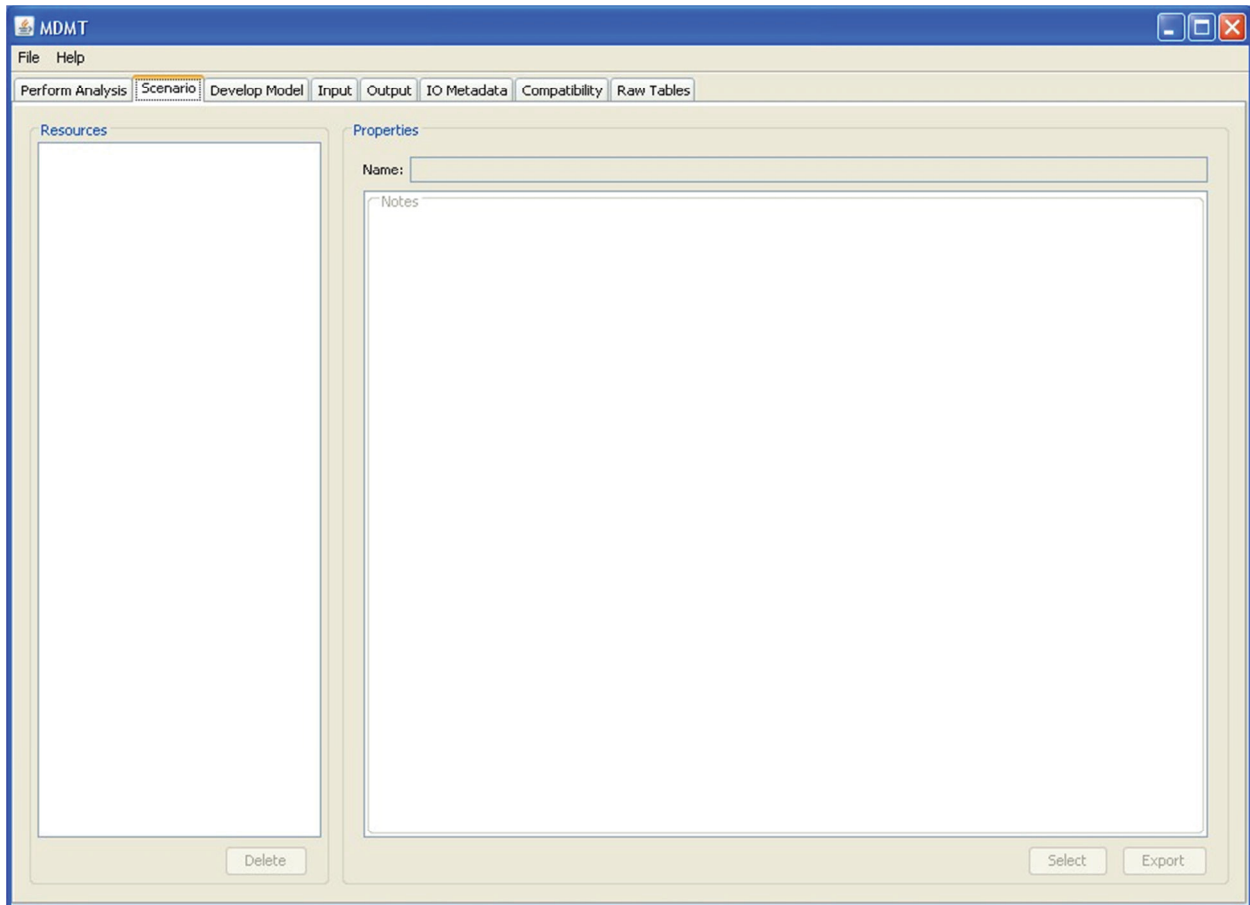


Figure 5-1: Scenario Tab

5.1 Display Scenario Files

If a user clicks the "Scenario" tab, all scenarios are displayed in the "Resources" pane.

If a user selects a scenario in the "Resources" pane, and then clicks the "Select" button in this tab, all relevant models, inputs and outputs in the "Perform Analysis", "Input", "Develop Model" and "Output" tabs are selected.

5.2 Export a Scenario

If a user clicks the “Export” button, all the files associated with the scenario are extracted to a location of the user’s choice.

5.3 Delete a Scenario

If a user selects a scenario in the “Resources” pane, and then clicks the “Delete” button under the “Resources” pane, the selected scenario is deleted.

6 DEVELOP MODEL

The “Develop Model” tab, as illustrated in Figure 6-1, is used to create, organize and manage model entries. However, the actual models need to be developed in MATLAB/Simulink, which consists of Simulink files (*.mdl”), MATLAB script files (*.m) and MATLAB data files (*.mat).

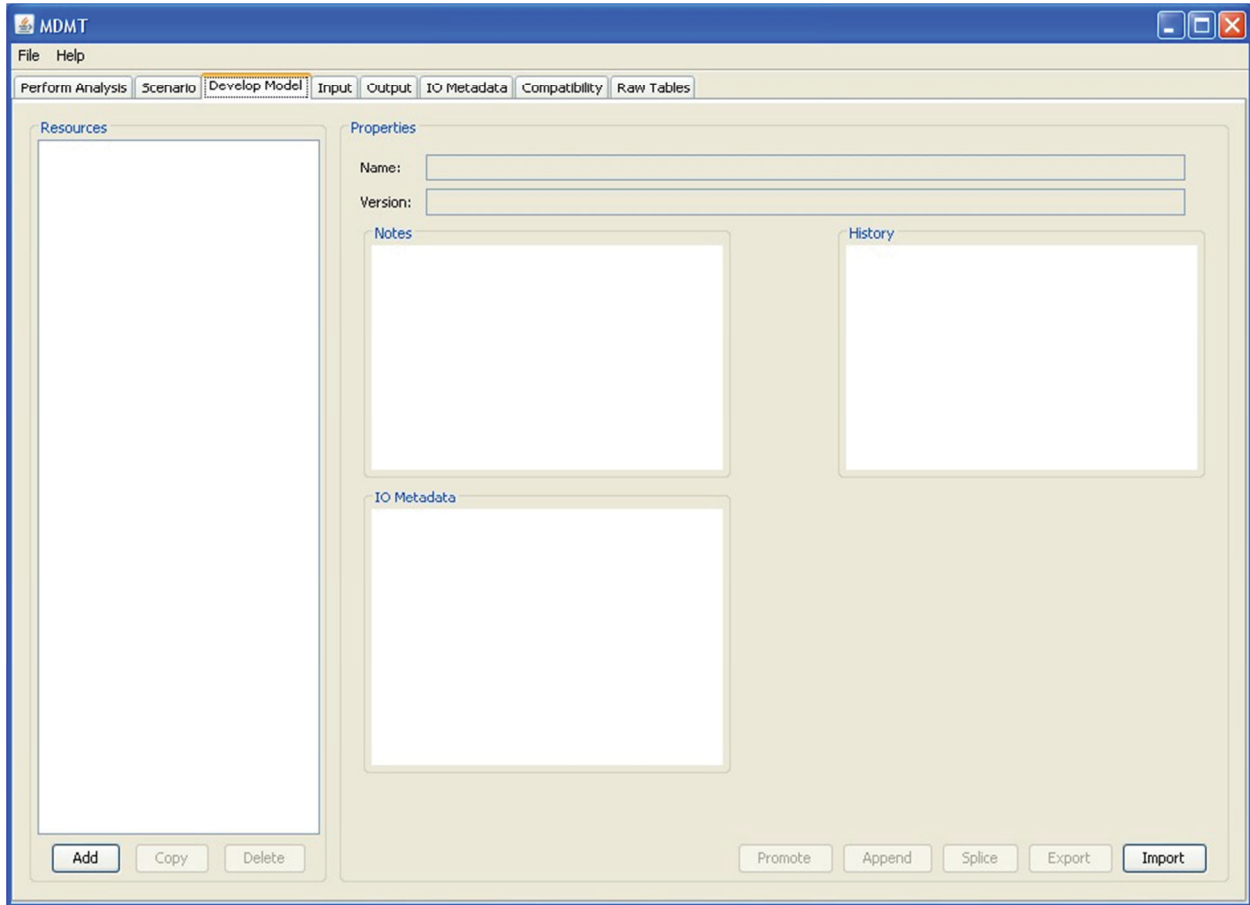


Figure 6-1: Develop Model Tab

6.1 Create a New Model

If a user clicks the “Add” button under the “Resources” pane without any attribute, the system creates a new model (which is blank); the user may then set attribute values to the model with the attribute fields or areas on the right side of the GUI. The new model is added to the DB.

Another option is to type the attribute values in the “Name”, “Version”, “Notes”, “History” and “IO Metadata” fields and click the “Add” button, the system creates a model entry with the attribute values and then adds it to the DB.

6.2 Copy a Model

If a user selects a model from the “Resources” list and clicks the “Copy” button, a copied model entry is created and added to the DB.

6.3 Delete a Model

If a user selects a model from “Resources” list and clicks the “Delete” button, the model entry and relevant files are deleted from the DB.

6.4 Promote a Model

By default, a model is only visible to an MDMT developer. When the developer hits the “Promote” button, the model is then visible to the MDMT user. Once clicked, the button’s text changes to “Demote” which inverses the procedure.

6.5 Append Files to a Model

When a model is initially created, its associated zip file is an empty file. A user may use the “Append” button to append files to the existing zip file.

6.6 Splice

If a user clicks the “Splice” button, a file can be removed from the model.

6.7 Export a Model

When a user clicks the “Export” button, the model can be exported as a zip file.

6.8 Import a Model

When a user clicks the “Import” button, files can be assigned to the model selected. If a model is selected, this command overwrites the zip file. However, if a model is not selected, the system creates a new model and links it to a specified zip file.

7 INPUT

The functionality of the “Input” tab, as shown in Figure 7-1, is very similar to the “Develop Model” tab.

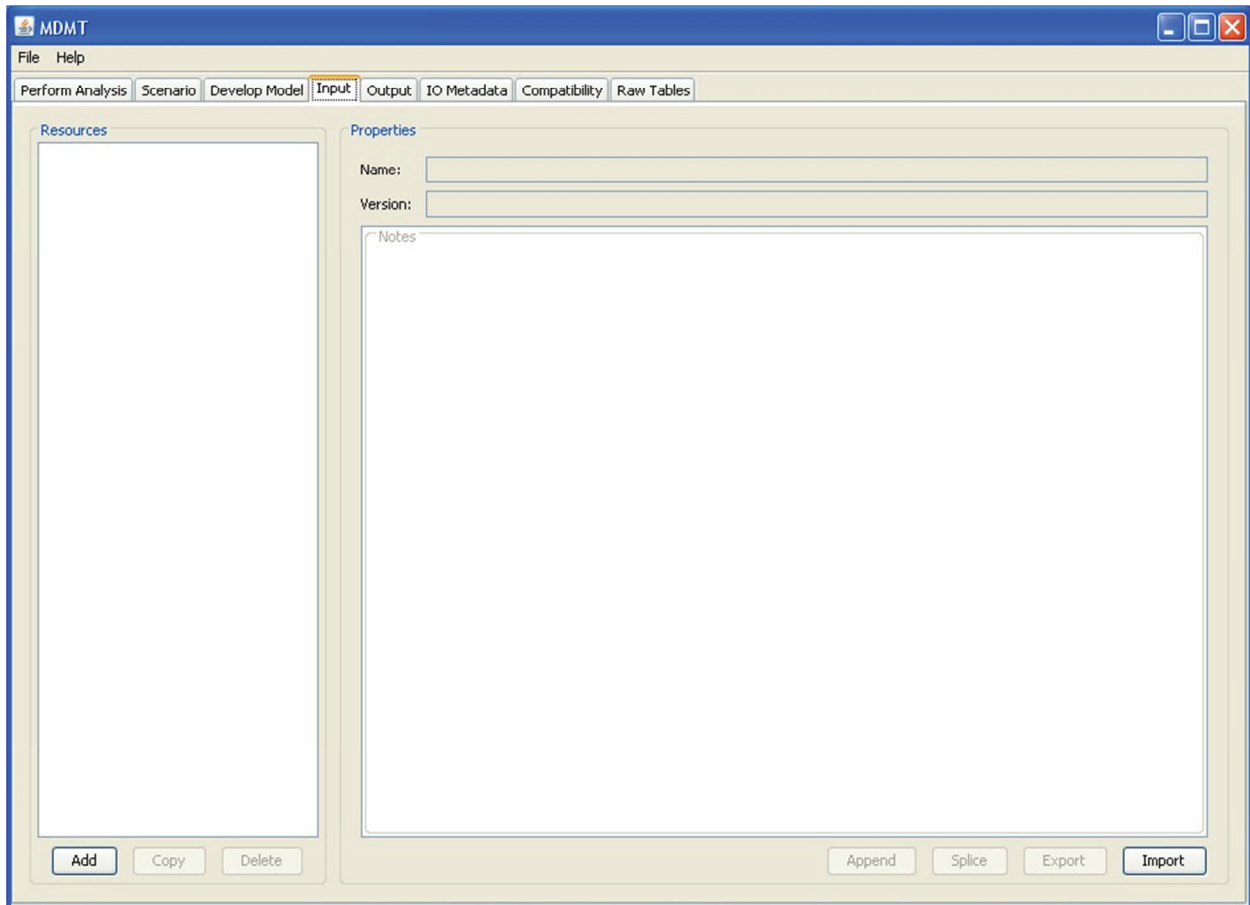


Figure 7-1: Input Tab

7.1 Create an Input

If a user clicks the “Add” button under “Resources” without any attribute, the system creates a new input (which is blank); the user may then set attribute values to the input with the attribute fields or areas on the right side of the GUI. The new input is added to the DB.

Another option is to type the attribute values for the “Name”, “Version”, “Notes” fields, and click the “Add” button; the system creates an input entry with the attribute values and then adds it to the DB.

7.2 Copy an Input

If a user selects a resource from the “Resources” list and clicks the “Copy” button, a copied input entry is created and added to the DB.

7.3 Delete an Input

If a user selects a resource from the “Resources” list and clicks the “Delete” button, the input entry and relevant files are deleted from the DB.

7.4 Append Files to an Input

When an input is initially created, its associated zip file is an empty file. The user may use the “Append” button to append files to the existing zip file.

7.5 Splice

If a user clicks the “Splice” button, a file is removed from the input.

7.6 Export an Input

When a user clicks the “Export” button, the input is exported as a zip file.

7.7 Import an Input

When a user clicks the “Import” button, files can be assigned to the input selected. If an input is selected, this command overwrites the zip file. However, if an input is not selected, the system creates a new input and links it to a specified zip file.

8 OUTPUT

An output is the result data created by a model execution. The “Output” tab, as shown in Figure 8-1, is used to organize and manage outputs of model execution.

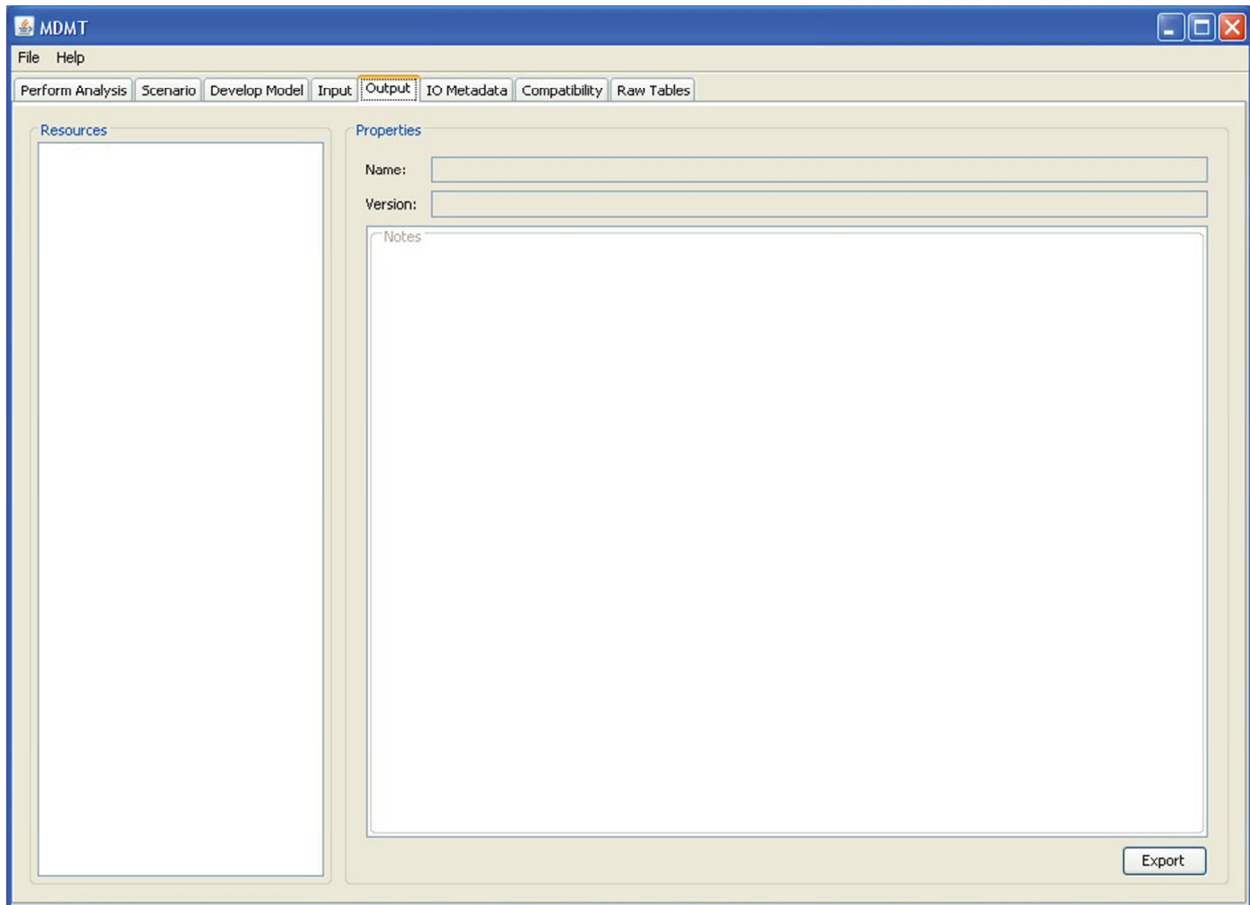


Figure 8-1: Output Tab

8.1 Display Output Resources

When a user clicks the “Output” tab, the system retrieves all model entries in the DB and displays them in the “Output Resources” list.

8.2 Edit Output

When a user selects a resource from the “Output Resources” list, its Name, Version, Path and Notes are displayed in appropriate fields.

8.3 Export Output

When a user selects a resource from the “Output Resources” list and clicks the “Export” button, the system exports the output of a scenario (*.mat and possibly *.csv files) as a zip file.

9 IO METADATA

IO Metadata is used to define the interface of the MATLAB model files with the scenario and input parameters, as shown in Figure 9-1.

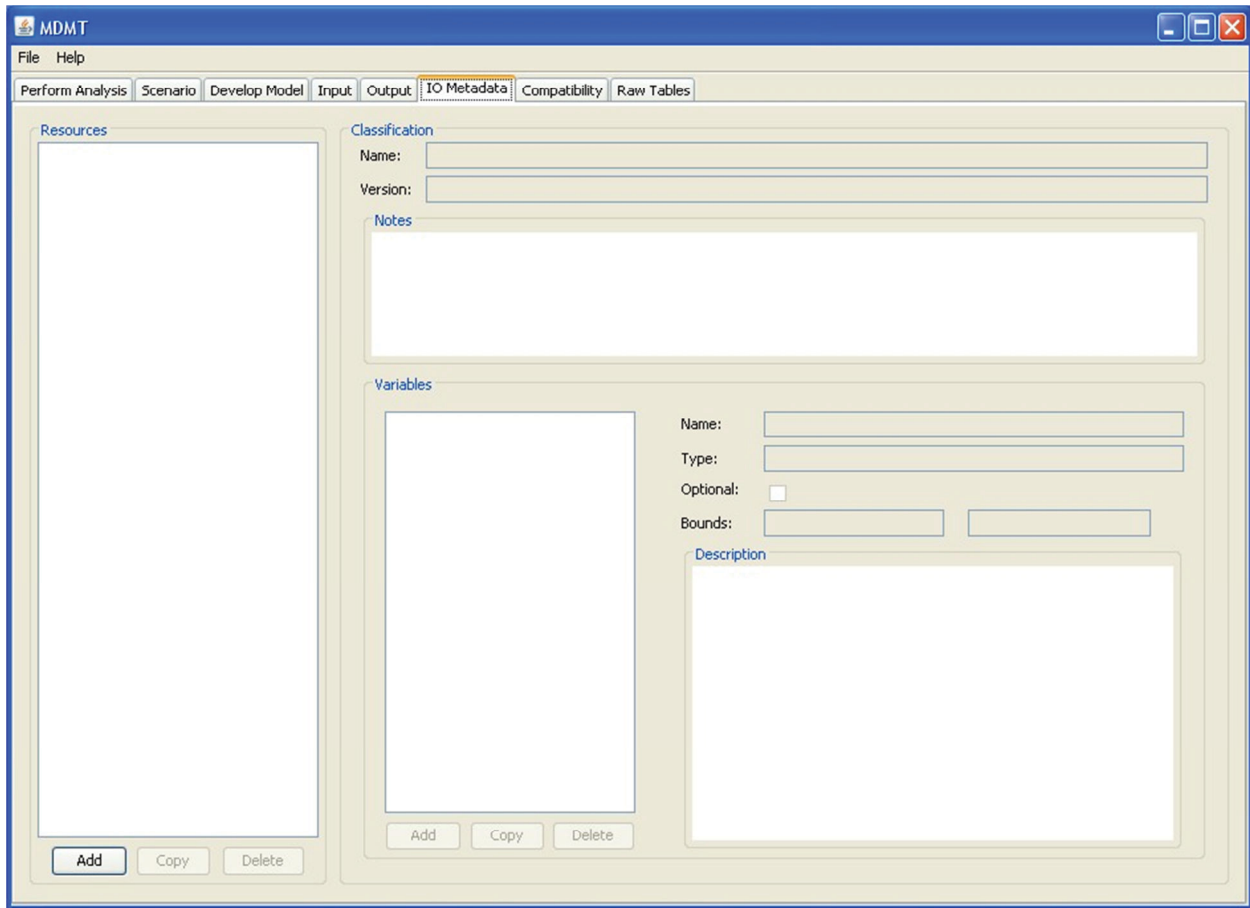


Figure 9-1: IO Metadata Tab

9.1 Display all IO Metadata

When a user clicks the “IO Metadata” tab, the system retrieves all IO Metadata entries in the DB and displays them in a list under “Resources”.

9.2 Create IO metadata

A user may type attribute values of an IO Metadata entry in the Classification fields. When the user clicks the “Add” button under the “Resources” list, a new IO metadata entry is created and stored in the DB.

9.3 Copy IO Metadata

When a user selects an IO metadata entry under the “Resources” list and clicks the “Copy” button, a copied IO Metadata entry is created and stored in the DB.

9.4 Delete IO Metadata

When a user selects an IO metadata entry under the “Resources” list and clicks the “Delete” button, the selected IO Metadata entry is deleted from the DB.

9.5 Add a Variable to IO Metadata

When a user clicks the “Add” button under the “Variables” list, a new variable is created and added to the IO Metadata.

9.6 Copy a Variable in IO Metadata

When a user selects a variable in the “Variables” list and clicks the “Copy” button under the “Variables” list, a copied variable is created and added to the IO Metadata.

9.7 Delete a Variable from IO Metadata

When a user selects a variable in the “Variables” list and clicks the “Delete” button under the “Variables” list, the selected variable is deleted from the IO Metadata.

10 COMPATIBILITY

Compatibility is used to assign compatibility and confirm if a model and an input are compatible, as shown in Figure 10-1.

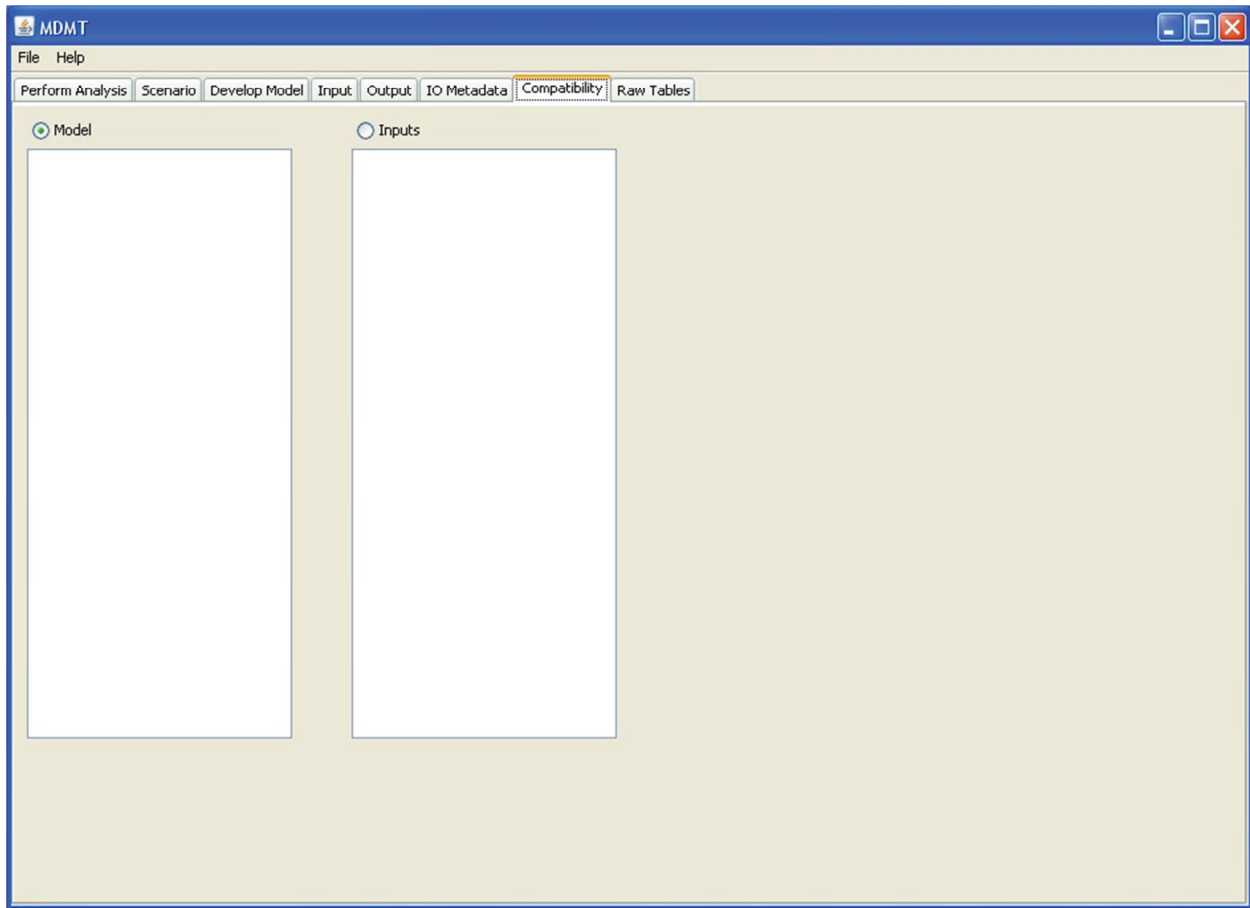


Figure 10-1: Compatibility Tab

10.1 Assign Compatibility

If a user selects a model from the model column, the compatible inputs in the input column can be assigned or de-assigned by selecting/de-selecting the items in the input column.

Similarly, if a user selects an input from the input column, the compatible models in the model column can be assigned or de-assigned by selecting/de-selecting the items in the model column.

10.2 Display Compatible Inputs for a Model

If the “Model” radio button is checked and a model is selected, all the inputs compatible with the selected model are highlighted.

10.3 Display Compatible models for an Input

If the “Inputs” radio button is checked and an input is selected, all the models compatible with the selected input are highlighted.

11 RAW TABLES

The “Raw Tables” tab, as shown in Figure 11-1, shows all the tables in the DB. A user can read and write the data shown. The tables can be modified directly by clicking in the data fields and overtyping the contents.

WARNING: CHANGES TO THE DATABASE TABLES ARE EFFECTIVE IMMEDIATELY UPON ENTRY. THERE IS NO “UNDO” FUNCTIONALITY.

THE MDMT USERS SHOULD EXERCISE CAUTION WHEN MAKING CHANGES USING THE RAW TABLES TAB.

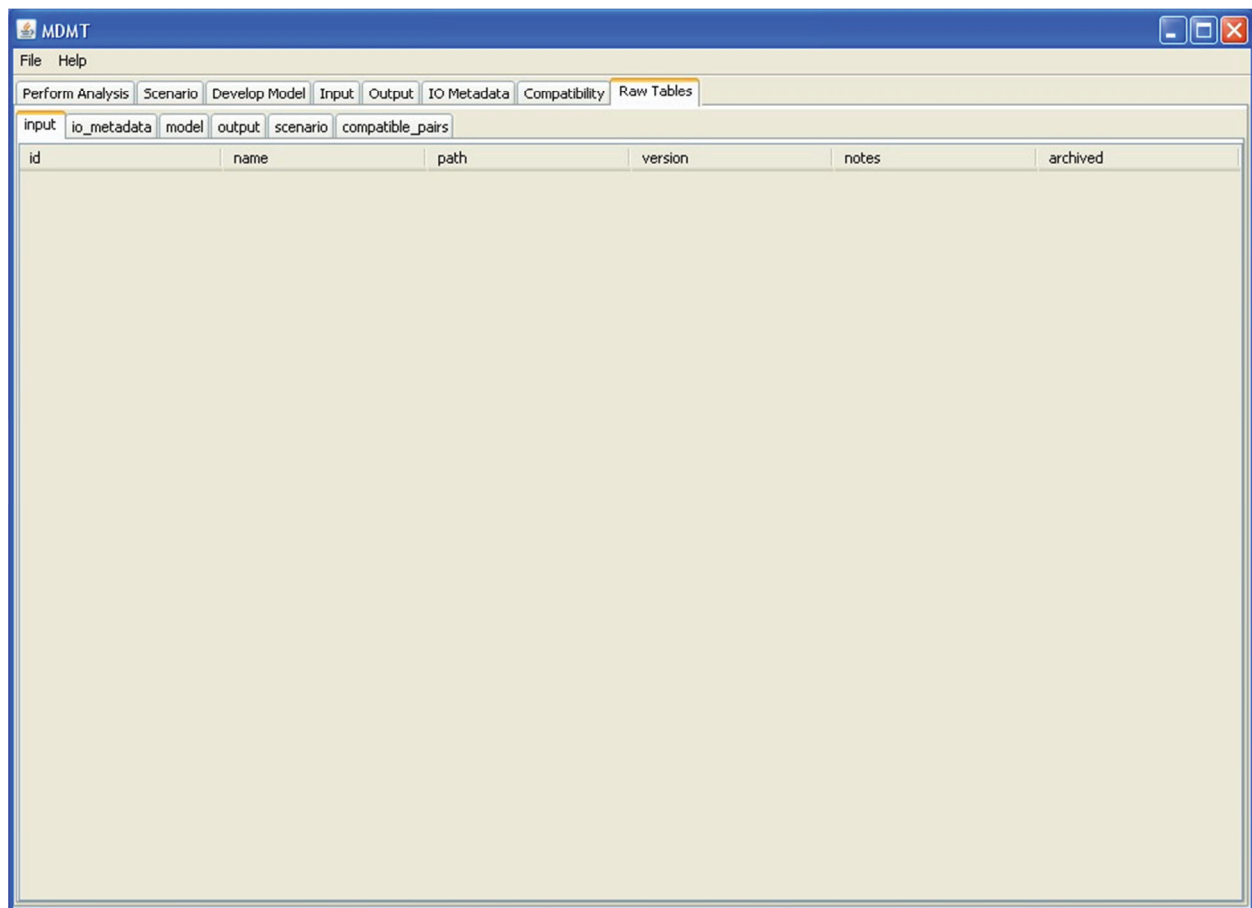


Figure 11-1: Raw Tables Tab

11.1 Load Database Tables

If a user clicks the “Raw Tables” tab, the system retrieves all tables in the DB, including the input, io_metadata, model, output, scenario, and compatible_pairs tables, and loads all rows in each table.

11.2 Display a Database Table

When a user clicks a sub-tab associated with a DB table, all records of the DB table are displayed. The user is able to read and write the data shown.

12 REFERENCES

The references used to guide this work include:

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13 LIST OF ACRONYMS AND ABBREVIATIONS

A list of acronyms and abbreviations used in this report include:

Acronym and Abbreviation	Definition
ASTRA	Air Force Structure Analysis
CORA	Centre for Operational Research and Analysis
CSV	Comma Separated Value
DASOR	Directorate of Air Staff Operational Research
DB	Database
DRDC	Defence Research and Development Canada
GUI	Graphic User Interface
IO	Input/Output
JAR	Java Archive
MDMT	Model and Data Management Tool

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MDMT was created to provide a user-friendly wrapper for various versions of the Air Force Structure Analysis (ASTRA) model. Its primary function is to keep track of the model versions along with all input data, output data and associated meta-data for the models and for each execution of the model. This user guide contains all necessary instructions for a user to import, develop and manage models and data within the MDMT construct.

Nous avons créé l'outil MDMT (Model and Data Management Tool) afin d'offrir une enveloppe conviviale pour diverses versions du modèle ASTRA (Air Force Structure Analysis). La fonction principale de l'outil est de faire le suivi des versions du modèle ainsi que des données d'entrée et des métadonnées associées aux modèles et à chaque exécution du modèle. Le présent guide de l'utilisateur décrit comment importer, élaborer et gérer des modèles et des données dans le cadre du schéma MDMT.

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