USING TWOPAS SIMULATION MODEL TO PROVIDE DESIGN AND OPERATIONS INFORMATION ON THE PERFORMANCE OF IDAHO'S TWO-LANE HIGHWAYS

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Michael P. Dixon

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INTRODUCTION TO TWOPAS

Two-lane rural highways are the predominant highway facility in the state of Idaho and ITD has given much attention in recent years to improving the operations and safety of these highways. Some of the design options that have been considered for these facilities are the introduction of passing lanes, improvement of sight distance, and roadway re-alignment. Software packages are available for evaluating these different design alternatives. In the past ITD has occasionally used a software package called TWOPAS to analyze these design options, but currently, ITD has limited capability in using the TWOPAS software because of the time required to learn the program. Furthermore, recent changes in the program have rendered obsolete some of the experience that ITD has with TWOPAS.

In this document, the first chapter describes the purpose of the model, its history, the program structure, and the model capabilities and limitations. The second chapter describes the input process beginning with the overall organization of the data in terms of time and location, then a description of the input data, and finally an overview of the user interface. The third chapter describes the output data that are available as well as the methods for accessing and outputting the data with particular emphasis given to the new user interface. Next, three test projects are presented in chapter four. As data is input, comments are provided to clarify the selection of model options in TWOPAS. Screen shots are included to give the reader a frame of reference and resulting values are pointed out at regular intervals so the reader can assure themselves that they are following the example correctly. In chapter five, a sensitivity analysis of common design variables related to two lane highways is presented. Variables included in this analysis are traffic volumes, horizontal curvature, passing lane length, shoulder width, lane width, and grade. In chapter six, comparisons of Highway Capacity Manual procedure results to specific TWOPAS results are made to illustrate commonalities and inconsistencies between the two methods. Finally, the seventh chapter summarizes the work, giving emphasis to areas of particular concern when using the model.

Purpose of the model

The TWOPAS simulation model is used to provide design and operations information regarding the performance of two-lane rural highways. The traffic flows on two-lane two-way rural highways are affected by different variables such as highway geometry, traffic control, the traffic characteristics, and the driver population. However, field data collection is expensive, nearly always incomplete relative to some measures of effectiveness (i.e., speed, delay, etc.) and there is no opportunity to examine the traffic operational effects of systematic variations in traffic control, geometry, flow rates, and vehicle characteristics.

An attractive support for field data is modeling traffic operations given the prevailing conditions of the roadway being analyzed. An analytic simulation model that contains a realistic account of highway geometry, traffic control, traffic characteristics, and driver behavior can be used to study the impact of these variables on traffic operations and this is the purpose of TWOPAS.

History

The TWOPAS model is a microscopic computer simulation model of traffic on two-lane highways. The predecessor of TWOPAS was originally developed by Midwest Research Institute (MRI) between 1971 and 1974 as a part of the NCHRP Project 3-19, "Grade Effects on Traffic Flow Stability and Capacity" [1]. The model was initially known as TWOWAF (TWO Way Flow) and was improved by MRI in 1981 in an FHWA study entitled, "Implications of Light-Weight, Low-Powered Vehicles in the Traffic Stream" [2]. Then, in 1983, the Texas transportation Institute (TTI) and KLD and Associates made further updates to TWOWAF, which resulted in the version of the model that was used in the development of 1985 Highway Capacity Manual (HCM) [3]. TWOWAF had the capability to simulate traffic operations on normal two-lane highways, including both passing and no-passing zones, as well as the effects of horizontal curves, grades, vertical curves and sight distance. Subsequent to the publication of the 1985 HCM, MRI developed the TWOPAS model by adding to TWOWAF the capability to simulate passing lanes, climbing lanes, and short-four-lane sections on two-lane highways.

Program structure

TWOPAS was originally developed on a mainframe computer and this original version of TWOPAS is not user friendly. An improved interface was needed to increase the user friendliness of TWOPAS and to allow it to be used effectively in the PC environment.

UCBRURAL Interface
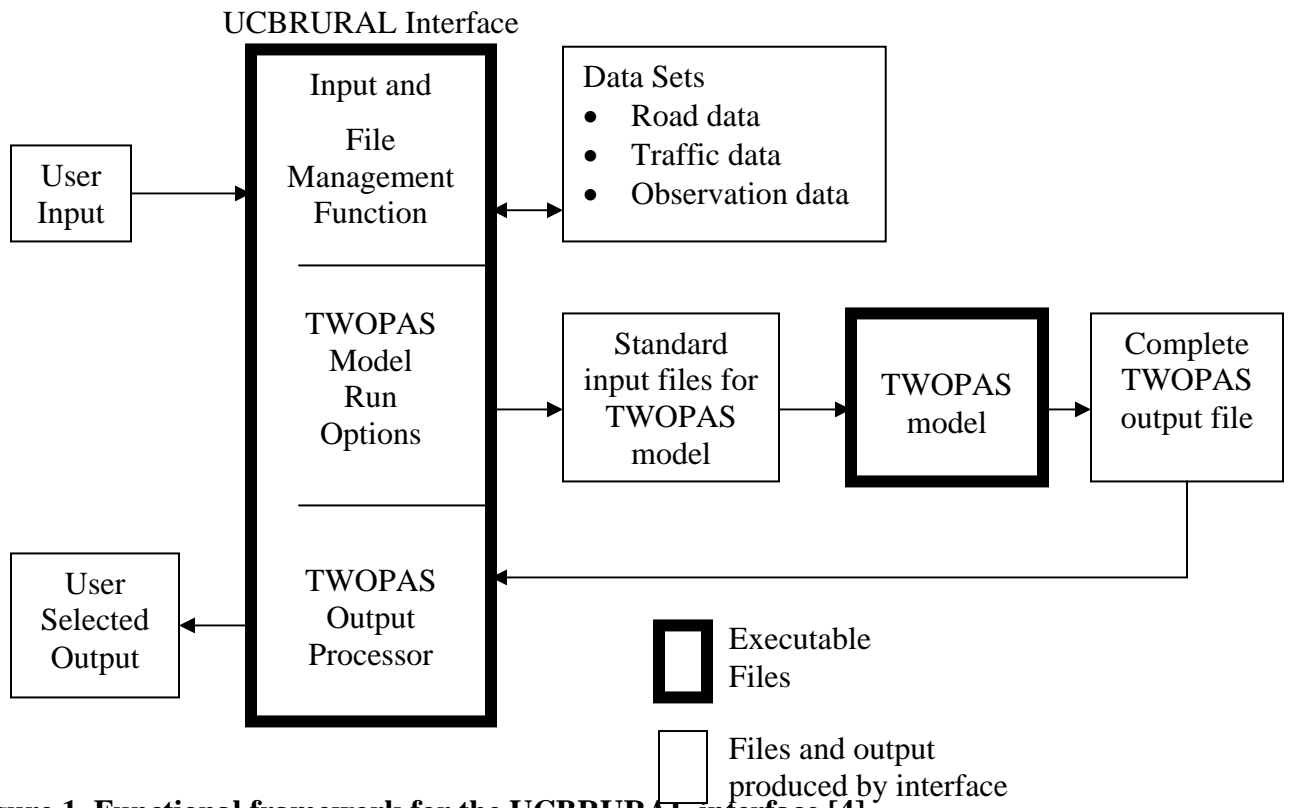
Figure 1. Functional framework for the UCBRURAL interface [4]

In the recent work for the California Department of Transportation, the Institute of Transportation Studies (ITS) at the University of California-Berkeley (UCB) has developed a user interface, known as UCBRURAL, for use with the TWOPAS model. The interface allows the user to input all data in a user-friendly manner and the functional framework of the interface is shown in Figure 1, which is also shown in the UCBRURAL software.

Description of each of the components in the framework

Each component of the UCBRURAL interface is discussed below, with the intention of informing the user of how the interface elements work together for operating the

TWOPAS simulation. The actual implementation of UCBRURAL in conjunction with TWOPAS is discussed and demonstrated in Chapters 2 through 4.

1. User input: interface allows the user to input the data like road geometry, traffic data, type of model runs, and desired output.

2. Input and file management function: component of the interface that allows the user to create and manage data sets required to run TWOPAS.

3. Data sets: three data sets are created from the user input. The data sets are the road data set, the traffic data set and the observation data set.

   ▪ *The Road Data Set* contains details of the barrier lines, passing lanes, curves, sight distance, and road grades at regular intervals. This set defines the geometric conditions of the highway to be studied.

   ▪ *The Traffic Data Set* contains the volume, composition, and desired speeds of directional traffic, it also describes the platooning of the traffic entering the roadway section and the simulation.

   ▪ *The Observation Data Set* contains the location of observing points and observing intervals along the simulated road. These points and intervals define where simulation information will be collected and the intervals over which this information will be aggregated, respectively.

4. TWOPAS model run options: component of the interface that controls the type of run being made by TWOPAS.

5. Standard input file: The UCBRURAL interface creates a standard TWOPAS input file from the current data sets and provides it to the TWOPAS model.

6. TWOPAS: executable file that processes the data sets, performs the simulation.

7. TWOPAS Output File: file generated by the simulation run.

8. TWOPAS output processor: component of the interface which processes TWOPAS output files into aggregate data and graphics.

9. User selected output: When the user requests either screen or hardcopy output from a TWOPAS run, the UCBRURAL interface extracts the necessary output variables from the output produced by the TWOPAS model and then produces the necessary graphs.

Capabilities

The model simulates traffic operations on two-lane highways by reviewing the position, speed, and acceleration of each individual vehicle on a simulated roadway at 1-second intervals and advancing those vehicles along the roadway in a realistic manner. To provide a more realistic representation of traffic operations, the model takes into account the effects of road geometry, traffic control, driver preferences, vehicle size and performance characteristics, and the oncoming and same direction vehicles that are within sight at any given time. Specific features of the TWOPAS model are listed below [5].

- Three general vehicle types can be specified– passenger cars, recreational vehicles, and trucks.

- Roadway geometry that can be specified includes horizontal and vertical curves, sight distance, passing lanes, climbing lanes and short four-lane sections.

- Traffic controls in the form of passing and no-passing zones marked on the roadway can be specified by the user or calculated automatically based on the horizontal and vertical alignment.

- Entering traffic streams at each end of the simulated roadway are generated in response to a user-specified flow rate, traffic mix, and percent of traffic platooned, or can be entered based on field data.

- Variations in driver performance and preferences are generally default values but can be changed or updated if the data is available.

- Driver speed choices in unimpeded traffic are based on a user-specified distribution of driver desired speeds.

- Driver speed choices in impeded traffic are based on a car-following model that simulates driver preferences for following distances, based on relative leader/follower speeds, driver desired speeds, and the desire to pass the leader.

- Processing of traffic and updating of vehicle speeds, accelerations, and positions occurs at intervals of 1 second of simulated time.

- Driver decisions concerning initiating passing maneuvers in the opposing lane, continuing/aborting passing maneuvers, and returning to the normal lane, are based on default values but may be changed if data is available.

- Driver decisions concerning behavior in passing/climbing/four-lane sections, including lane choice at the beginning of the added lane, lane changing/passing within the added lanes and at lane the lane drops, are based on default values but may be changed if data available.

Limitations

As with all models, TWOPAS has its limitations. Some of them are related to the model capabilities, while others are related to data input. Listed below are some limitations that were found during the project as well as in the literature.

- Passing maneuvers in TWOPAS have been modeled based on field data collected in the 1970's [6].
- No intersection operations or turning movements are modeled [6].
- Turnout operations are not modeled [6].
- Data intense input—may be able to rectify in some cases by providing an interface between design software and the simulation software.
- The flexibility of TWOPAS and its current interface, UCBRURAL, regarding traffic characteristics is limited. Specifically, it does not allow variations in AADT, the vehicle and driver characteristics can not be changed from the user interface, and the definition of a platooned vehicle can not be modified from the user interface.
- Knowledge of the surrounding environment such as intersections, bridges, environmentally sensitive areas, earth works, roadside obstructions, etc. is not considered.
- If consideration of restricted sight distances due to roadside obstructions is necessary they must be manually entered.
- The definition of the roadway is entered in subsections, which limits the detail and accuracy of input.

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