Forecasting Future Travel

When the front page of the *Washington Post* Metro section featured a story on regional travel forecasting, it seemed a clear sign of the increased—and somewhat unusual—attention that has focused in recent years on the TPB's analytical work.

"Usually, the calculations end up in technical reports seen by only a handful of politicians, air quality experts and transportation planners," wrote *Post* reporter Katherine Shaver on January 8, 2002. "Now those estimates could jeopardize billions of dollars in new road and transit projects across the region—and, suddenly a lot more people are noticing."

The *Post* was referring to a potential cutoff in federal funding that could happen if the region failed to meet air quality improvement goals for 2005. Emissions estimates caught a lot of attention in 2002, but these forecasts are really just the tip of an iceberg of data produced through the regional transportation modeling process.

The TPB's travel forecasting process combines scientific theories, an enormous amount of data and a painstaking level of professional effort. Ultimately, this process yields a wealth of information reflecting the transportation choices we make every day, and predicting how our travel behaviors might change down the road.

Finding Patterns in Human Behavior

Across the region, similar scenes are taking place every morning in thousands of places:

Jane leaves her Silver Spring home at 7:15 a.m. She drops off her kids at school and weaves her way through traffic to her job in Rockville. Over the years, she generally has figured out which route is fastest, although she's always looking for better options.

Near Bailey's Crossroads, Jim dashes out the door to catch the 7:48 bus. If he gets on the express bus, he knows he will be at the Pentagon early enough to find a seat on the Yellow Line train, and get downtown 20 minutes earlier.

In their daily commutes, Jane and Jim follow regular patterns, although they frequently make adjustments based on emerging conditions. A lot of "Janes" are going to Rockville every day; as certain roads become progressively worse or better, a certain number of these commuters can be expected to change their routes. And a lot of "Jims" are taking buses to the Pentagon every morning. Crowds on trains, bus availability, and the prices of different trips are among the many factors that will persuade a certain number of these workers to travel earlier or later, or find some other way to get downtown.

These small changes in travel behavior, which often seem random, actually follow fairly predictable patterns. Collectively, they can add up to big changes in traffic flow and congestion.

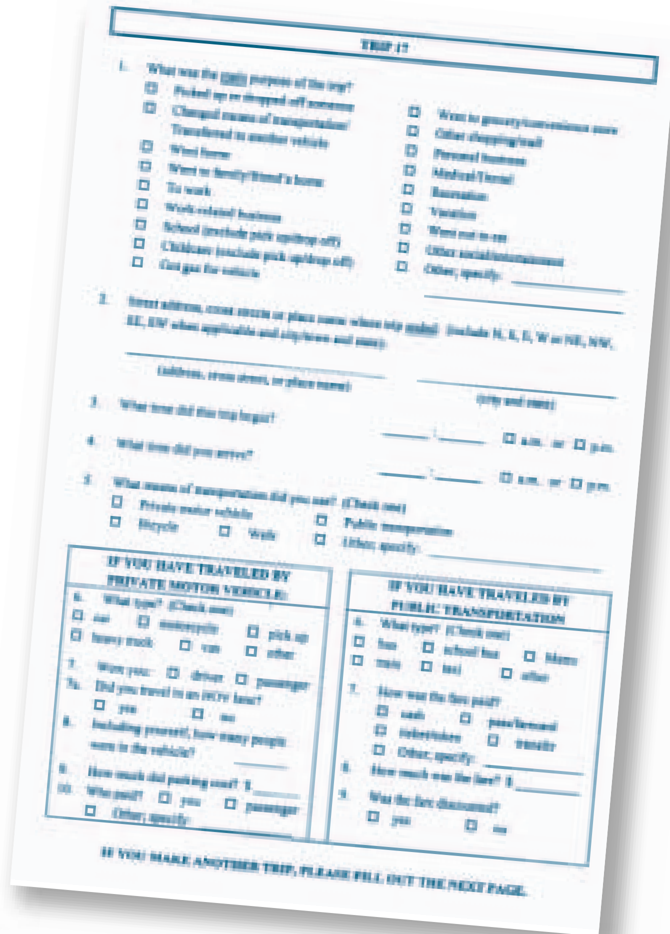
Planners and engineers working for the Transportation Planning Board have developed computer models that reflect the millions of decisions that, in combination, cause traffic at different points in the region to move at various speeds—and sometimes not to move at all. These travel forecasting models enable planners to look at the effects of what has been planned and to test potential changes. What if a road is widened? How about a new rail line? How will new jobs affect traffic?

The models are essential tools for the development of the TPB's Constrained Long-Range Transportation Plan (CLRP) and the six-year Transportation Improvement Program (TIP). Any time these documents are amended, the region's road and transit networks, including all new projects, are "modeled." This process produces travel forecasts, including information on the number of miles people will be traveling (vehicle miles of travel), the way they will travel (mode choice), how fast they will be going, and many other pieces of information.

Modeling is required by federal law. Travel forecast data are fed into a separate model that forecasts vehicle emissions levels. This "mobile emissions" model is mandated by the U.S. Environmental Protection Agency. Under the Clean Air Act, the TPB must show the CLRP and TIP are "in conformity" with regional air quality improvement goals. A new conformity finding is required any time the CLRP and TIP are amended to include projects that affect air quality.

The TPB's travel forecasting models are also used in various studies throughout the region. State departments of transportation, the Metro system and local transportation departments all use the models to produce corridor studies and other analyses.

Travel forecasting is not a crystal ball that can precisely predict traffic patterns in small areas, especially over a longer time frame. Instead, its greatest value is comparative. The travel forecasting models offer a means by which decision makers can look at different transportation options and see the potential effects they might have at the regional or corridor level.



The TPB's Household Travel Survey is a primary source of data for travel demand modeling. Survey respondents fill out trip diaries, pictured above.

What Goes Into the Models?

The Transportation Planning Board maintains a staff of specially trained transportation engineers with expertise in developing, running and validating models. Staff also performs various types of surveys to obtain data for the models and to check the accuracy of their predictions.

Modeling is not cheap. In a four-month period in 2002, modeling to test the air quality conformity of the proposed CLRP and TIP cost more than $400,000 for staff and other resources. Overall, maintaining and applying the models requires approximately 36 percent of the TPB's transportation planning budget, or about $2.9 million per year.

The two basic inputs for applying the travel demand models are:

- Land use inputs, including forecasts of future population, household growth, and employment; and
- Transportation inputs, including the current transportation network, and planned or potential changes.

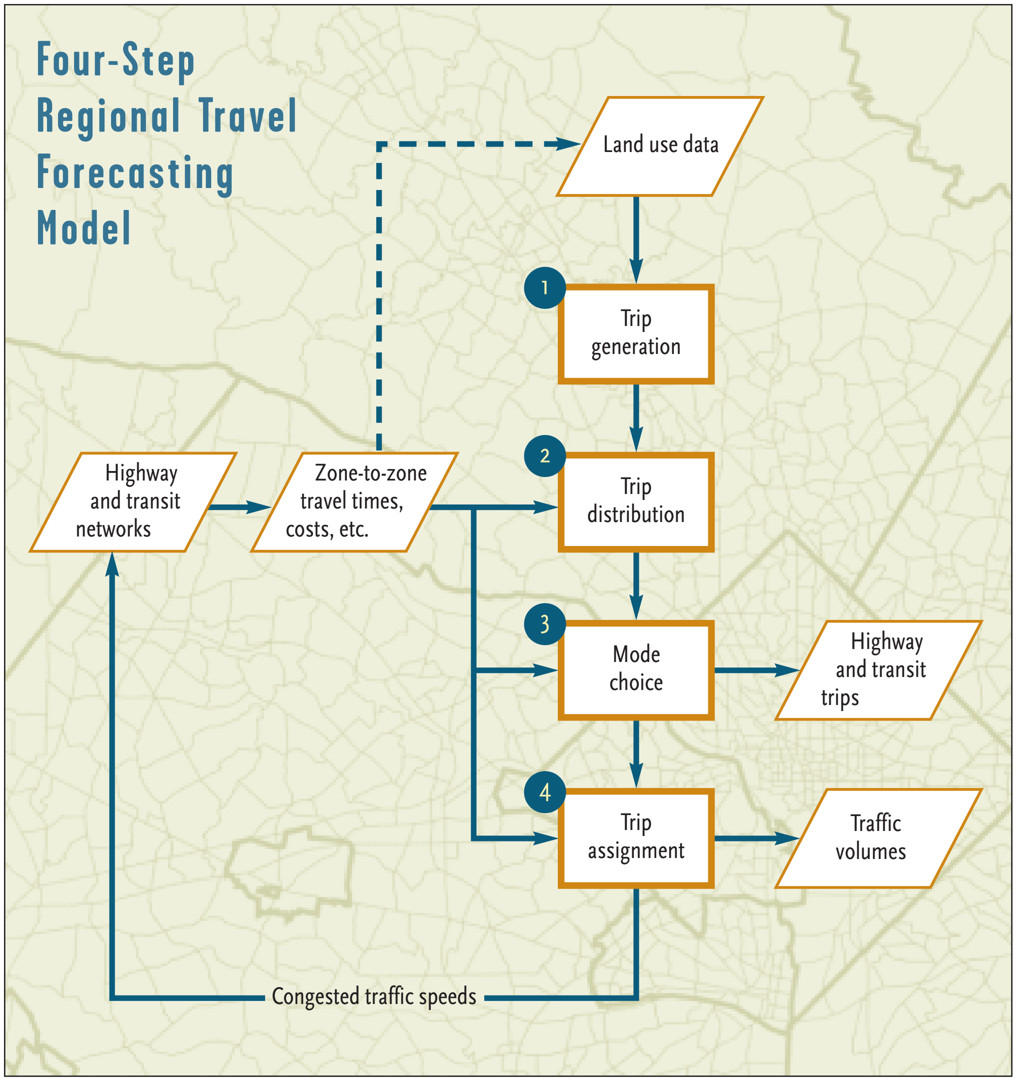
COG's Cooperative Forecasting Program develops the land use inputs. The data developed through this program, which reflect the best judgment of local planning officials, enable local and regional planning to be coordinated by using common assumptions about future growth. The Cooperative Forecasts combine regional data, which are based upon national economic trends and regional demographics, with local projections of population, households and employment. These local projections are based upon data about real estate development, market conditions, adopted land use plans and the effects of planned transportation improvements.

Transportation inputs are a little more straight-forward. What facilities and policies, such as Metro fares, are now in place? What projects and other changes are planned? These are the kinds of inputs that are coded into the model. For example, modeling for the CLRP includes the existing transportation system along with changes planned across the region over the next 25 years. The model also can be coded for "what-if" scenarios, asking questions like: What would happen if we upgrade a local bus route to express service?

TPB staff performs a variety of surveys that provide data used to develop and validate the travel models.

A household travel survey is based on "trip diaries" filled out by randomly selected individuals. For every trip they take, respondents fill out a page-long questionnaire recording where they went, how long it took, how they traveled, and other information. The respondent is also frequently telephoned for followup information.

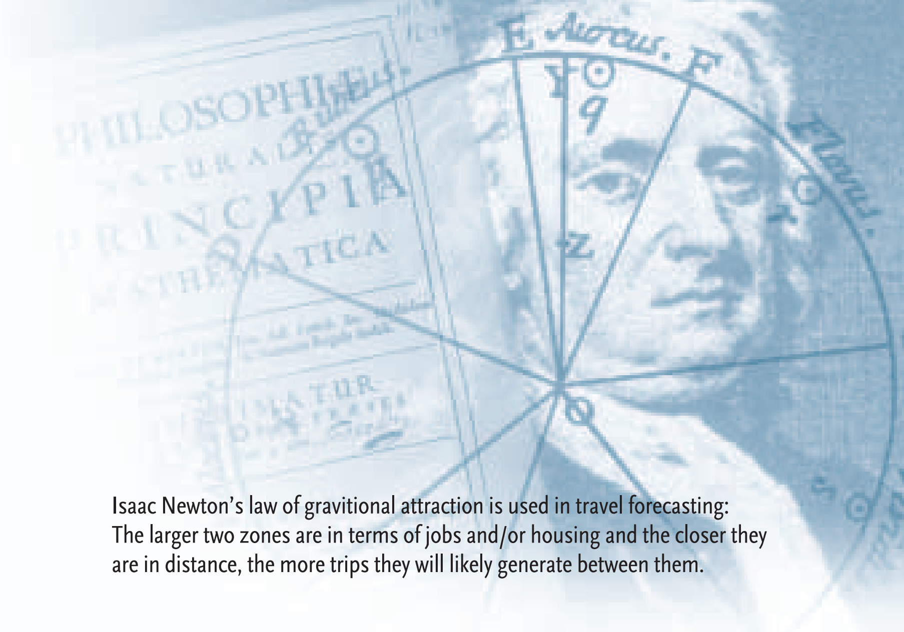
U.S. Census data is another important source of information for developing and validating the models. Transportation "journey to work" information is derived from the Census long form, distributed to one out of six Census respondents. It is limited, however, to information about work trips only.



In addition, the TPB staff performs various traffic counts. Temporary workers do much of the basic work for these surveys, which requires them to sit by the sides of roads and actually count the number of cars that pass and how many people are in each car.

Other studies focus on transportation demands for certain types of facilities. A freeway monitoring study, performed every three years, uses aerial photography to record traffic along every stretch of freeway in the region. A survey of travel times on arterial roads is performed using global positioning systems hooked up to conventional automobiles. An airline passenger survey provides information about traffic coming in and out of the region's three major airports. These surveys are valuable tools for developing the TPB's travel forecasting model and validating its outputs. (See the previous chapter for recent results from the freeway, arterial and airport surveys.)

Traffic counts and truck surveys are two more sources of data for the TPB's travel forecasting process.



Isaac Newton’s law of gravitional attraction is used in travel forecasting: The larger two zones are in terms of jobs and/or housing and the closer they are in distance, the more trips they will likely generate between them.

How Do the Models Work?

Virtually all U.S. metropolitan areas use a similar “four-step process” to replicate regional travel behavior:

1. Trip Generation: How much travel?

First, the TPB’s modelers divide the region into 2,200 traffic analysis zones. A zone can be as small as a few city blocks in downtown Washington or bigger than 100 square miles in rural areas.

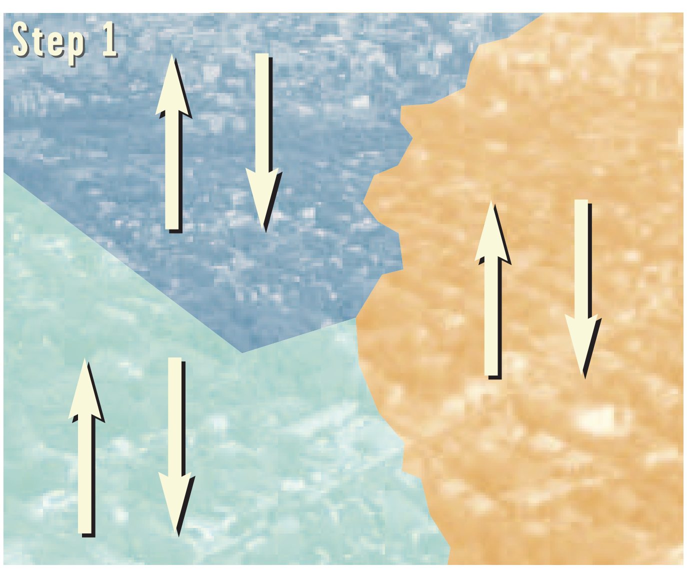
Then the modelers estimate the number of trips to and from each zone. The model separates trips according to purpose—people going to work, shopping, and so forth. Each zone “produces” and “attracts” a certain number of trips. The model estimates the number of trips produced by and attracted to each zone, based on the residential and employment characteristics of the zone. For example, a zone in downtown Washington would attract far more morning trips than it produces.

2. Trip Distribution: Who goes where?

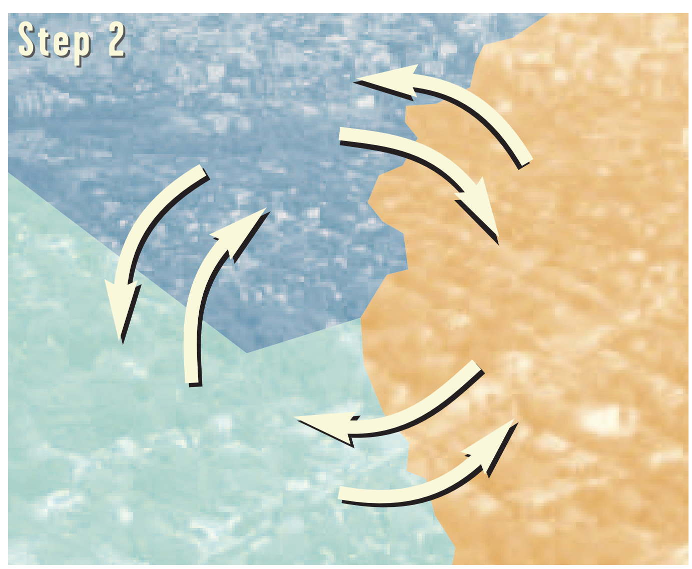
This second step matches the trips produced in each zone with the zones to which they are attracted. For example, after step one estimates the number of work trips produced by a zone in Gaithersburg, step two matches all those trips to other zones around the region — to downtown DC, to nearby suburbs, to Northern Virginia, and elsewhere. These linkages are counted as origin/destination pairs.

Modelers invoke Newton’s law of gravitational attraction at this point. In planetary science, this theory says that the greater two planets are in size, the greater the gravitational pull between them. Similarly, in transportation modeling, the larger two zones are (in terms of jobs, households or both), the more trips they will generate between them.

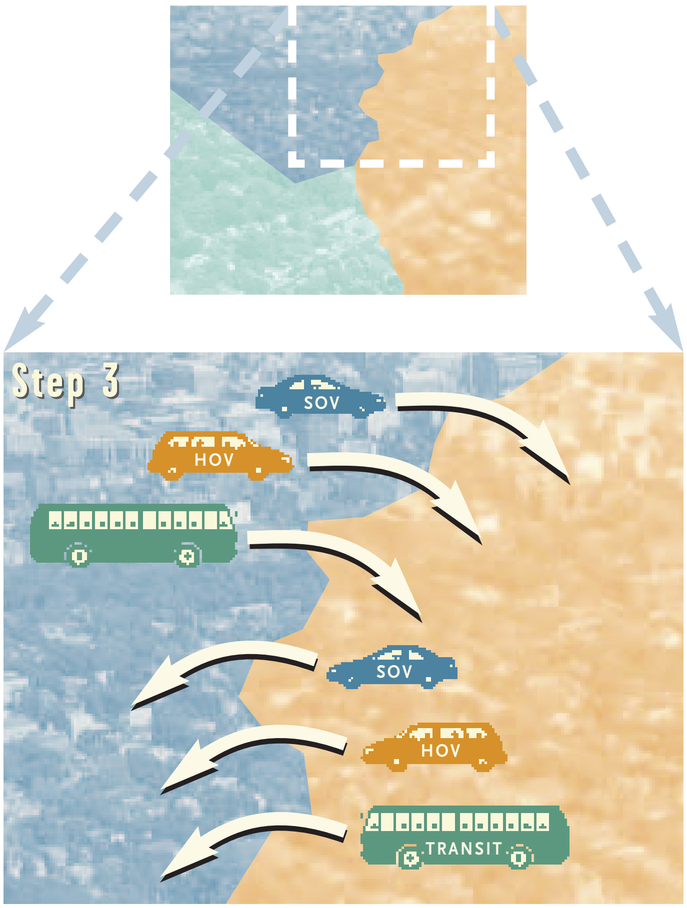
Distance is also key. A Fall Church resident feels more “gravitational pull” to Tysons Corner than to a shopping center in Montgomery County.



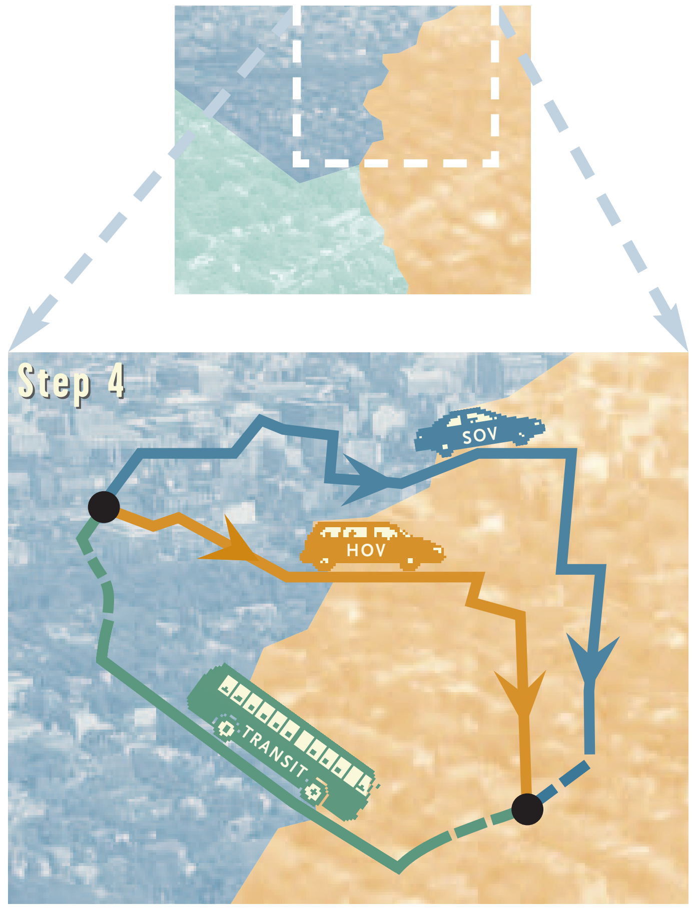
Trip generation in three fictitious traffic analysis zones: This step estimates the number of trips produced by and attracted to each zone.



Trip distribution among three fictitious zones: This step estimates how many trips are going from zone to zone.



Mode choice between two fictitious traffic analysis zones: Estimating the way people get from zone to zone.



Trip assignment between two fictitious traffic analysis zones: Selecting the fastest route between zones.

3. Mode Choice: How do people travel?

Drive or walk? Bus or train? In step 3, the model determines how people are likely to get around based on the relative attractiveness and availability of each transportation option.

The model considers factors like the accessibility of mass transit, automobile ownership and proximity to carpool lanes. It also factors in costs and time required to use the mode of travel. Cost variables include the price of gas and parking, transit fares, and other expenses. Time considerations include time waiting for trains and buses, time for transfers, time to drive and park, and time to walk to a final destination. These and numerous other factors are plugged into a series of equations estimating the probability of each traveler selecting each mode.

4. Trip Assignment: What routes do travelers take?

Finally, the model selects the best "paths" for travelers to take. It assumes people will take the quickest route, avoiding traffic jams and bottlenecks where they may occur. The model looks at each type of trip, determining the best path—both in terms of time and distance—to get from zone to zone.

The model also predicts factors that might trigger changes in travel behavior. If Jim is frustrated by the growing congestion on his drive to work, he may find an alternative place to live or work. If Jane gets a Metrochek transit subsidy from her employer, she might take Metrorail instead of driving.

The whole modeling process takes a lot of time. The models currently include computerized representations of more than 28,000 road segments, hundreds of transit lines, and travel data for 2,200 geographic zones. Depending on the application, each model "run" can take as much as eight hours of processing time on a personal computer (11 hours with the new Version 2 model).

The area used for travel forecasting, shown by the heavy blue line, extends beyond the boundaries of the TPB's member jusridictions.

New Tools, More and Better Outputs

An updated travel demand model, known as Version 2, has been developed by TPB staff. This new model is more sensitive to things like household size and income, bicycle and walking trips, non-work transit use, and the time of day when trips are made. The TPB staff is planning a number of other enhancements, both in terms of inputs and applications of the model.

Emissions forecasting is also undergoing major changes with the introduction of another new model, which was mandated by U.S. EPA. This mobile emissions model, known as Mobile 6, requires substantial new data and relies on a new understanding of vehicle emissions.

Models Under Scrutiny

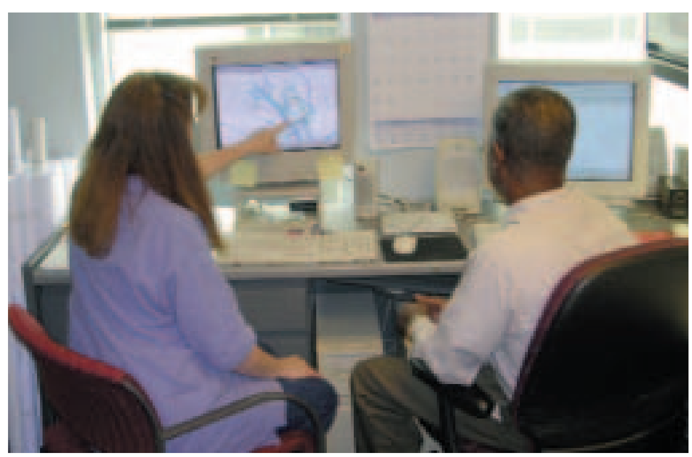
The TPB's computer models took on a heightened relevance in 2001 when the region's regular transportation planning process was put on hold after forecasts predicted that transportation-related emissions would exceed the region's air quality improvement goals in 2005.

TPB staff spent months reexamining and documenting the analysis predicting the region would exceed its 2005 limits on nitrogen oxides (NOx), a component of ground-level ozone. Facing an indefinite delay of new transportation projects, state and local officials, and their staffs, closely examined the findings that created the deadlock and worked with TPB staff to develop solutions.

The TPB's technical work came under added scrutiny in December 2001 when a coalition of environmental groups issued a critique of the TPB's modeling. Although staff found no basis for the coalition's assertions, the TPB agreed this was a good time to conduct an independent peer review of the region's transportation modeling process. In April 2002, the board authorized staff to proceed with organizing this review.

The Transportation Research Board of the National Academies will conduct the peer review in 2003. In this process, national experts on travel forecasting will provide comments on the model's effectiveness, and advice on how to refine it further.

TPB members and staff welcomed the opportunity to find new ways to enhance the modeling process. "I think COG has been known in the past for having a state of the art model," said Marsha Kaiser who represents the Maryland Department of Transportation on the TPB. "I'd hope that Version 2 continues to keep us on the leading edge."



As a basis for travel forecasting, TPB staff develop detailed computerized networks that include current and future transportation facilities.