# Regional Travel Forecasting Model System for the San Francisco Bay Area

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**A regional travel forecasting model system update using a 1980 data base is reported. Use of the 1981 Bay Area travel survey and the 1980 census Urban Transportation Planning Package is described in terms of providing a data base for model estimation and validation. Historical model development efforts in the Bay Area are compared with current efforts. The demand model development process is characterized as a six-step process involving development of component models and the subsequent packaging into an aggregate forecasting system. The MTCFCAST-80/81 forecasting system involved reestimation of all model components. Simplifications to the original MTCFCAST system were introduced where warranted; the structure of the mobility and work trip models was tampered with the least. In contrast, the work-trip mode choice model was expanded to distinguish between two-occupant and three-plus-occupant carpools, in support of travel forecasting for high-occupancy-vehicle lane projects. Continuity is seen as the key to maintaining and updating regional travel demand model systems.**

The use of travel demand models in transportation systems analysis has found widespread acceptance among metropolitan planning organizations (MPOs) across the United States. Typically, the focus of model development activities has been on the estimation and validation of individual model components, particularly the work-trip mode choice model. Less attention is generally given to the "packaging," or combination of individual travel demand models into a comprehensive regional travel forecasting model system.

This paper summarizes the modeling system developed by Metropolitan Transportation Commission (MTC) staff to describe base-year behavior and to be used for travel forecasting in the San Francisco nine-county Bay Area. The model system is part of the 1980–1981 model update to best represent recent survey, census, and networks. The system is designed by building on previous modeling efforts in the Bay Area.

The model system described here is called MTCFCAST-80/81. The "80/81" label distinguishes it from the previous version, MTCFCAST, developed from the 1965 data base. It includes a set of worker/nonworker models, two-automobile ownership models, a full sequence of work-trip demand models, and three sets of nonwork demand models, and relies on UMTA's Urban Transportation Planning System (UTPS) for network and trip assignment models. The demand models are implemented in a system written in FORTRAN for mainframe computers.

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## HISTORY OF MODEL DEVELOPMENT IN THE BAY AREA

This section provides the background for understanding the regional model system and its individual components, which are traced from 1965 to 1980. The earlier models are described briefly to provide a context for the present model system.

### Bay Area Transportation Study Commission

Model development in the San Francisco Bay Area dates back to the 1960s when the Bay Area Transportation Study Commission (BATSC) was created by the California legislature to conduct comprehensive transportation studies, prepare a master regional plan, and provide for an ongoing planning program. One of the major undertakings of BATSC was the 1965 Home-Interview Survey. Some 30,000 households were surveyed for their socioeconomic characteristics and their travel diaries. This survey became the backbone of model development and travel forecasting through the 1970s.

The BATSC models, developed in house, were mainly of the traditional aggregate type, characteristic of MPO efforts of that era. The exception was the trip generation research into disaggregate household trip production models (*1*). Eight trip purposes were carried through trip distribution and three into mode split. The models used in forecasting trip generation productions were a mix of zonal linear regression and household trip rates stratified by income and housing structure type. Trip attraction models were of the zonal linear regression type. Both production and attraction models were stratified by land use type. The trip distribution models were of the gravity type with fitted friction factors and balanced attractions through iteration. The mode split model was of a diversion type with transit-to-automobile-travel-time ratios stratified by three residential density ranges at the production end and by central business district (CBD) versus non-CBD at the attraction end (*2*). Networks and assignments were done in the TRANPLAN software with all-or-nothing loadings.

### Regional Transit Travel Projections Project

The second generation of Bay Area travel models was developed by a consultant for Bay Area Rapid Transit and MTC in 1973 as part of the Regional Transit Travel Projections Project. The purpose of these models was to produce forecasts for five transit corridor-planning projects. The models were based on the 1965 data base and can best be described as "aggregate stratified." Several stratification levels by household types were carried through mode split. Employment type and density levels were also used at the attraction end. The trip generation production was a household cross-classification model. Trip attraction used trip rates by employment type. Trip distribution was a gravity model. Mode split was a modified logit in which the parameters were estimated by trial and error to fit the aggregate data rather than by statistical estimation. FORTRAN software was written for the demand models and the TRANPLAN package was used for the networks and assignments.

### Travel Model Development Project

An evaluation of the MTC modeling needs was undertaken by MTC management in 1974. Other regional agencies and transit operators were sympathetic toward a quantum jump in the state of the art of travel forecasting. It was decided to put the region in the forefront and have a commitment to a continued effort in model development. The Travel Model Development Project (TMDP) was initiated, and a consultant team was selected to carry out a two-phase study. Phase 1 was devoted to review of data bases, a comparison of model systems, and the preparation of a work program for Phase 2. Thus, the third cycle of model development in the Bay Area was under way in 1975. The 1965 data base was revised and reexpanded, networks were converted to the UTPS, and extensive use of disaggregate logit models was made. The demand models included 21 components covering four trip purposes that were packaged in a system, written in FORTRAN, and fully compatible with UTPS. The forecasting version of the model system, known as MTCFCAST, used market segmentation by three-income or three-automobile-ownership groups. The models were complemented by UTPS network and trip assignment procedures. The models are documented in a three-volume final report (*3*). Summary reviews of the original MTCFCAST travel forecasting model system were conducted by Ruiter and Ben-Akiva (*4*) and Ben-Akiva et al. (*5*). Transportation planning textbooks by Manheim (*6*), Meyer and Miller (*7*), and Ben-Akiva and Lerman (*8*) provide highlights of the Bay Area forecasting system.

Several versions of MTCFCAST have been used in the Bay Area for specific studies. These include the Santa Clara Valley Corridor Evaluation, the Air Quality Plan Update, and the Guadalupe Corridor Alternatives Analysis. Each version incorporates some type of refinement of the MTCFCAST system. Some refinements were the reestimation or replacement of the work-trip mode choice model, recalibration of the trip distribution model, and/or the aggregate validation of the models to a 1975 data base. Several versions of the models have been applied to average values of zonal variables without market segmentation by income, automobile ownership, or any other stratification. This was done in conjunction with work-trip, person-trip tables derived from the traditional gravity or FRATAR trip distribution models. Two examples of this are the model application in 1977 to generate travel forecasts for the Air Quality Management Plan by MTC staff, and the Guadalupe Corridor Alternatives Analysis mode choice model application in 1984 to generate travel forecasts for the Fremont-South Bay Phase I Corridor Study, by a consultant.

## PREPARATION OF 1980–1981 DATA BASE

Base-year data are an important component in any travel model update. A great deal of effort was expended in securing the best 1980 data possible. The effort included the acquisition of 1980 census and Association of Bay Area Governments (ABAG) demographic, land use, and employment data. The key to a meaningful model update was the collection, preparation, and use of a special travel pattern data base.

By the end of the 1970s, the 1965, 1970, and 1975 data bases had been exhausted. In particular, the age of the 1965 travel survey had called into question its reflection of present travel behavior in light of major changes to transit service in the region. On the other hand, fiscal constraints against large-scale surveys dampened the desire for travel data updates. Thus, the concept of a small sample survey became appealing, especially when the new breed of disaggregate models was thought to require fewer data for their development. Experience with the Bay Area disaggregate models developed from the 1965 data indicated that a rich aggregate data base was necessary for base-year validation in addition to a small survey for the estimation of model coefficients. All these factors prompted MTC to embark on a new survey to coincide as closely as possible with the 1980 census journey-to-work questionnaire for compatible disaggregate and aggregate travel data sets.

### 1981 Household Travel Survey

The 1981 household survey was conducted in the spring of 1981 by telephone with a sample of about 6,200 households and their trip diaries (*9*). The sample was of a stratified type selected disproportionately throughout the region. About one-half of the surveyed households were residents of San Francisco County, at a sampling rate of 1.0 percent. The other eight counties had a sampling rate of 0.2 percent. Beyond this sample control total, households were selected by using telephone directory-based random digit dialing in such a way that unlisted households could be selected.

Extensive preparation and analysis of the survey data were undertaken by MTC staff. This included data cleanup, trip linking, household weighting, trip expansion, and reporting of key data (*10–12*). The survey was assumed to represent 1980 travel behavior and was therefore expanded to total 1980 households in the region. Because of the disproportionate nature of the sample, this expansion was necessary to weight the survey observations. It was also necessary for the development of aggregate nonwork models. Master files of household and trip characteristics were prepared to provide a common and easy-to-access data base for the development of individual component models.

### 1980 Census Urban Transportation Planning Package

The 1980 census provided valuable aggregate data, at the census-tract level, of household characteristics derived from the weighted sample or from the 100 percent counts. In addition to the standard files and reports, the Urban Transportation Planning Package (UTPP) for the nine-county region was purchased from the Bureau of the Census to be the basis for tract-level work-trip locations. Responses to the journey-to-work questionnaire were collected from a sample of 1-in-6 and coded to a geography ranging from tract to county for a reduced sample of 1-in-12 by the Bureau of the Census. The main data files included the number of workers by place of residence reporting their mode of travel to work destinations. MTC staff processed the data and converted the information to aggregate home-based work-trip tables as follows:

1. For unallocated place-of-work data, the census-reported geography of "place" (mainly for Sonoma and Napa counties) and "county" were allocated to the 550-regional-zone system. This entailed detailed analysis of ABAG's employment data to form the basis for judgments about the allocation of workers to zone of work.
2. The tract-zone-county commuter data were aggregated to 550 zone matrices by drive alone, shared-ride passengers in two-occupant vehicles, shared-ride passengers in three-or-more-occupant vehicles, and transit passenger modes.
3. The 1981 survey data were analyzed to produce county and superdistrict estimates of home-based work trips per employed person.

The factors from item 3 were used to convert the census commuter matrices to home-based work trips by mode. The results are called the 1980 "observed" trip tables and form the most reliable aggregate data base available in this region. These tables were the main source for base-year model system validation.

## DEMAND MODEL DEVELOPMENT PROCESS

With the 1980–1981 data base on hand, the task of demand model updating was undertaken in house. The objective was to develop a bank of model components that could be packaged in various combinations for various uses. Past experience with model development and application indicated that the update should build on the disaggregate model structure of the earlier Travel Model Development Project. The disaggregate models are considered to be the most advanced and to have more behavioral content than other model types. Although the main framework of the earlier effort was used, many changes were introduced to improve the models and to simplify the process. These included changes to specification of variables, component linkages, and emphases by trip purpose. The linkages in the work models were those least tampered with, whereas those of the nonwork models were substantially changed. The feedback loops from nonwork to work-trip models were removed, the structure of the nonwork distribution models was changed to the gravity form, and the only logit form used in nonwork models was for mode choice. The idea was to keep the main structure of work-trip models and to introduce warranted simplifications wherever possible.

The model development process covers two domains. The first includes the individual components and the second contains the model system. Six distinct steps in the development process span the two domains. Model specification, estimation, and disaggregate validation produce a candidate component model. Market segmentation, software preparation, and aggregate base-year validation are used to package the components into a forecasting model system.

### Development of Component Models

Component models perform individual functions in the model system and were therefore uniquely treated in the update process. The six sequential steps of model development mentioned above may not apply to all components; in addition, there are varying degrees of partial or complete recycling throughout. The terminology and the process are geared more to disaggregate models than to aggregate components because the latter require fewer steps than the former.

Component model development is described in the following sections.

#### *Model Specification*

Model specification advances a hypothesis about the representation of the phenomena being modeled. It requires the identification of the component function and the dependent and explanatory variables and the selection of a mathematical form for the model. The function may pertain to such factors as automobile ownership prediction, trip attraction estimation, and mode choice simulation. Different combinations of socioeconomic variables, transportation level-of-service variables, or urban growth density variables have been used for different components. Four mathematical forms have been used. Linear regression is used for trip generation production models. Trip rates are used for some attraction models. Logit is used for automobile ownership, work trip distribution, and all mode choice models. Finally the gravity type is used for nonwork trip distribution models. Model specification applies equally to disaggregate and aggregate models.

#### *Coefficient Estimation*

Coefficient estimation is the process of applying the observed behavior reflected in the data base to the hypothesis advanced in the previous section. It uses statistical data-fitting techniques to quantify the relationship between the dependent and the independent variables. It produces the coefficients and constants of linear regression or logit utility functions. For aggregate models, *calibration* of gravity model friction factors is a more conventional, yet analogous, term.

Estimation is done by preparing special input files for use in special packages like SAS (multivariate analysis), LOGIT (maximum likelihood logit estimation), or AGM-UTPS (gravity calibration and application program). The resulting coefficients are reviewed for correct sign, reasonable size, and statistical significance. The results suggest either recycling through the previous step or acceptance of a candidate model for subsequent testing steps.

#### *Disaggregate Validation*

Disaggregate validation is unique to disaggregate models and involves applying the estimated coefficients to a sample of households from the 1981 survey to simulate their choice behavior. The predicted choices are compared with the reported choices to detect any biases by several socioeconomic stratifications. The results may suggest recycling back to specification, estimation, or acceptance of the component model for subsequent testing.

### Development of the Regional Model System

Development of the regional model system was begun after selecting the candidate component models. At this stage, both the disaggregate and the aggregate components were in their semifinal versions. The three steps that compose the regional model system development are described briefly as a continuation of the discussion in the previous section.

#### *Market Segmentation*

Market segmentation involves adaptation of the disaggregate model coefficients for forecasting by market segment. In the conventional aggregate model systems, average zonal values are used in forecasting. In the MTC model system, the use of disaggregate models is accompanied by a number of stratifications in which group averages of household characteristics are used instead of zonal averages. The process involves analyzing the variables used in each component model to ascertain the need for revising the input zonal averages to reflect a market segment or to compute market-segment-specific coefficients based on the regional or county variations of household characteristics by market segment. The segmentation varies by component or group of component models. In total, the following segmentations are used: households with workers versus all households; primary workers versus secondary workers; three-income groups; and three-automobile ownership levels.

#### *Software Preparation*

Software preparation consists of revising, rewriting, or inserting a special code in existing programs to implement each component model equation on a particular computer. Each component model is implemented in one or more data processing "steps" by one or more data processing programs written in FORTRAN and compatible with the UTPS software. In the MTC model system update, most of the computer programs were rewritten to accommodate the new 1980–1981 models. Although the same framework, style, and file-naming conventions were used, consolidation of a number of steps and programs was undertaken to improve efficiency.

#### *Aggregate Base-Year Validation*

Aggregate base-year validation involves simulation of the 1980 base-year travel through the model system, comparison of the simulated choices with independent observed estimates, and calibration-adjustment of model constants to reasonably match observed choices or travel patterns. After market segmentation and model implementation in the software, the model system package was run on the 1980 data base to produce a simulation by each component model. The results of each model prediction were analyzed and compared with the most reliable and available 1980 observed data. The analyses led to either a recycling back to the specification-estimation steps or acceptance of the model with or without constant adjustments. Changes to these alternative-specific constants reduce prediction errors in the forecasting process. The errors can be attributed to a number of factors, including weakness in the underlying theory of the model structure, absence of important but unavailable or nonforecastable variables from model equations, biases in survey data, misrepresentation of time and cost level-of-service data, error in the base-year employment data, misrepresentation of captivity to alternative choices or modes, the regional averaging effect in model estimation, and deviation of actual human behavior from rational choices presumed by the models.

To validate the model system in one continuous cycle and at the same time eliminate compounding of errors from one component model to another, a separate analysis was done at the end of each step to validate each model before proceeding to the next.

For work-trip and mobility models, the MTC travel model update effort included several cycles through the three-component model development steps and two full cycles through model system validation. Disaggregate nonwork model components were developed in the same manner as the work-trip models. Aggregate nonwork models were developed in the traditional manner of gravity model calibration. One cycle of base-year aggregate simulation was undertaken. The models were aggregately validated to the 1980–1981 survey trip tables by mode. Although the survey had a small sample resulting in sparse and lumpy trip table entries, it was the only aggregate data base available to which to validate. It certainly was not as reliable as the census journey-to-work tables but appeared to adequately represent aggregate county modal shares.

## MODEL CHARACTERISTICS

The 1980–1981 travel model update resulted in a bank of component models and networks to draw on for planning studies and special applications. In particular, the regional MTCFCAST-80/81 is packaged to represent state-of-the-art systems for demand forecasting and, together with its UTPS network package, represents a sophisticated and practical system. Travel demand model components and component linkages are shown in Figure 1. The 24 component models, their acronyms, and mathematical forms are shown in Table 1. The bank of alternative models provides for a number of conventional models (FRATAR, gravity, etc.), which are used side by side with MTCFCAST-80/81 for generating alternative forecasts to assess reasonableness, establish ranges, and bring about acceptability of such forecasts. The objective of this section is to report the highlights of unique characteristics of component demand models, regional model systems, and some recent network representation improvements.

### Characteristics of Component Models

For convenience, the demand models are grouped into four functional areas, and their special characteristics are summarized accordingly in the following sections.

Detailed specification and model estimation results are summarized in three MTC technical summaries or working papers (*13–15*). Home-based work trip and mobility models are fully described elsewhere (*13*). Nonwork trip generation

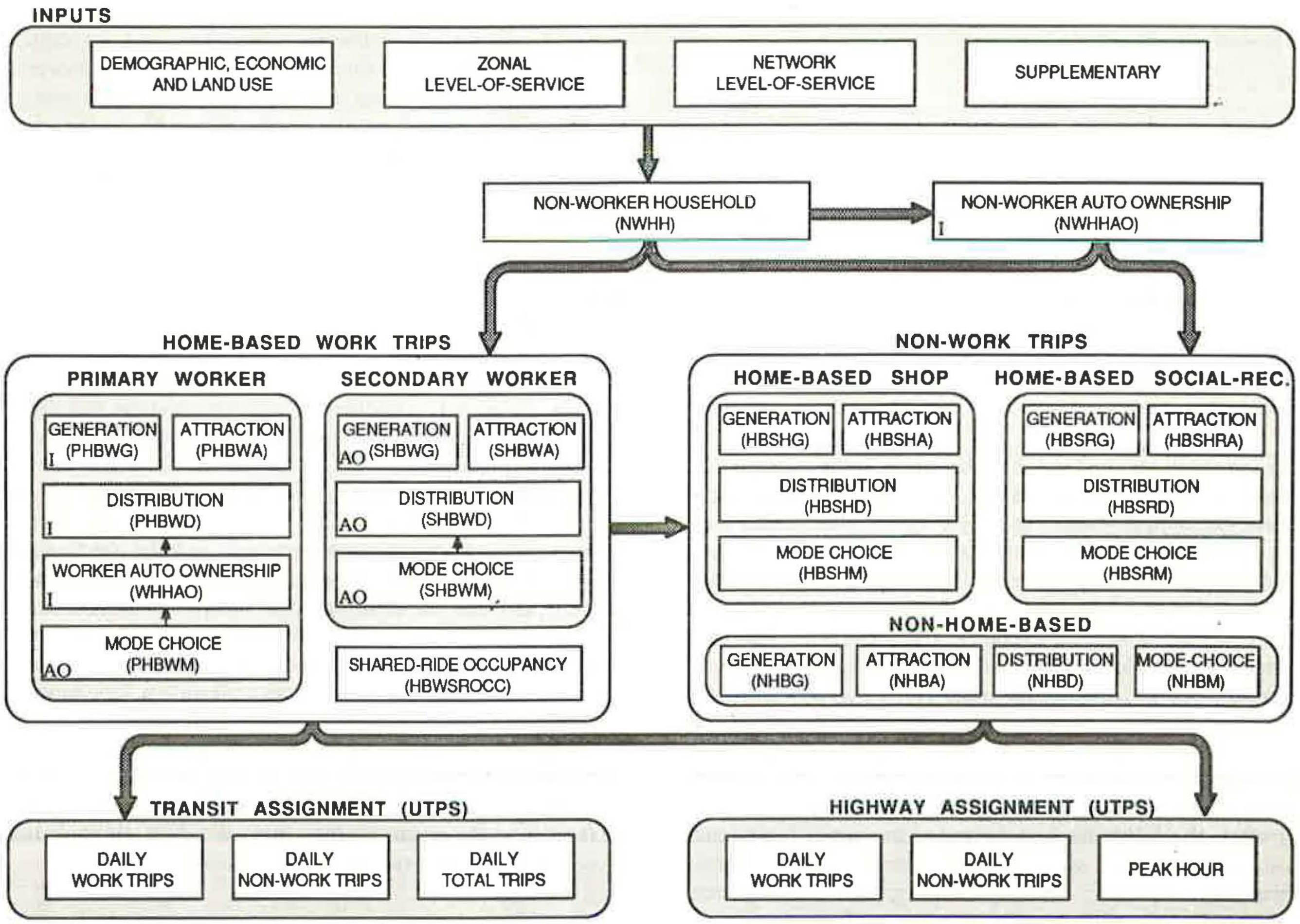


**FIGURE 1 Regional travel forecasting model system (MTCFCAST-80/81).**

and trip distribution models have been analyzed previously (*14*), as have final specifications for nonwork mode choice models (*15*). Given that the scope of this paper concerns travel model systems rather than detailed model components, estimation results are not presented here.

### *Mobility Block Models*

The mobility block of models consists of the worker-nonworker household, nonworker household automobile ownership, and worker household automobile ownership models. These models use the most predictable socioeconomic, housing type, and density variables available from ABAG, which show a logical relationship to the independent variables they forecast and statistical significance of the estimated coefficients.

### *Trip Generation-Attraction Models*

The trip generation-attraction models for work trips use the most basic units of observation—the worker at place of residence and job at place of work. In addition, the trip generation production models add socioeconomic and density variables to reflect other zonal characteristics.

For home-based nonwork trip generation production models, the most relevant socioeconomic variables (income, household size, and automobile ownership) are used to predict trips per household. For trip attractions, the most relevant sector employment and other variables are used to predict trip attractions. Similarly, a variety of employment sector variables to predict non-home-based trips are used.

### *Trip Distribution Models*

Trip distribution models for work trips are of the logit form and are probabilistic in their destination choice. They incorporate the traditional attraction balancing and trip length matching to observed behavior as well as *K*-factors. Most notably they include composite accessibility variables by mode and automobile ownership. These accessibility variables are derived from lower-level models in the forecasting process and are fed to upper-level models as generalized variables that enable travel time and travel cost by mode to influence trip distribution. They are derived from a rigorous theory consistent with modal and automobile ownership probability.

### *Mode Choice Models*

The mode choice model for work trips is a disaggregate logit model that predicts drive alone, shared ride with two occu-

TABLE 1 DEMAND MODEL SYSTEM COMPONENTS (MTCFCAST-80/81)

| Model | Form | Description |
|---|---|---|
| 1. NWHH | Logit | Worker/Non-Worker Household |
| 2. NWHHAO | Logit | Non-worker Household Auto Ownership |
| 3. WHHAO | Logit | Worker Household Auto Ownership |
| 4. PHBWG | Linear | Primary Worker Home-Based Work Trip Generation |
| 5. PHBWA* | Rate | Primary Worker Home-Based Work Trip Attraction |
| 6. PHBWD | Logit | Primary Worker Home-Based Work Trip Distribution |
| 7. PHBWM | Logit | Primary Worker Home-Based Work Mode Choice |
| 8. SHBWG | Linear | Secondary Worker Home-Based Work Trip Generation |
| 9. SHBWA* | Rate | Secondary Worker Home-Based Work Trip Attraction |
| 10. SHBWD | Logit | Secondary Worker Home-Based Work Trip Distribution |
| 11. SHBWM | Logit | Secondary Worker Home-Based Work Mode Choice |
| 12. HBWSROCC | Linear | Home-Based Work Shared Ride Occupancy |
| 13. HBSHG | Linear | Home-Based Shopping (Other) Trip Generation |
| 14. HBSHA* | Linear | Home-Based Shopping (Other) Trip Attraction |
| 15. HBSHD | Gravity | Home-Based Shopping (Other) Trip Distribution |
| 16. HBSHM | Logit | Home-Based Shopping (Other) Mode Choice |
| 17. HBSRG | Linear | Home-Based Social-Recreation Trip Generation |
| 18. HBSRA* | Linear | Home-Based Social-Recreation Trip Attraction |
| 19. HBSRD | Gravity | Home-Based Social-Recreation Trip Distribution |
| 20. HBSRM | Logit | Home-Based Social-Recreation Mode Choice |
| 21. NHBG* | Linear | Non-Home-Based Trip Generation |
| 22. NHBA* | Linear | Non-Home-Based Trip Attraction |
| 23. NHBD | Gravity | Non-Home-Based Trip Distribution |
| 24. NHBM | Logit | Non-Home-Based Mode Choice |

* Aggregate Model

pants, shared ride with three or more occupants, and transit passenger modes. Great care was taken in the development of this model because of its importance for transit planning. The model was estimated from survey samples and aggregately validated to replicate 1980 census journey-to-work modal shares through adjustment of modal constants. The main variables and features of the mode choice model are

1. Socioeconomic variables that are forecast by ABAG (income, household size, workers per household).
2. Automobiles per household forecast internally by the model system.
3. Mode-specific dummy variables.
4. Natural logarithm of total employment density as a continuous variable to reflect CBD characteristics in preference to judgmental CBD geographical definition.
5. Time and cost peak level-of-service matrices segmented to in-vehicle and out-of-vehicle travel time.
6. Two variables to reflect mode of access to transit stations. The first is the automobile access dummy with a 0/1 value to reflect the negative consequence of the automobile access requirement in a transit journey. The second is the household automobile ownership for trips requiring automobile access to transit. The latter has a positive consequence that mediates the negative ones as automobile ownership rises.
7. Stratification by primary and secondary worker and application to segmented person trip tables by three-automobile ownership groups. The mode choice application uses transit level-of-service matrices derived from the walk-only mode of access to transit for households owning no automobiles.

The nonwork mode choice models are simpler logit models yet include socioeconomic variables, total travel times, travel costs, and various employment and residential density variables.

**Model System Characteristics**

The regional travel model system MTCFCAST-80/81 is a packaged set of component models that convert logit models, developed from sample data, to an aggregate forecasting system (*16*). These new models are integrated with the conventional MPO-type models in a sophisticated process that produces what appears to be a product in a conventional format. The resulting system has the following unique characteristics:

1. The updated models better represent travel behavior through the rich 1980–1981 data base. Coefficients for the entire model system are estimated with large samples and extensive specification and statistical testing. Furthermore, the entire system is validated to the 1980–1981 observed travel behavior from the mobility block through trip assignment.
2. The model system relies on individual representation of modal level-of-service time and cost matrices for a practical representation of modes as well as the upward probabilistic representation of feedback between mode choice, automobile ownership, and work-trip distribution models.

Through the use of logsum variables, the joint decision travel behavior process is correctly represented by the apparent individual decision step of the conventional process.

3. The model system avoids the use of imaginary average traveler behavior through the use of market segmentation. It uses three income groups for the first part of the work-trip model sequence and three automobile ownership groups for the balance. By doing so, the travel decisions of these regions' residents are better represented than with average zonal characteristics.

### Network and Trip Assignment Modeling

The MTC model system relies on UTPS for its network representation and trip assignment process. The characteristics of this system are well documented in UMTA manuals on this package. One unique improvement in the UROAD traffic assignment program is the representation of high-occupancy-vehicle (HOV) lanes and subsequent separate trip assignment to mixed flow and HOV facilities. The coding of HOV facilities using a "parallel" approach has been fully tested and implemented by MTC staff using Bay Area networks and trip tables. The results have been encouraging and useful in evaluating the impact of HOV improvement proposals. The parallel coding approach uses separate links for HOV lanes parallel to the mixed-flow adjacent facilities. This allows for coding separate speeds for the two types of facilities. After recycling through mode choice, new speeds are estimated for these facilities using capacity restraint results. Both speed estimation and volume assignment are reported separately to allow for realistic representation of the actual operation of these facilities. The improved coding procedures allow for different definitions of HOV operations in the region. They can be represented as allowing two-or-more occupants or three-or-more occupants in the vehicle.

Transit assignment incorporates two improvements. First is the use of a walk-only transit path in the process. This is done to allow market segmentation in the transit assignment where transit trip tables (out of the mode choice model) for the zero-automobile-ownership group can be assigned only to a path that uses walk-only centroid connectors to transit stations or bus stops.

The second improvement in transit assignment is the prevention of long automobile connectors to a transit station followed by a short hop on a line-haul system to the desired destination. This improvement is done through a series of logical checks to trip tables and network paths to identify unreasonable transit trips, divert them from the automobile-access transit path, and add them to the walk-only path.

## CONCLUSIONS

Travel demand forecasting at MTC combines practical needs to provide long-range travel forecasts with the theoretical research and development work associated with disaggregate model estimation. Balancing the practical forecasting aspects with model development research provides Bay Area researchers and planners ample opportunity to test alternative model structures as well as to update the models as needs arise.

The MTCFCAST-80/81 travel forecasting system represents a major effort to build on past model structures with updated data bases. Simplifications to the MTCFCAST system were introduced as warranted except in the case of the work trip and mobility model sequences that had the fewest modifications. New demands on the model system to distinguish between two-occupant and three-plus-occupant carpools led to the estimation of a four-mode home-based work-mode choice model. Previous Bay Area models considered only three modes: drive alone, transit, and shared-ride two-plus occupant.

On the negative side, the sparseness of the 1981 travel survey data base proved to be a challenge in the estimation of disaggregate choice models, especially nonwork mode choice models. Given the overwhelming automobile choice predominance for nonwork trip purposes and the small sample size, the resulting nonwork mode choice models were simple in their final specifications. For example, in-vehicle and out-of-vehicle travel times were aggregated into a generic total time variable given unsatisfactory estimation results when travel times were disaggregated.

Next steps at MTC will include a new household travel survey to coincide with the 1990 census. The sample size of the 1990 survey will be determined in terms of balancing fiscal constraints with the demand for quality data necessary for estimating robust travel demand models. Lessons from developing travel demand models using the 1980 data base will be passed on to the 1990s. Continuity is the greatest challenge and benefit for regional transportation planning agencies charged with the responsibilities of providing skills and tools for travel demand forecasting.

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