The Kentucky Statewide Transportation Focusing Process

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Kentucky Transportation Cabinet

INTRODUCTION

This purpose of this paper is to review the Kentucky Transportation Cabinet's statewide traffic forecasting function. Traffic forecasting's role in the structure of the organization and its impact on policy issues will be covered first. Next, the various techniques that are used will be reviewed with emphasis on the traffic modeling tools. Finally there will be discussion of possible future directions in both the policy and technical spheres.

TRAFFIC FORECASTING: POLICY REVIEW

Kentucky Transportation Cabinet

Structure

In order to properly understand the impact of traffic forecasts on Kentucky Transportation Cabinet policy, it is useful to understand what the Cabinet is and to know its structure. The Cabinet - in many states known as the Department of Transportation - is Kentucky's responsible authority for the state maintained transportation system in Kentucky. Exhibit 1 shows the organizational structure of the Cabinet. The Highway Department is the portion of the Cabinet that contains the engineering and planning functions.

Planning Function

Within the Highway Department is the Office of Intermodal Planning. This office contains two divisions that perform traffic forecasting tasks. The Division of Transportation Planning is responsible for statewide traffic forecasting and the Division of Multimodal Programs is responsible for urban traffic forecasting. Other groups that are involved in the planning function are the district planning offices, the metropolitan planning organizations, the area development districts, the Kentucky Transportation Center (the Cabinet's research partner) and the consulting industry.

Empower Kentucky

State government began a radical new look at all functions when Governor Paul Patton was elected three years ago using Total Quality Management principles. This initiative is called Empower Kentucky. Empower Kentucky has resulted in many changes in the Transportation Cabinet in an effort to better serve the taxpayers. One of the results of Empower Kentucky is an increased emphasis on project development. The Cabinet has decided that project development needed to be done more seamlessly and quickly. This has increased the importance of timely traffic forecasts since traffic forecasting occurs early in the project development process.

Another by product of Empower Kentucky has been the restructuring of many engineering processes.

Planning functions have not yet had a process review but are in the process of making significant changes. One change has been the reorganization of the Division of Transportation Planning into teams of no more than four to five people per team in order to improve productivity and customer service. This has resulted in separating the traffic forecasting function from the traffic data collection and processing function. Another change under consideration is the unification of two traffic forecasting units (statewide and urban) into one team.

TRAFFIC FORECASTING FUNCTION

The traffic forecasting function is currently administered by the Division of Transportation Planning. All traffic forecasting requests are initially sent to the Division of Transportation Planning. Urban projects (about 20% of all projects) are then sent to the Division of Multimodal Programs who either completes the work in-house or sends the request to an MPO if the project is in the MPO study area. The Division of Transportation Planning does most of the statewide traffic forecasts in-house. A statewide traffic forecasting consultant is used to complete about 10% of the incoming forecasts.

Demand for Traffic Forecasts

About 180 to 240 traffic forecast requests are received every year. The source of the forecast requests and the use of the forecasts are shown on Table 1 - Types of Traffic Forecasts. The major customers of traffic forecasts are project development (highway design), planning, research, materials and others. The types of traffic forecasts received by the Cabinet and the products given are shown on Table 1.

This demand has recently undergone an increase due to Empower Kentucky. Empower Kentucky, in an effort to expedite the construction letting process, has started developing some projects before they have formally received funding. This improved readiness should allow the Cabinet to respond more quickly to changes in funding and to shorten the time to get a project constructed.

Importance of Traffic Forecasts

One of the Cabinet's assistant state highway engineers recently stated "make no mistake, traffic forecasting and financial resource commitment are closely tied." This statement - and many others by top management within the Transportation Cabinet - have underscored the importance of accurate traffic forecasting. Even with the additional funding due to TEA-21, the state of Kentucky's unfunded needs greatly outnumber the finances available. For example, Kentucky's draft 20-year Long Range Highway Plan estimates funding at $8.5 billion for new highway construction or reconstruction while the database of unfunded needs exceeds $32 billion.

The reason that traffic forecasting and financial resource commitment are so closely tied is because of the importance of traffic forecasts in determining what is built. Traffic forecasts are the main input into highway capacity analyses which in turn determine the geometric requirements for highway projects. Geometric requirements have great impacts on costs. For example the growth rate used on a traffic forecast frequently makes the difference between a project having two lanes or four lanes. Obviously, the cost differential between the two geometric scenarios can cause other worthy projects to go unbuilt.

Traffic forecasts are also very important for pavement design. Equivalent single axleloads (ESALs) are usually the most important parameter in the pavement design process. Often the success of the pavement of a new or reconstructed highway is dependent on the accuracy of the forecasted ESALs. Because of the importance of traffic forecasts in the design process, the decision-makers within the Transportation Cabinet have sought to respond appropriately.

The Cabinet budgets about $500,000 per year in traffic forecast related expenditures in order to provide for an accurate product. This includes staffing, model updates and other major expenses. One difficulty the Cabinet has had is keeping the function adequately staffed. ISTEA and TEA-21 have produced a demand for transportation engineers that has made it difficult for government to compete with the private sector, especially in respect to starting salaries. The Transportation Cabinet has dealt with that difficulty by hiring engineering students as interns and by using the services of a statewide traffic forecasting consultant. These measures have helped the Cabinet maintain a high quality and timely product.

The Cabinet has recognized the importance of traffic forecasting by maintaining excellent tools for its forecasting staff. The Cabinet has had a statewide traffic model since 1971 for statewide traffic forecasts. The Cabinet has also generated small urban traffic models for all 37 of the cities in Kentucky with population of greater than 5,000 and less than 49,999. Finally, all of the MPOs have their traffic models. It is safe to say that the Cabinet is highly committed to traffic modeling as a tool for high quality traffic forecasts.

Other tools that the Cabinet has provided for traffic forecasting are state-of-the-art computers, plotters, printers and other computer equipment. GIS/mapping tools such as ArcInfo and Maptitude are provided for displaying the information to forecasting customers. Finally, the Cabinet has always provided the best traffic modeling software for its analysts and engineers.

Traffic data collection has always been highly responsive to the traffic forecasting function with more than 700 counts made annually as special counts. Additionally the Cabinet performs another 4,000 counts made for its traffic volume data collection program which are available on-line for forecasting use.

Another area that has supported the traffic forecasting function is research. The Cabinet's research partner - the Kentucky Transportation Center (KTC) - has performed numerous research studies that have had forecast related themes. There have been several studies that have improved the equivalent single axle load processing area and traffic data collection/processing, including vehicle classification, weigh-in-motion and volume data processing. There are currently two ongoing studies related to traffic forecasting. One is the creation of a computer program to estimate ESALs for Superpave asphalt mix design and the other is a study which is creating seasonal factors for improving the data quality of vehicle classification data.

The only real deficiency that the Cabinet might be said to have in respect to traffic forecasting is the current lack of origin-destination data. The Kentucky Attorney General issued a ruling in 1994 that prohibited stopping vehicles for the purpose of conducting an origin-destination survey. This has made it more difficult to collect origin-destination data since the non-intrusive alternative (video tape origin-

destination surveys) are very expensive to conduct. The Cabinet has had to resort to using synthesized external-external trip equations to make up for the lack of real O-D information.

TRAFFIC FORECASTING TRENDS

Personnel

The trends experienced by the Kentucky Transportation Cabinet are probably similar to those of other state highway departments. We have experienced some staff reductions in all areas of state government in an effort to cut costs and increase efficiency. Largely, this has not impacted traffic forecasting due to its perceived contribution to the project development area. No one has been dismissed nor have any vacant positions been eliminated. As stated above, the main staffing difficulty has been to attract engineer-in-training personnel to the function in view of the great opportunities available in the private sector.

The Cabinet currently has four full-time employees involved in traffic forecasting and two engineering student interns (part-time employees). There is also one engineer devoted to monitoring traffic modeling update efforts by consultants retained by the Cabinet. Finally, there is approximately one-half of a staff person in the three major MPOs in the state involved in traffic forecasting. Cabinet forecasting is supplemented by a statewide traffic forecasting contract that is used to handle forecasts beyond Cabinet staffing availability.

Information Technology

The Cabinet's Division of Information Technology has been very supportive of the traffic forecasting function. State-of-the-art tools have always been available such as personal computers, laser printers, plotters, software and technical support. Recently, there has been an interest in using GIS for various tasks within the traffic modeling area. GIS has been used primarily for product displaying traffic assignments and recently - for the first time - used in producing link-node/zone maps. It is anticipated that we will have much more wide-scale GIS applications since most of the 120 county level base maps are now complete. The Cabinet has a statewide database - the Highway Information System - that can be associated with the GIS maps fairly easily.

Workload

The traffic forecasting workload has increased in recent years due to several factors. The quantity of forecasts needed has increased due to the need for equivalent single axle load (ESAL) information by the Division of Materials. The Division of Materials uses ESAL information for designing Superpave asphalt mixes. Another factor that has caused the workload to increase is the need for traffic forecasts - particularly time consuming intersection turning movements - for the purposes of determining the impact of highway projects on air quality.

Issues

Since traffic forecasting is a major contributor to several processes within the Kentucky Transportation

Cabinet, it is only natural that some issues would arise. The Cabinet has formed a Traffic Model Users Group to help discuss some of the issues and to share information. The Traffic Model Users Group consists on Cabinet forecasters/modelers, MPO modelers, consultant partners, research partners (Kentucky Transportation Center and the University of Kentucky), the Federal Highway Administration and interested Cabinet decision makers.

The Model Users Group has mostly been a forum for technical issues but has also seen the discussion of topics of interest such as the availability of data owned by the state. Current issues that have sparked discussion are:

- Should low design year values be used in order to conservatively prevent overbuilding or should higher design year values be used in order to account for possible unanticipated growth?
- Vehicle mile travel estimates in the future. Should they be prepared using HPMS or with a traffic demand model? Also, how should future values be determined for statewide VMT and county-level VMT?
- Traffic modeling software is rapidly changing. Which software package best serves the Transportation Cabinet and should the Cabinet's software be compatible with the state's MPOs?
- Documenting traffic modeling is very time consuming. To what extent should procedures be documented and standardized?

These issues will be resolved by a combination of feedback from management, the Traffic Model Users Group, by insights from other practitioners and the passage of time.

TRAFFIC FORECASTING: TECHNICAL REVIEW

While the policy questions are of great interest, it is difficult to separate the role of the technical preparation of traffic forecasts. This part of the paper will review traffic forecasting techniques, especially the statewide traffic model, and a brief look will be given to possible changes in the future.

Forecasting Techniques

There are many tricks of the trade used in producing the typical traffic forecast. Some interesting facts about the Kentucky Transportation Cabinet's traffic forecasting standard practice are listed in Table 2. The basic product consists of some measure of traffic - ADT, DHV, truck percentage, ESAL, MOE - in different points in time and in different geometric scenarios. The first area that needs review is the method used to estimate existing traffic.

Current Year Traffic Estimation

The Kentucky Transportation Cabinet has a strong traffic data collection program that is the source of most of its traffic forecasting information. The Cabinet makes approximately 4,700 counts annually including about 700 special counts made just for traffic forecasting. The Cabinet has 65 automatic traffic recorders that are excellent sources of information. The Cabinet also makes about 300 vehicle classification counts annually to provide detailed information concerning the vehicle types. Finally, the Cabinet has collects weigh-in-motion data from nearly 90 sites on a three year cycle.

The traffic data is available in many formats: reports, databases, maps and summary reports. The forecaster takes the source traffic data, smooths and factors the data so that it is consistent with the other data in an area. It is absolutely critical for the forecaster to be knowledgeable about the source of the traffic data. Since traffic data is only one "snapshot" of the traffic at a given point or area, the forecaster must produce a rational estimate of current conditions. Therefore the experienced forecaster must review the count factors (axle, temporal), the count area, and the count history in order to arrive at a reasonable estimate of the current traffic.

The forecasting analyst is also required to make diverse data that doesn't fit perfectly into a smooth, balanced seamless flow of information.

Future Year Traffic Forecasting

Once the current year traffic is finalized, the traffic forecaster must project this traffic into the future. There are two main sources of information used to accomplish that task. The first is historical traffic data. The historical data trends are computed and assumed to be reliable indicators of future travel patterns. The data is then extrapolated into the design year (or other desired future year). The Cabinet uses two main extrapolation tools. The first is a computer program that produces current year estimates based on previous counts at a location and functional class averages when there is not much data available. This microcomputer program is known as the "Counts" program, primarily uses weighted linear regression to produce the estimates. It also produces a 20-year estimate based on linear regression. The other main extrapolation tool is the use of trend line analysis programs available in commercial spreadsheet packages.

Socioeconomic information is also used to produce estimates of future travel. Traffic models, of course, have population and employment information embedded in the trip generation step. Socioeconomic data is also used to get a "feel" for an area to see if conditions are right for higher growth rates. The Cabinet relies on the Kentucky State Data Center to produce reliable estimates of population in the future (see reference 1).

This area involves a tremendous amount of engineering judgement. Traffic forecasts in Kentucky tend to average around 2.5% growth compounded per year. Areas with high growth (for example new highways) often exceed that rate while other areas might have lower growth rates due to capacity restraint or lack of economic vitality. There has never been a study reviewing the traffic forecasts by the Cabinet compared to actual traffic. This might be interesting and useful. It should be noted that the annual VMT growth average in Kentucky over the past 10 years is about 4% per year! This would seem to indicate that we are under forecasting.

Hourly Estimates

While average daily traffic is the most common and widely used traffic parameter, design hour volumes are of most use in the design process. The 30th highest hour of traffic in the year is the designated design hour used by the Transportation Cabinet. The Transportation Cabinet relies heavily on data obtained from continuous traffic recorders (ATRs) to obtain factors (k-factors, directional factors and

peak hour factors) to convert daily traffic to the design hour traffic. The report *Traffic Characteristics of Kentucky Highways 1996* (see reference 2) contains a list of Kentucky's ATRs along with the k-factors for each ATR.

Short term 48-hour counts are used to get a relative idea of the amount of traffic in the peak hour. The peak hour traffic is then adjusted, based on ATR data, to obtain the design hour volumes. Although a true k-factor is not obtainable from a short term count, the directional factor from a short term count is usually acceptable. Thus, thefactors for the hourly counts usually come from more than one source.

Turning Movements

Many of the traffic forecast requests involve the calculation of turning movements at key intersections. The Transportation Cabinet has a fairly refined process for determining turning movements. A recent report *Turning Movement Estimation Guidelines* (see reference 3) summarizes the methodology used for estimating turning movements. Actual turning movement counts are made for most design projects, while the Cabinet is usually content with computer generated turning movements for other purposes. The estimation of turning movements is a time intensive task that requires good judgement from the analyst.

Traffic Diversion/Generation Tools

One of the most important tasks that the traffic forecaster must perform is the estimation of traffic on new facilities or alternate alignments to existing facilities. This requires that the forecaster must have tools to divert and/or generate traffic. The most commonly used technique for estimating traffic on new highways is with a traffic model. The Cabinet's use of traffic models is covered in the next section. Other tools used by the Cabinet include the Modling external-external trip estimation equation (see reference 4), the California Diversion Curve (see reference 5) and the "manual gravity" method.

The manual gravity method is used to estimate the travel demand between two locations and the diversion curve is then used to estimate the percentage of the traffic demand diverted to the new facility. The manual gravity method is based on successively reducing the through traffic due to turning movements. This technique requires excellent count coverage in an area in order to calculate turning movements at all intersections on the subject corridor.

The main trip generation tool used is the ITE Trip Generation Report (see reference 6). This report is used if there is no local trip generation information available. One slight divergence from the national ITE trip generation rates is the use of eight trips per household when estimating traffic on rural dead-end roads. Our experience has shown that the trip making of most rural Kentucky households is less than the national 9.57 average.

Traffic Models

The Transportation Cabinet uses traffic models heavily within the traffic forecasting function. Traffic models have been developed for all seven of Kentucky's Metropolitan Planning Organizations (MPOs) and most of Kentucky's 37 small urban areas (areas with population greater than 5,000 but less than

50,000). In addition, the Cabinet has developed the Kentucky statewide traffic model. The traffic models used by the MPOs and the small urban areas are used for traffic forecasting purposes as well as for developing transportation improvement programs (see reference 7).

Most of the current small urban models are being developed by consultants under contract to the Cabinet. Usually, the hardest data to collect for traffic models is through trip data. The state of Kentucky has synthesized data for that purpose using regression equations developed by the Kentucky Transportation Center.

Statewide Traffic Model

The Kentucky Transportation Cabinet has used a statewide traffic model for many years. This section will discuss the history of the model, current model specifications, model usages and the ongoing model update. Table 3 gives a capsule summary of the Kentucky statewide traffic model and it is covered in more depth below.

History

The first Kentucky statewide traffic model (KySTM) was developed in 1971. This model had a large network which included zones in many states outside of Kentucky. It was similar in principles and methodologies to traditional urban models. It had several trip purposes including truck trips. It was updated in 1973 using new origin-destination data, household interviews, and 1970 census information. The model was recalibrated in 1975. Unfortunately, maintenance of the model was not deemed practical at that time and was therefore not maintained well for several years after that.

The model was updated in 1991 by Wilbur Smith and Associates (see reference 8). This update took the 1975 model and adjusted the trip table using a ground count calibration program. It reduced the network to contain only zones inside the state of Kentucky. The final products included a 1990 current year trip table and a 2010 future year trip table.

The next update was in 1997 by Wilbur Smith and Associates (see reference 9). The model was updated as a part of a corridor study on I-66. This new model significantly improved the 1991 model. It restored trip generation, added a truck trip purpose and enlarged the study area to include all of the surrounding states. The final products were a 1995 current year model and a 2025 future year model.

Model Specifications

The 1997 Statewide Traffic Model update was a major effort since the network was expanded beyond Kentucky and trip generation capability was added. The model took approximately 18 months to develop and cost about $190,000. The model update was included as a part of a larger task which was a corridor study on the proposed I-66 high priority corridor in Kentucky. This larger task helped “sell” the need for updating the model.

No new travel data was collected for the model. It used data available from existing databases. A network was produced containing 1,530 zones (including 823 Kentucky zones) and 28,282 separate links

(see Exhibit 2). The modeling software used is MinUTP, and the assignment methodology is "all or nothing." The traffic model has five trip purposes: Home Based Work, Home Based Other, Non-home Based, External-External and Truck. These purposes are similar to most urban models and were agreed upon after much discussion.

Other notable aspects of the Kentucky statewide traffic model are the use of the National Highway Planning Network Version 2.0 to create the MinUTP roadway network outside of Kentucky. This network was combined with the 1991 model network to create a seamless network. Another interesting characteristic of the model is the use of a program that calibrates the generated trip table to ground counts. This program adds an extra measure of accuracy that is needed because of the large area that is being modeled.

Statewide Traffic Model Usage

The Kentucky Statewide Traffic Model was designed for use in major statewide highway projects. It is less accurate in urban areas and is not used there. It is very useful for corridor studies, for alternative analysis and for new rural highways. For corridor studies, the model can produce measures of effectiveness, such as vehicle miles traveled and vehicle hours traveled, that can be used to perform economic analyses. For new statewide highways, the model can be used to determine the estimated average daily traffic that will use the proposed new road.

As with any traffic model, care must be taken to inspect the fineness of the highway/zonal system to see if the "answers" given by the model are useful. In general, most assignments from the model must undergo some adjustment before being used in the actual traffic forecast. This adjustment is based on both the accuracy of the specific highway link volume accuracy and the surrounding subarea volume accuracy. Since the model is relatively easy to recalibrate based on new traffic volume information, recalibration is an option. Another means of producing accurate assignments is the creation of a subarea model that can contain a refined highway/zone network.

Consideration has been given to using the model for intermodal freight movement prediction but this would probably require further refinement of the truck trip information.

1999 Update

The upcoming 1999 KySTM update will be a "minor" update compared to the previous effort. It will recalibrate the network based on new count data and on improved network link information. The new data years will be 1998 for the current year and 2030 for the future year. Several programs will be written that will allow easier post-processing use of the model for the average user. Other new planning data will be incorporated into the model such as origin-destination data (where available), commodity flow data (if available) and possibly aggregated MPO model data.

This model update will also provide for training, staff support and conversion to new modeling software if that comes to pass. The 1997 model is still useful but this update is aimed at making incremental improvements and to recalibrate the model. This update will cost an estimated $37,000.

After the year 2000 census (by year 2002 or so), will probably be a good time for another traffic model update which would incorporate the new census data and would take a look at the need for collecting actual origin-destination data on key corridors, the incorporation of freight modeling, the use of aggregated MPO model data and, then, unforeseen changes.

Traffic Forecasting Improvements in the Future

It isn't easy to anticipate what changes will occur in the future so these predictions should be taken with the usual shaker of salt:

- Improved feedback loop to decision-makers using GIS will help improve data collection needed for traffic forecasting.
- Improvements in technology will allow for the easier creation of traffic models and will allow for some overlap between travel demand modeling and traffic simulation modeling.
- The new AASHTO Pavement Design Guidelines should eventually result in improved ESAL forecasting.
- Length-based vehicle classification and ITS data sources will be valuable additional sources of data for traffic forecasting.
- The accuracy of traffic forecasting will increase if population growth finally slows down.
- Designers will become comfortable working with traffic forecast ranges or intervals which will further increase the sophistication of the forecasting discipline since confidence intervals will vary based on the data available and the tools available.
- Staffing DOTs will continue to be a problem and so the relationship between the consulting industry and government will grow closer.

The crystal ball is growing cloudy ...

CONCLUSION

Traffic forecasting performs several valuable roles in the Kentucky Transportation Cabinet including providing data to designers, planners, researchers, enforcement personnel, materials engineers and decision-makers. In order for traffic forecasting to remain useful, it is essential that the Cabinet use state-of-the-art tools; for the Cabinet to allow traffic forecasting to evolve into new areas; and for individual forecasters to be mission-driven in order to serve the customers.

We think that we are successfully meeting the challenges in Kentucky and intend to continuously improve in the future.

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