Employing Exploratory Techniques with Travel Forecasting Models

Travel Model Improvement Program Exploratory Modeling and Analysis Tool (TMIP-EMAT)

U.S.Department of Transportation
Federal Highway Administration

TMIP
Better Methods. Better Outcomes.

TMIP-EMAT Benefits

Traditionally, travel forecasting models have been used to provide single point predictions, usually ignoring the deep uncertainty that exists in future land use, demographic, and transportation systems inputs. TMIP-EMAT can be integrated with existing travel modeling tools to facilitate the application of those models in an exploratory, rather than predictive, manner.

TMIP-EMAT can assist MPOs in conducting DMDU analysis. TMIP-EMAT is built to provide insight into the relationships between policy levers, uncertainties, and performance measures. TMIP-EMAT not only provides interactive tools to stakeholders, but also allows analysts to explore and vet ideas on their own and discussing key relationships and tradeoffs of different decision pathways. It can be used for some of the following applications:

- Understand the effects of future mobility impacts on travel patterns
- Incorporate exploratory-type visualizers and optimization search tools to present and analyze the results
- Produce results for performing risk analysis and exploratory analysis
- Serve as a utility tool that enables an analyst to use the region's transportation model for exploratory analyses

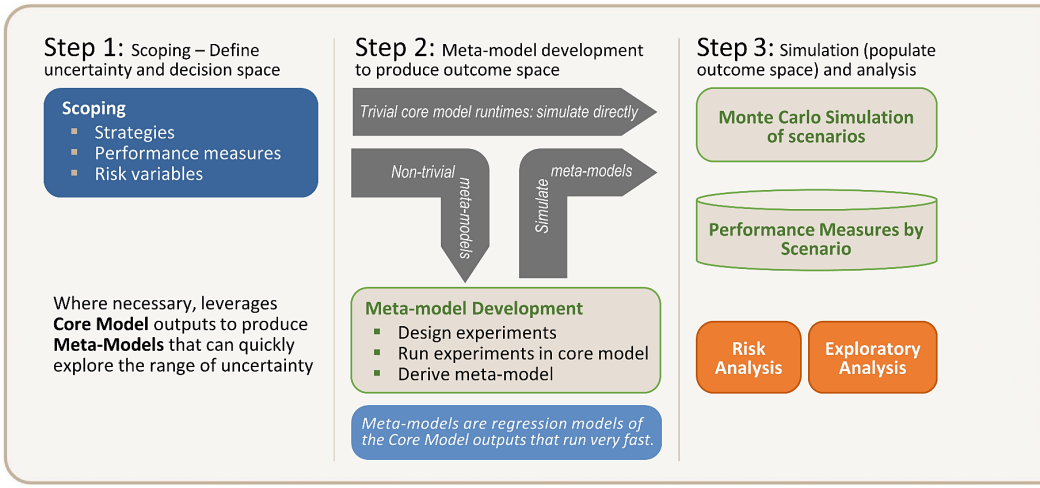
TMIP-EMAT can be a valuable tool for proactive, iterative, continuous, and comprehensive transportation planning, especially under the conditions of deep uncertainty. It is a tool that planning agencies can use to facilitate community engagement and visioning process, and enable effective communication among technical analysts, planners, various stakeholders and decisionmakers. With appropriate robust core models from the users, TMIP-EMAT empowers communities to conduct a much broader question-driven exploration, leading to decisions that are robust in a wide range of futures at a time when planners must deal with deep uncertainty.

TMIP-EMAT Features

TMIP-EMAT employs a methodological approach to exploratory modeling and analysis. It provides a window to rigorous analytical methods for handling uncertainty and making well informed decisions using travel forecasting models of all types. It is designed to integrate with an existing transportation model or tool to perform exploratory analysis of a range of possible scenarios. TMIP-EMAT provides the following features to enhance the functionality of the underlying core model (Figure 1):

- A structure to formalize and distill an exploratory **scope** to define uncertainty and decision space in a concrete, application-specific form.
- A systematic process for **designing experiments** to be evaluated using the core model, and support for running those experiments in an automated fashion.
- A **database** structure to organize and store the results from a large number of experiments.

Figure 1: Diagram. Travel Model Improvement Program – Exploratory Modeling and Analysis Tool Process Flow.



Source: Federal Highway Administration

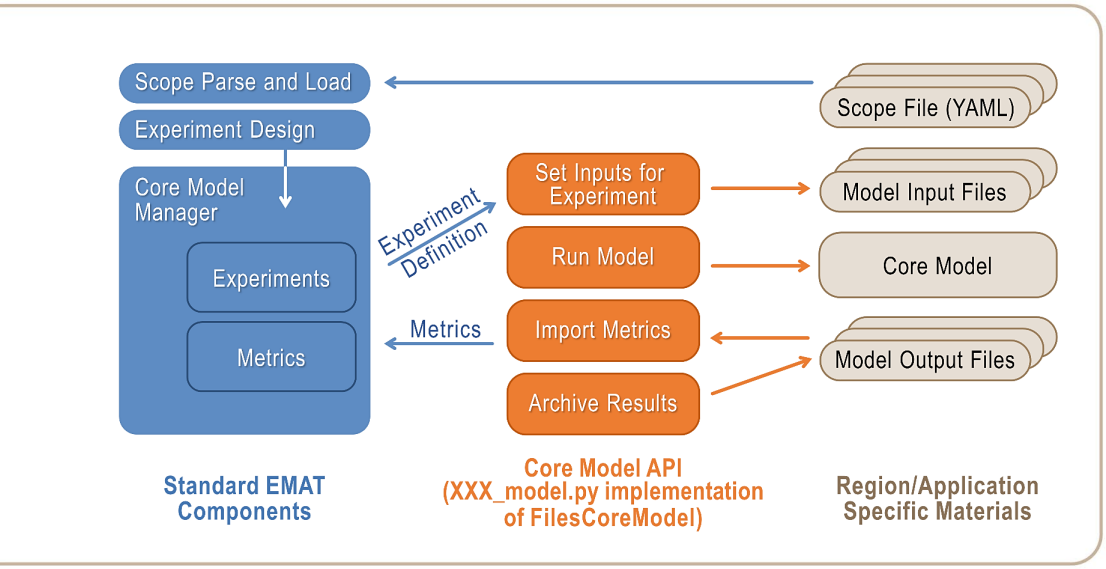
- A facility to automatically create a **metamodel** from experimental results, which uses machine learning techniques to rapidly approximate new outputs of the core model.
- A suite of **analytical and visualization tools** to explore the relationships between modeled inputs and outputs and develop robust policy strategies that might be effective across a range of possible future scenarios.

TMIP-EMAT Workflow and Core Components

To utilize TMIP-EMAT, users will need to bring their own core model, defined as any application or region-specific transportation model that can project future values of factors (e.g., VMT, trips, emissions, access, cost of travel, etc.) of particular interest to the user and estimate how policy actions might affect those factors.

In Figure 2, an outline of a workflow for TMIP-EMAT includes core components, API, and application specific materials. Once the core model has been linked to TMIP-EMAT, a typical application would then run the core model over an experimental design of multiple cases to generate the meta-model.

Figure 2: TMIP-EMAT Workflows.



Source: FHWA. TMIP-EMAT Workflow: Experiment Design and Core Model Runs

The user would then generate a much larger experimental design over the meta-model and store the results in the database. The user could then employ TMIP-EMAT visualization, scenario discovery, and other sensitivity analysis tools to explore the robustness of the MPOs plans, the uncertainties to which the plan is most sensitive, and how the MPO might adjust their plans to make them more robust.

TMIP-EMAT Resources

For an introduction to the concepts and tools, installation, troubleshooting and other resources, visit https://tmip-emat.github.io.

The full report on TMIP-EMAT is available at https://www.fhwa.dot.gov/planning/tmip/publications/other_reports/uncertainty_travel_forecasting/.

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