Communicating Operational Data on High Occupancy Vehicles (HOV) Facilities to the General Public

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Submitted by

Francisco Torres, P.E.
(corresponding author)

Arash Mirzaei
Modeling Group Manager

North Central Texas Council of Governments
616 Six Flags Drive, Centerpoint Two
Arlington, TX 76011

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1. Introduction

As the Metropolitan Planning Organization (MPO) of the Dallas-Fort Worth (DFW) area, the North Central Texas Council of Governments (NCTCOG) has been in charge of developing the Dallas-Fort Worth Regional Travel Model (DFWRTM) and of obtaining the most accurate and reliable data for its calibration and validation. High occupancy vehicle (HOV) lanes have been a key element on this process. The first HOV lane of the DFW area was opened for operation on October 1991. Since then, six more HOV lanes have been opened, totaling a length of 84 miles. The HOV operational data, which includes traffic counts, vehicle occupancies, and travel times, has been collected on a monthly basis for several years. This document describes the procedures that were followed to integrate the HOV data collected and the development of tools that facilitate its maintenance, analysis and visualization.

2. Background

By 2030, the length of the HOV system in the DFW area will increase from the current 84 miles to 144 miles. This planned system will not only include regular HOV lanes but also managed lanes that would make these facilities more responsive and adaptive to the level of congestion experienced by the regional network. Therefore, the simulation of their operation in the travel forecasting process establishes new challenges that require the use of detailed operational data including the historic variation of the demand, among other characteristics.

The HOV facilities are treated in the DFWRTM as a separate functional class. The accessibility of users to this type of facility plays a key role in the steps of Trip Distribution, Mode Choice, and Traffic Assignment.

3. Integration of Data

The HOV facilities are currently operated by the Dallas Area Rapid Transit (DART) agency. This agency is in charge, among other responsibilities, of collecting the operational data on monthly basis. The data collected every month is provided in electronic files that provide several performance indicators that include the following: daily usage by vehicles and persons, definition of peak hour periods and their associated demand, number of people transported on HOV facilities at key intervals, occupancy ratios, distribution of usage by vehicle type, travel time savings, and reports of incidents and accidents. Although the data and summaries contained in these files are certainly valuable, analyses such as the comparison between different months, the development of indicators for more than one month, or the identification of time-based patterns becomes burdensome because it requires dealing with several files that might not be homogeneous in its structure.

Keeping the HOV data in a unique repository not only facilitates the execution of the indicated analyses but also provides a way to manage the data in a more efficient way. On this regard, the idea of integrating the scattered files in a centralized database represents an efficient and

feasible solution. Additionally, using a centralized relational database for the storage of HOV data offers the following advantages:

- Provides a systematic set of tools that describe the relations between the different data sets.
- Allows for the simultaneous access of several users to the same data sets.
- The dissemination of data can easily be handled over the internet at predefined levels of accessibility with reading or writing privileges.
- Analyses over time and space can be easily handled.
- The datasets shared by all users are always consistent and uniform.

For the integration, storage, and analysis of the HOV data, it was decided to use a popular commercial software specialized in managing databases of large size under a secure and reliable environment. The indicated software provides the additional advantage of having available items and tools to store and manipulate geographic entities that override the restriction of using any specific Geographic Information System (GIS)

4. Database Design

Before proceeding with the integration of HOV data, an analysis of the characteristics of the datasets provided and their relationships among them was conducted. The main result of this analysis was the development of the basic database structure. The schema of this database is shown in Figure 1.

As seen in Figure 1, the database consists basically of five interrelated tables. The characteristics of each HOV facility are identified in the table “HOVs”. Among other parameters, each HOV is identified by length, hours of operation, and opening date. The HOVs are represented internally as geographic line entities which were defined as a set of pairs of longitudes and latitudes.

The traffic counts are stored in the “Counts” table. The counts are presented in this table at 15-minutes intervals associated with the data and time stamp on the moment they were collected.

The occupancy data is collected by visual inspection of the vehicles. Five different types of passenger vehicles are considered and for each of these; five different levels of occupancy are defined.

The travel time data is stored in the following 3 tables: “Travel Runs”, “Travel Times”, and “PointsHOVs”. With the objective of identifying time savings obtained by the users of HOV facilities, the travel time data is also collected for the main lanes of the freeways where the HOV lanes are located. The “Travel Runs” table identifies the basic information of each run, such as date and time of the collection, as well as if the run was made along the HOV or the main lane. Each travel run has associated several partial time readings that are made at pre-defined control points located along the freeway or the HOV lane. The time readings at each control point are stored in the “Travel Times” table. Finally, the coordinates and description of each control point are stored in the “PointsHOVs” table.

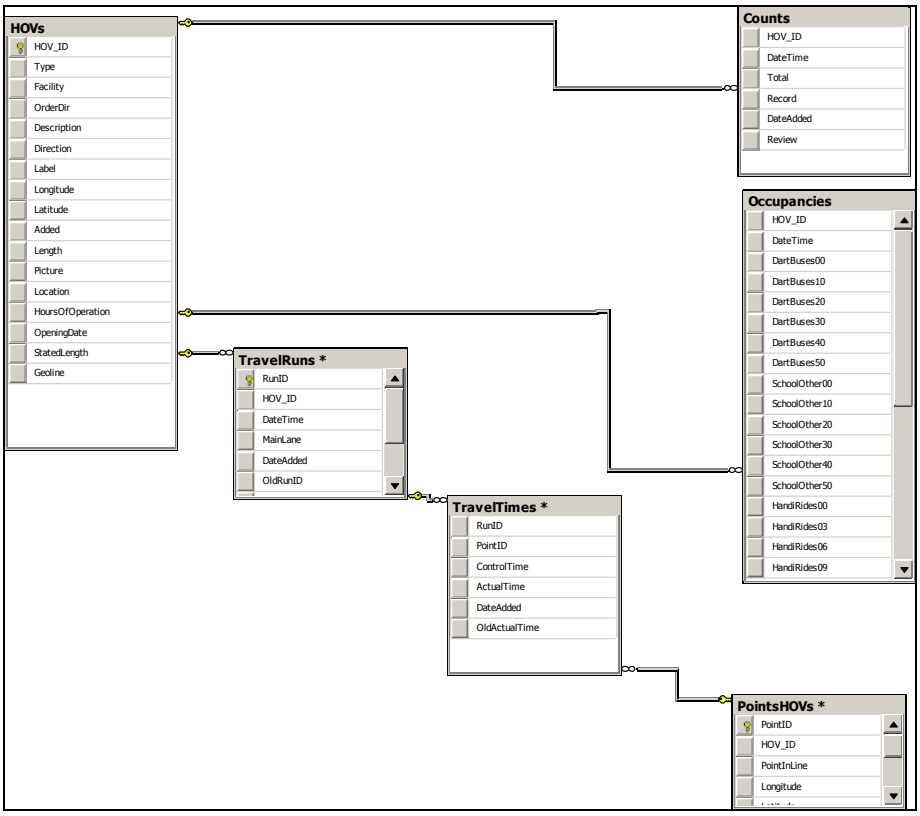


Figure 1. Diagram of the HOV Database Schema

Once the structure of the database was defined, its tables were populated with the data contained in the files provided. The oldest month for which files were available corresponds to August 2004. The data for all months from the indicated date to the current month was then integrated to the database.

The integration stage required the implementation of computer routines and the manual input of the data to the corresponding tables in the database. The routines prevented the input of duplicate or inconsistent data.

In the database, internal procedures were implemented to allow for the identification of outliers of the data which might be produced by errors in the integration process. In this regard, typical outliers are daily traffic counts that are statistically different from those presented in other months. Occupancies that are below or above historical averages were checked and corrected, if required. Travel speeds above the speed limit are examples of other checks that were made. Whenever atypical patterns persisted after no difference was found between the original files and their corresponding integrated data, a flag was established to request a validation from the collecting agency. In some case, the source of typical values could be accidents on the road or special events.

With the validated data, any kind of data mining process or geographic analysis can be implemented with the execution of specially designed queries or procedures in the database. These analyses can include the correlation of operational HOV data with other databases such as transit demand or cost of gasoline. Since the HOV facilities are geo-referenced, these

correlations can also be performed with geographic information such as land use or socio-demographic data for the zones located within a given distance of each HOV facility.

5. Characteristics of the Web Page

The web page of the HOVs includes several features that make it easy for a typical user to navigate and find the information sought with a minimum of requests. These features include controls and elements such as dynamic maps and charts. Figure 2 presents the aspect of the initial screen of the interface. The HOV facility of interest can be selected using a drop-down list control. Upon selection of a facility, the associated map is zoomed to show the entire extension of this facility. The basic information of the selected facility is shown at the right part of the screen. At the bottom section of the screen, different types of reports available are clearly displayed as hyperlinks to other Web pages.

Figure 3 presents an image of the screen that corresponds to the report of Historic Occupancies. In this screen, the user can select, using drop-down lists, the HOV facility, as well as the range of dates for the report. In the section below, a chart is displayed and automatically updated based on the identified range of dates. In this chart, the variation of the average daily occupancy is clearly shown for both directions of each HOV facility. Finally, a table with more detailed data is presented at the bottom of the screen. In this table, not only the average occupancies are displayed for each collection date but also the total number of riders and vehicles. Similar design and operational elements can be found in the Web pages that display the historic Traffic Count and Travel Time data.

The collected data for any specific day can be found in another set of screens that can be invoked from the initial HOV Web page. Similar features to those explained for the historic data can be found in these screens. An example of the screen associated to the Travel Time data for a specific day is presented in Figure 4. In this case, every travel time recorded is represented in the chart as a point. The color of each point is associated to the direction and the type of lane (HOV or main). This chart provides a very valuable way to identify erroneous or suspicious data. The basic characteristics of this page can be found in the screens that present the Travel Time and Occupancy data for specific days.

6. Future Plans

Along the comprehensive information system for HOV facilities, NCTCOG is also working on several other information venues. One the most popular and widely-used venues in our system is our pilot tracking system of inter-relation of gasoline prices and transportation performance measures (one of these measures are HOV usage). This informational web site was developed in response to public interest in observing the effect of high gas prices in Fall of 2008. Figure 5 shows the chart that present the correlation between riders on HOV facilities and gasoline prices. .

Creation and maintenance of a public information system requires significant amount of resources. NCTCOG information system group continues to use advance technologies to maintain the highest level of transparency for public while minimizing the cost of operation.

7. Conclusions

The database and the Web page described in this document comprise an excellent system to analyze and display operational data for HOV facilities. As in any information system, it is expected that this will evolve as we receive feedback from our partner agencies and the general public. Any improvement considered will aim to accommodate for more sophisticated analyses and better ways to present the results from these analyses.

As a MPO, NCTCOG is responsible for involving public in transportation decision. Decisions about future of a region are best made when public and the decision makers have access to meaningful information. Creating awareness of system performance in a complicated system of transportation requires efficient products that go beyond intangible and abstract pile of data. The tools for public use has to be simple, self-descriptive, and engaging. Our information system for HOV is in a test period to be evaluated through use of public.

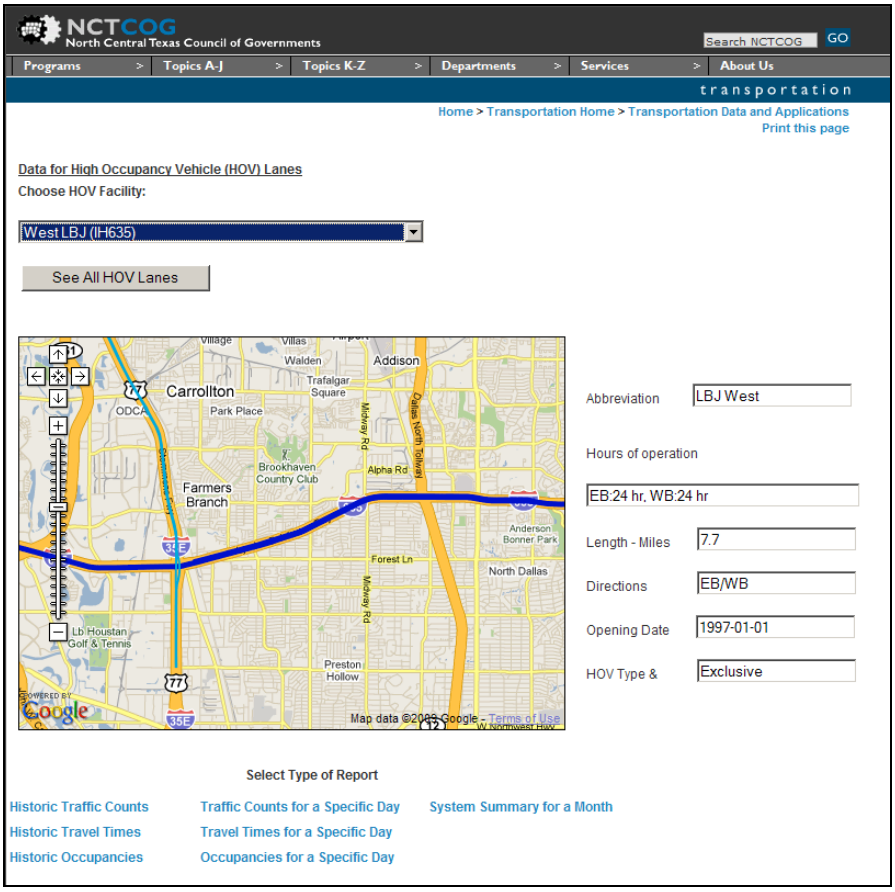
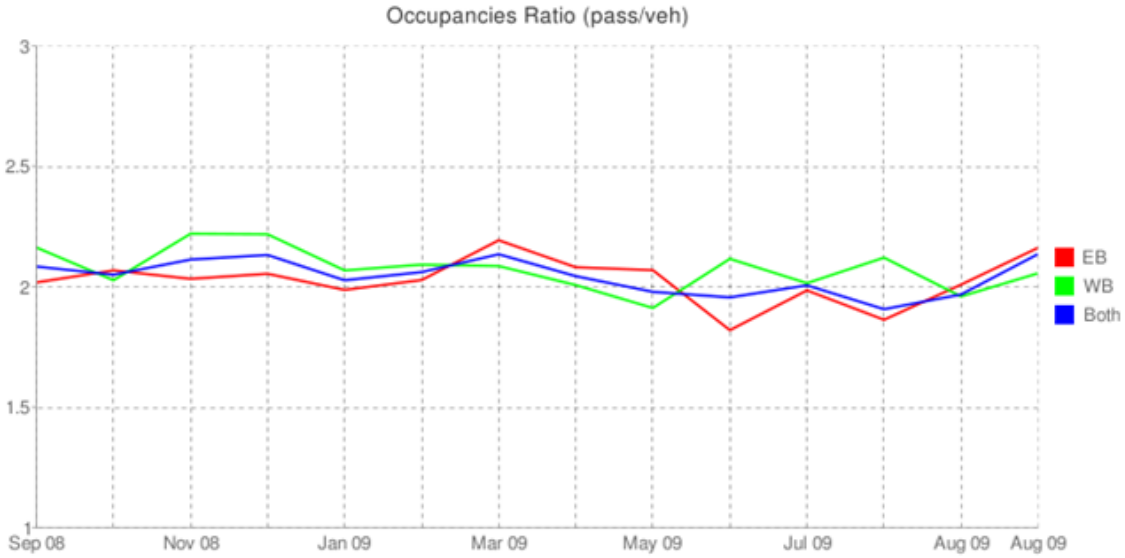


Figure 2. Initial screen of the HOV web page

HOV Facility: East LBJ (IH 635)

Start Date : Tuesday, September 9, 2008

End Date: Wednesday, August 12, 2009



	Direction AB				Direction BA				Both Directions		
Date of Count	DIR	Riders	Vehicles	Avg Riders	DIR	Riders	Vehicles	Avg Riders	Riders	Vehicles	Avg Riders
2008-09-09	EB	8587	4256	2.018	WB	7671	3546	2.163	16258	7802	2.084
2008-10-01	EB	8084	3910	2.068	WB	5775	2849	2.027	13859	6759	2.05
2008-11-11	EB	7774	3823	2.033	WB	6258	2819	2.22	14032	6642	2.113
2008-12-04	EB	8950	4357	2.054	WB	8721	3932	2.218	17671	8289	2.132
2009-01-06	EB	7628	3839	1.987	WB	7960	3850	2.068	15588	7689	2.027
2009-02-03	EB	7903	3896	2.028	WB	8815	4214	2.092	16718	8110	2.061
2009-03-03	EB	7989	3643	2.193	WB	9130	4377	2.086	17119	8020	2.135
2009-03-31	EB	7260	3488	2.081	WB	7196	3585	2.007	14456	7073	2.044
2009-05-05	EB	6470	3127	2.069	WB	8031	4201	1.912	14501	7328	1.979
2009-06-02	EB	6540	3594	1.82	WB	6476	3061	2.116	13016	6655	1.956
2009-07-07	EB	1804	909	1.985	WB	4483	2225	2.015	6287	3134	2.006
2009-07-22	EB	4435	2381	1.863	WB	1050	495	2.121	5485	2876	1.907
2009-08-04	EB	886	441	2.009	WB	4954	2527	1.96	5840	2968	1.968
2009-08-12	EB	5490	2539	2.162	WB	1686	820	2.056	7176	3359	2.136

Figure 3. Display of Historic Occupancy Data for an HOV facility

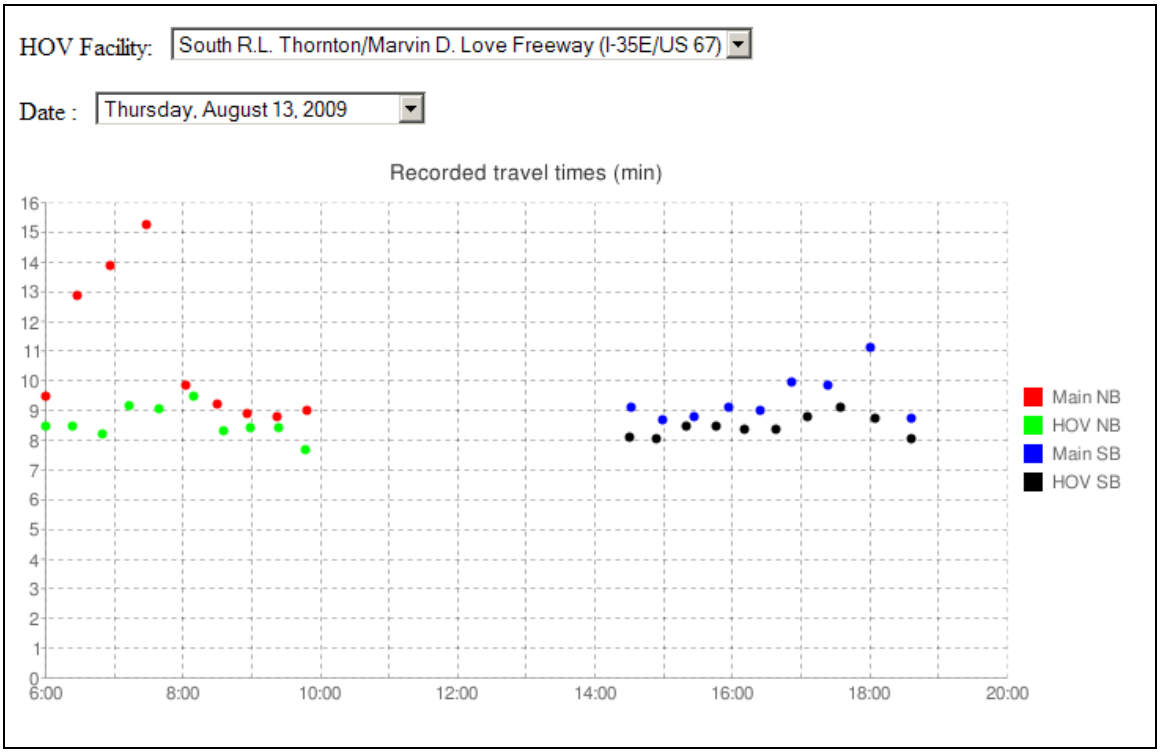


Figure 4. Travel Times for a Specific Day at an HOV Facility

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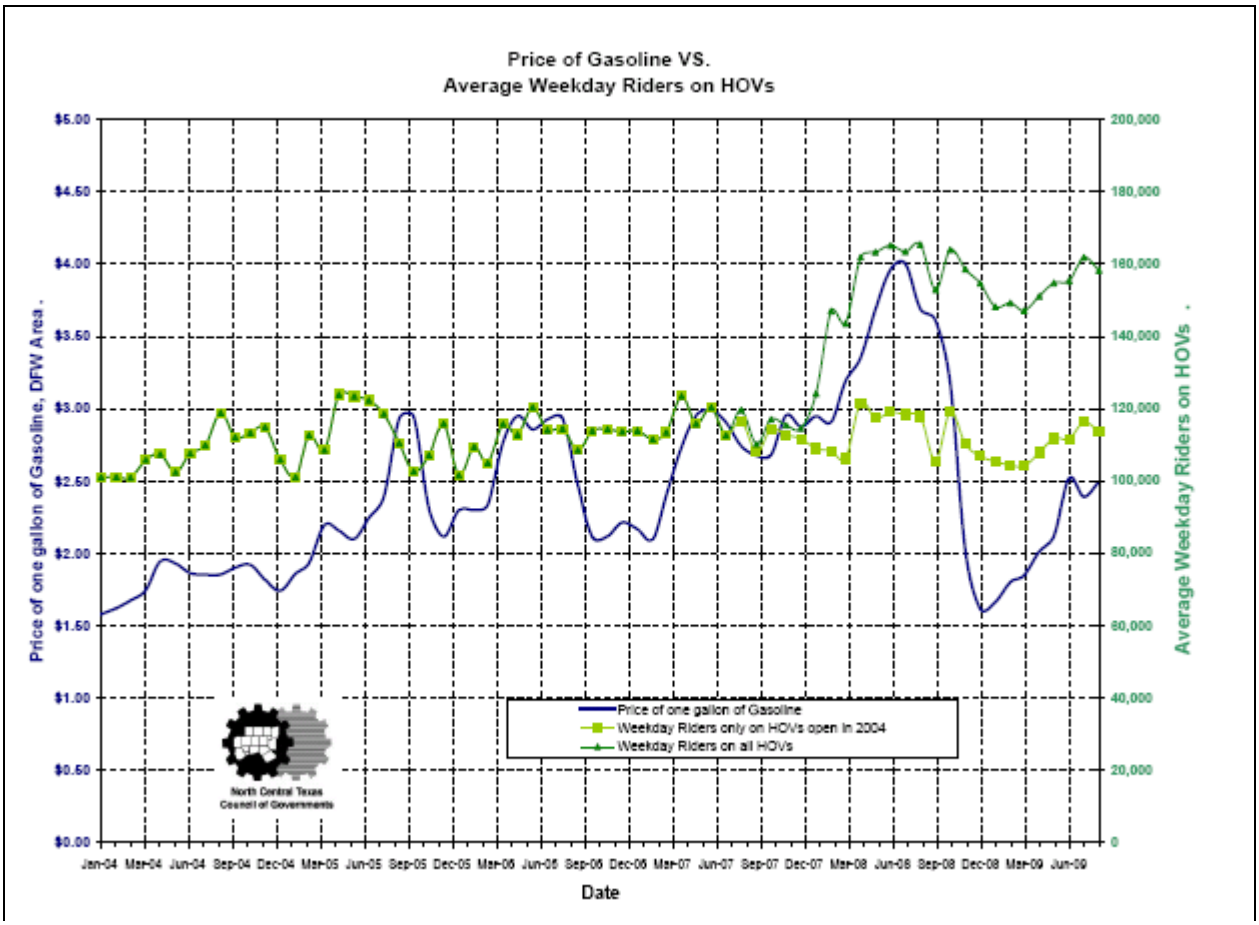

Figure 5. Correlation of Gasoline Prices and Riders on HOV Facilities