

Network Model

The Transportation Plan refers to the region's major roads and highways, as they are included in the Travel Demand Forecasting (TDF) Model. Currently, as identified in the introduction, the TDF software that MACOG uses is TransCAD.

TDF Models and Air Quality Models

SAFETEA-LU and the CAA require computer modeling for the MACOG transportation network and for certain areas designated as non-attainment or maintenance by the United States Environmental Protection Agency (USEPA). All urbanized areas designated as non-attainment or maintenance areas are required to continue computer modeling if they had been using a TDF model in previous years prior to the SEAFETEA-LU legislation. Mobile source pollution can be more accurately forecasted for air quality conformity purposes using a TDF model and mobile source emission modeling software.

Original Model Development

MACOG staff, using base maps for St. Joseph and Elkhart County, created traffic analysis zones (TAZs) to include all of the Urbanized Area, which had been designated as non-attainment for the original 1-hour ozone standard. The TAZ's were reviewed, revised and numbered from 1 (downtown South Bend) to 440 (Goshen area). External stations were selected and numbered from 450 – 523. Additional nodes were added to assure that there would be no gaps between the centroids connectors and the external stations. These nodes were numbered 441 – 449 during the MINUTP conversion. The links and nodes within the road network were then selected with node numbers ranging from 713 through 4193. The gap between numbers for the TAZs and external stations was left to accommodate any future changes or expansions that may become necessary.

Using AutoCAD and the Indiana East State Plan Coordinates, a digitized map of the urbanized area network was completed. This yielded a proper coordinate identification system for each node included in the network. Using these coordinates, an XY coordinate file was created in order to accurately read the MINUTP software.

MACOG staff then created a link file for use with MINUTP. This file included the following data for each link record:

- A node
- B node
- Distance (in miles)
- Average actual travel speed
- Capacity class
- Number of lanes (directional)
- Annual Average Daily Traffic (AADT)
- One-way indicator
- Pavement width
- Functional Classification (using original classifications)
- Facility type
- Census tract
- TAZ
- Corridor ID (defined by BLA)
- Outline/Screenline ID (defined by BLA)
- Cordon Line ID (defined by BLA)

Each link had to be identified by its A and B nodes. The A node was the southern most or western most node of each link. If a centroid connector was part of the link, that number was always listed as the A node. Distance between nodes was measured and average travel speeds were estimated using local knowledge.

Capacity class was determined and documented. This field (called CODCURVA for MINUTP) is user definable and is used to tell MINUTP what the hourly per lane capacity is for each link. There were nine different capacity classes. Each capacity class corresponded with a specific facility type and there were nine facility types identified. The facility types ranged from "full access control, divided, 4 or more lanes" down to "rural 2-lane county road". A separate capacity class was listed for centroid connectors.

The number of lanes was listed in each direction. For example, a four-lane, two way street would have a 2 in this field. A three-lane, one-way street would have a 3 in this field. The one-way indicator was used to tell MINUTP the configuration.

AADT was identified for any links where it was available. If enough links on a stretch of road had counts, the AADT was interpolated for the

links with no actual count. Pavement width was pulled from the Street Tabs List, which MACOG staff kept current.

Functional classification was coded using the State designated functional classifications. This also came from the Street Tabs List. At the time, however, the functional classification system had not yet been revised. Therefore, this field was originally created using the old functional class identification and was later re-coded with the current functional classification system.

Each link record had to contain the number of the Census Tract and TAZ in which it was located. Also, if it was located on one of the sixty-seven corridors used for calibration purposes, this had to be identified. (This was later expanded to sixty-nine corridors when the network was expanded). Similarly, there were five screenlines, ten outlines, and eight cordon lines identified by BLA that had to be coded.

Trip Distribution

Trip distribution tables are another requirement of the TDF software package. Trip distribution is the science of allocating every automobile trip to a specific link in the network. A trip occurs every time a motor vehicle is moved, under its own power, from one location to another. For example, if a person living and working in South Bend drives from home to work, that is one trip. However, if that person stops to get gasoline on the way to work, that creates an additional trip.

Trips are divided into several categories, or purposes. These are as follows:

Home based work (HBW) – these are trips that have one end at home and the other end at work. Both home to work and work to home are HBW trips. The trip must be direct with no other stops.

Home based other (HBO) – these are trips that have one end at home and the other end any place besides work.

Non-home based (NHB) – these are trips that neither begin nor end at home.

Another city non-home based (ACNHB) – these are trips that do not begin or end at home and also have their beginning and ending points in different cities.

The first example listed above would be a single HBW trip. The second example consists of two separate trips. The first is a HBO trip and the second is a NHB trip. If the person in this example stops at a gas station in South Bend, but is working in Goshen, the trip between the gas station in South Bend and the work location in Goshen would be an ACNHB trip.

The purpose of this break down is an attempt to identify the number of trips going from each TAZ to every other TAZ. Trips that occur entirely within a single TAZ are also identified. This will help the computer assign trips to the proper links. This information is put into Production-Attraction (P-A) tables, sometimes called trip distribution tables. The MACOG TDF model includes twenty-eight trip purposes in six different P-A tables.

These P-A tables are created for each year based upon socio-economic projections for that year and data from an O-D (origin-destination) survey conducted in 1993.

The number of trips entering or leaving the network study area must also be included in the trip generation programs. A file was created containing the number of trips originating or terminating within the study area, as well as the number of through trips for each external station. This was done for 2000 using AADT. For each station, a mathematical percentage was determined and used to calculate the daily total for each category.

Using historic data and local knowledge, external station counts for the target years were calculated for each external station. These base and target year numbers were then interpolated to create a file for each horizon year.

Five trip generation programs were developed, which take as input the socio-economic data and the external station data for the year being modeled and output production-attraction rates for each TAZ, which are used as inputs.

Model Update

For the 2035 Transportation Plan, the travel demand model was updated using the latest data available and the Geographic Information Systems (GIS) developed by St. Joseph and Elkhart County. The line work used to represent the roads in the TDF model was spatially adjusted to the address centerline file from the GIS. This allowed for a more accurate distance calculation because the links now closely follow the length and curvature of the roads.

The aerial photography was then used to further adjust the alignment of the roads while updating the attributes of the roads that could be determined by visual inspection. These attributes included the number of lanes on the road in each direction and the facility type of the road. With the traffic counts collected by MACOG now referenced to a point in space, the traffic counts could also be updated using GIS data. The traffic counts site number was also added to the TDF model to improve future updates.

The last attributes to be updated were the functional classes and the link speeds. The functional classes were updated based on the latest available functional class maps from INDOT. Any functionally classified roads not already modeled were added, along with any local roads deemed necessary for balancing the model output. After the functional classes had been updated, the link speeds were updated by functional class using the annual travel time studies conducted by MACOG staff.

Model Calibration

Once all the input data for the base year had been assembled, the next task was to calibrate the network model. Calibration is the process by which the model is “tweaked” to replicate traffic patterns that are actually occurring. The basic theory behind this is fairly simple.

The TDF model receives as input, the physical characteristics of the links (roadways included in the network) and production-attraction matrices. The socio-economic and external station data files are read by the trip generation programs, which were converted to GISDK to create the production-attraction matrices that

are read directly by the TDF software. The software then converts these completed tables into origin-destination trip matrices within the program. The TDF is “run” and the traffic volumes generated by the model are compared with actual ground counts.

Screenline, corridor and cordon line counts were used for this comparison, as it is not practical to attempt to check each link individually. Screenlines are imaginary lines drawn across several parallel facilities and used to check the total number of vehicles crossing the line. The specific number on each facility may be somewhat inaccurate, but so long as the total is accurate for each screenline, the model is considered calibrated within an acceptable tolerance.

A corridor is an actual facility that traverses a large part of the Network. Average counts on the corridor are compared with average computer generated counts along the corridor.

A cordon line is an imaginary line drawn around a special generator (such as the University of Notre Dame). This is used similarly to screenlines in that the total number of vehicles actually crossing it must be close to the total number of vehicles assigned by the computer to cross it.

There were five screenlines, sixty-nine corridors, and eight cordon lines used to calibrate the TDF model. The overall picture is what is important; achieving accuracy for each link is not possible with the current technology and methodology used for traffic forecasting.

It is highly unlikely that the first run will yield particularly accurate results. Therefore, it is generally accepted that slight adjustments may be made to the input link data in an attempt to improve the overall accuracy of the model. Prior to making any changes, the output is examined for any trends among specific facility types or other data. For example, many roads with facility type 5 (2 lanes with continuous center turn lane) may be attracting too many trips. This may be corrected by categorically dropping the speed on all links with facility type five by one mile per hour, thus making them slightly less attractive in the model.

The final base year network as calibrated and assessed by MACOG showed the overall VMT to be within 3.97% of the collected ground counts. This is not to imply that all generated counts are within 3.97% of reality; the “actual” ground counts themselves are generally considered to be accurate to within 15% of the “truth”. What this actually means is the sum of all of the counts generated by the model, for links having an actual ground count, is within 3.97% of the sum of all these actual ground counts.

Once the network has been calibrated to replicate base year traffic patterns, the same assumptions can be made for future years. This means that friction factors created to calibrate the model for the base year will be assumed to be correct for future years. The trip generation programs will need to be run again to incorporate the socio-economic and external station data into the new production-attraction matrices for the new run. These were prepared for the plan target year (2035) and interpolated for each horizon year between 2005 and 2035, so any year may be run with the model.

Build Scenarios

As the project selection process continued, the projects were built into the model in five-year increments. For example, anything built between 2010 and 2015 was first introduced into the model in the 2015 build network. Each successive model included all previous projects as well as the new projects. The MACOG TDF model contains all regionally significant added travel lane projects. This includes new road construction as well as road widening projects. Simple pavement and intersection improvements cannot be modeled and are therefore not required to be in the transportation plan or TDF model, but are considered in determining the financial constraints of the Plan.

Future Uses of the Model

SAFETEA-LU requires that MACOG staff update the Transportation Plan every four years as a non-attainment or maintenance area for air quality. This includes revisions, as needed, new forecasts for socio-economic data, external station data, and link data, as well as updates to the current year data. A new calibration run

must also be completed for the beginning model year.

Beyond the air quality conformity analysis, the TransCAD transportation model is extremely useful for long range transportation system planning. Examining model output can help clarify existing problems with the roadway network that need to be addressed. The main impact of the model, however, is in evaluating different proposed solutions to existing (or perceived) problems. For example, it may be suggested that an interchange be constructed on a highway giving direct access to a community or development, as this may help attract people to that community. The model may indicate residents would use this new route to and from their homes rather than passing through the existing business district and through traffic would continue to use the highway around the community. Of course, further research would need to be done to assess the probable result of any project. As explained earlier, model output on a small area cannot be accepted as “truth”, but can give good insight as to what type of impact a project may have.

Modifications are made to the network model to reflect new projects or project changes easily evaluated. Therefore, several different possible solutions to a given problem can be modeled and evaluated to help determine the best solution(s). This is much more efficient than mapping an area and performing all the necessary computations manually. However, the accuracy of the model decreases as the size of the sub-area being examined decreases. Since the Transportation Plan generally consists of relatively large, regionally significant projects, the level of detail is generally acceptable and the results may be assumed to be plausible.