The Community Options Model©: Using Artificial Intelligence for Transportation Planning and Community Decision Making

Daniel R. Talhelm, Resource Econometrics and Michigan State University,
and Aarne H. Frobom, Jr., Michigan Department of Transportation

Abstract

This paper describes the Community Options Model for Transportation-Related Issues. COMTRI is designed to help both the Michigan Department of Transportation (MDOT) and individual communities "see" the likely outcomes of potential highway realignments and other changes, and of potential community responses to such changes. It predicts the change in community indicators over time—such as population, jobs, income, unemployment, tax rates, local government income and spending, property values, vehicle trips and congestion, education attainment, and community services quality—in response to policy or action scenarios posed by the user. The model is equally useful for evaluating a wide variety of non-transportation community options for community development.

COMTRI is a hybrid knowledge-based and statistics-based systems analysis of community social, economic, and transportation systems and their responses to exogenous action and policy scenarios. Knowledge-based simulation models are simple forms of artificial intelligence, in which the model's equations—and thus its predictions—are constructed to mimic the thinking of experts on the topic. They can utilize available human knowledge to specify relationships that would be impractical to estimate statistically.

COMTRI's structure and equations were initially specified in general form by a group of experts and practitioners. Its details were specified as necessary to predict actual conditions in three-case study communities over the period 1980-1992. The resulting model "thinks" and predicts much as the team would if it could integrate its collective best thinking to predict the indicators over time, but using some 400 equations that have been fitted to statistical data.

COMTRI is designed to be used by rural communities throughout Michigan. We describe how several Michigan communities are using COMTRI interactively to evaluate the effects of their own potential policies and actions. Extensive detail about any given community must be entered into the model to predict outcomes specific to that community.

The example first estimates the likely community impacts of possible highway realignments (bypasses) being considered by MDOT. Then we explore community options for responding to these changes. Bypasses tend to redistribute retail sector activity from former thoroughfares to new bypass intersections. Other economic development also follows eventually, further influencing traffic volume and flow.

Local strategies for increasing retail sales can increase local employment, which in turn increases population and local expenditures for education and other services. Changing tax revenues and demands for services create pressures to increase or decrease property tax rates.

By exploring a variety of options, communities can identify strategies that are more likely to produce the outcomes they prefer. Skillfully used, such information can help unify community efforts, which should increase the community's chances of reaching its goals. Further, with the model the MDOT's formal economic and environmental impact assessments can now specify how the impacts of a given realignment may vary depending upon the community's response to the change.

Road agencies and communities are often intensely interested in the local impacts of road improvements. Socioeconomic impact assessments are usually intended to provide most of the information agencies need to evaluate projects from the public point of view. Such assessments should form the heart of agency and public debate regarding which actions and projects should be undertaken.

Impact assessments are rarely utilized this way. They are almost never used to help formulate the best actions or project options. They are much more likely to be used to confirm or support choices that have already been at least tentatively decided.

We believe economic and social information is underutilized primarily because such information is expensive and not readily available. Scientific tools and statistical data have been of little help in predicting the outcomes of local changes to highway networks. Econometric or land-use allocation models work only at the largest scales, and often the small-scale impacts generate the most controversy. Planners usually resort to judgment based on observation of similar cases and local conditions. Further, socioeconomic information is poorly understood by the general public, and is often estimated and presented in a confusing variety of formats. However, these latter problems would probably subside if the information were used more often.

These limitations may soon evaporate. Widespread use of personal computer technology and new simulation model techniques can make such information quickly and easily available.

This paper describes one such personal-computer application program: the Community Options Model for Transportation-Related Issues (COMTRI), designed to estimate the social and economic impacts of highway realignments on rural Michigan communities for the Michigan Department of Transportation (MDOT).

COMTRI allows MDOT and individual communities quickly "see" the likely outcomes of potential highway projects, and of potential community responses to such projects. It predicts the change in community indicators over time — such as population, jobs, income, unemployment, tax rates, local government income and spending, property values, vehicle trips and congestion, education attainment, and community services quality — in response to policy or action scenarios posed by the user. COMTRI also estimates the impacts of a wide variety of potential community responses to highway realignments as well as the impacts of local community development actions such as granting tax abatements.

This paper describes COMTRI and its use in estimating the socioeconomic impacts of highway projects. We first describe the rationale for developing the model for use by a transportation agency. Following that, we describe how the model's framework was specified by a multi-disciplinary group of experts and practitioners, and its equations were fitted to data from three case-study communities. The fourth section illustrates use of the model in estimating the impacts of a highway realignment in one of our test communities. It describes the types of qualitative and quantitative community information required to initialize the model — usually involving some community self-assessment — and the types of information estimated by the model. The examples also illustrate how decisions made by the community can change the impacts of the realignment. We conclude that COMTRI's rapid and comprehensive impact estimates could be used as a decision support system in planning and decision making processes. By exploring a variety of options, the agency and communities can identify strategies that are more likely to produce the outcomes they prefer. Skillfully used, such information can help unify community efforts to cope with and take advantage of the local impacts of highway realignments. New technology and new approaches to model development and estimation have made it possible to develop and utilize large, comprehensive models such as this.

Rationale For COMTRI

This project began as a response to highway-improvement projects in Michigan. MDOT needed forecasts of the impacts of alternative improvement schemes on small cities, including relocations of state highways bypassing main streets, freeway extensions, widening of main streets and one-way pairs:

- Project planners needed to resolve controversy between competing client groups.
- Highway-agency managers needed to choose between proposed alternatives.
- Environmental staff needed to forecast project impacts for NEPA reporting.
- Local residents and entrepreneurs wanted to know how proposed alternatives would impact their neighborhoods and businesses, how to manage adverse impacts, and how to take advantage of new conditions.
- Local planners wanted to build on the improvement for community growth.

Demands for Impact Assessments

These customers all demanded *quantified* forecasts of impacts, typically focusing on retail sales, but also including land development, residential migration, employment growth and quality-of-life issues. Local officials and the public often presume that it is practical to produce detailed forecasts of the performance of business sectors, not understanding that at the local level these sectors consist of a very few actors, and that few relevant statistics are available for small communities.

Further, public debate over impacts often focuses on highly-visible or notorious issues — for example, the impact on established retailers when traffic is relocated to a new route, or the competitive position of a destination relative to places made effectively “closer” by a new road. From the viewpoint of the project planner, it would be desirable to focus more debate on impacts on the whole local economy rather single components. A simple, systematic analysis of the whole community may place individual gains and losses in perspective.

Strengths and Inadequacies of Traditional Approaches

Traditional approaches to impact assessment have often involved:

- Synoptic judgments by one person, such as a planner, sociologist, consultant or other expert.
- Check-off lists of potential impacts, perhaps amplified by weighted multi-objective evaluation criteria.
- Case studies after the fact, used as predictors in comparable cases.
- Custom statistical analyses for projects large enough to have statistically-meaningful populations.

Case studies have formed the backbone of forecasting tools for impacts on local development, especially for retail and residential location and other land development. This has been the most reliable approach until now. Studies of small-town bypasses, for example, now number in the hundreds; so many that the accumulated mass of studies now provides a basis for statistical study. But the case-study approach has a key failing: even a large number of prior cases is insufficient to consider all of the factors that influence the outcomes in any individual instance.

Ideally, a general statistical model could be adapted for use in small communities. For instance, land-use allocation models have been used for some time in parallel with regional transportation system models, and econometric and input-output models are being used to test the economic worth of very large-scale road system changes, such as new multi-state freeways. However, such models are inaccurate at the community level and estimate few of the variables needed.

Integrating Expert Knowledge and Statistical Data

COMTRI is a hybrid *knowledge-based and statistics-based systems analysis* of community social, economic, and transportation systems and their responses to actions and policies.

COMTRI's structure and many key equations were initially specified in general form by a group of experts and practitioners. Knowledge-based simulation models are simple forms of artificial intelligence, in which the model's equations — and thus its predictions — are constructed to mimic the thinking of experts on the topic. Such models can utilize available human knowledge to specify relationships that would be impractical to estimate statistically.

The equations that make up COMTRI were then estimated by fitting them to data from three case-study communities over the period 1980-1992. The resulting model "thinks" and predicts much as the team would if it could integrate its collective best thinking to predict the indicators over time, but using some 400 statistically estimated equations.

Expert-Based Framework for COMTRI

COMTRI began with a workshop on transportation and community development in April, 1993. The workshop followed a procedure largely based on the Adaptive Environmental Assessment workshop technique developed by the International Institute of Applied Systems Analysis (Holling, 1978; Walters, 1986). The workshop specified which components to incorporate into COMTRI, and their general interrelationships. The 21 participants included academic researchers in economics, sociology and demography, several transportation engineers, and several community development practitioners, including state, regional and local planners and community development specialists, two city managers, a city assessor, a township supervisor and a city administrative assistant.

The workshop first listed some of the current issues facing rural Michigan communities undergoing major highway realignments. *Communities* were defined as any population (under 30,000) that identifies with and frequents a central rural location, and the cities, villages and/or townships they inhabit. Then, in view of these issues, the workshop listed the indicators and actions they wanted the model to predict and simulate. *Indicators* are the information people use to keep track of conditions over time, such as population, unemployment rate and average daily traffic. Table 1 lists the categories in which the approximately 400 indicators in COMTRI are grouped. The objective of the model is to predict these indicators over time under specified scenarios. *Actions* are the changes or options that are to be evaluated by the model. Table 2 lists most of the actions suggested by the workshop. Some actions are policy changes or components that can be implemented by MDOT or by the community, such as *highway realignment, park development, or cre-*

ating a Downtown Development (tax-increment capture) Authority (DDA). Other actions may be exogenous events outside the control of the community, such as changes in *state economic conditions* or *relocations of plants or employees*.

The indicators were grouped into ten *sectors* (Table 1). Participant subgroups specified which variables and general equation forms predict change over time in each indicator. For instance, the economics subgroup specified a variation on standard economic frameworks for predicting earnings and employment by sector in the community. That is, employment in the services, construction and local retail sectors depends largely upon total community personal income, employment in the retail mall sector depends in part upon the amount of community income derived from outside the community, and employment in manufacturing and several other sectors depends largely upon state and national trends. Subgroups also specified some additional variables produced in their sectors that other subgroups needed for estimating their indicators.

Table 1: Sectors and subsectors of COMTRI

Population	**Labor Force/Commut./H'holds**
Population by 7 age classes	Labor force & commuting
- Population density index	Households
- Senior attraction index	**Property Values**
Economy	Residential/developmental
Retail/wholesale	Commercial
Travel/tourism	Industrial
Construction	Agriculture/forest./open
Services/FIRE	Personal property
Manufacturing	**Community Services; Indicators**
Mining/trans./utilities	Recreation/tourism
Education	Institutional services
Government	Community indicators
Agr./forestry/fisheries	- Cost of living
Earnings	- Cost of government
Economic base	- Crime
Transfer payments	- Housing
Personal income	- Education attainment
Economic attractiveness	- Social services
Retail Land Use	**Public Budget**
Retail & traffic x bus. district	City & township taxes
Traffic Volume & Safety	Education taxes & budget
Volume by road link	City/village/twp revenue
Local trip generation	City/village/twp expenditures
Corridor volume/speed	County health/welfare/judicial
Traffic safety indexes	Fiscal equity
Seasonal Population & Lodging	**Community Organization**
Lodging	Self investment
Camping	Competence index
Seasonal homes	Attractiveness index

These variables and interrelationships form an initial outline or framework for an expert-based systems analysis of community socioeconomic and transportation systems composed of:

- perspectives and findings of several scientific/engineering disciplines,
- practitioners' and trades' explicit and implicit rules of thumb, and
- best judgment regarding relevance and interrelationships of systems and components.

Equation Estimation

After the workshop we began estimating the approximately 800 individual equations that comprise the simulation model described at the workshop. The equations are grouped into 10 sectors and 42 subsectors (see box). Roughly half of the equations perform "housekeeping" operations, such as integration, summation, or recording constants, so did not require statistical estimation or verification. The other half, representing real-world phenomena, were estimated or verified using data from Michigan communities.

Table 2: Actions proposed by the workshop to the simulated in COMTRI (partial list)

Transportation options:	Inter-community cooperation
Bypass (freeway, limited access, highway access)	Support services for elderly, etc.
Improve (widen, controls, straighten, 1-way pr.)	Limit signs or noise
Highway access controls: Curb cuts, blvd vs 5-lane	Park development, scenic preservation, open space
Controlling water/sewer hookups	Provide off-street parking; on-street parking
Zoning extent and intensity	Increase pedestrian capacity
Master planning; corridor planning	Public communication: attitude surveys, meetings, etc.
Community strategic planning	Develop public & private campgrounds, marinas, etc.
Economic development activity (EDA, DDA, etc.)	Beautification programs
Tax abatements	Promotion; Adopt a theme for the community
Change tax rates (mileage, income tax rates)	Local budget reallocations
Industrial parks; Business incubators	Annexation/separation; 401(5)'s (revenue sharing)
Permit planned unit developments	New state tax laws
Airport development	State/national economic conditions
Educate/train local work force	Local competitive position for retail, tourism, etc.

Most equation forms were specified in the workshop, and simply needed to be fitted to actual data. We fitted equations to 1980-1992 data from three rural Michigan communities for which through traffic had been rerouted away from the downtown areas during the mid-1980s. We initialized the model to each community for 1980, then compared predictions of any equations to be fit to actual data from the community for 12 years: 1981-1992. Each equation was modified first to reasonably predict conditions in one community, then two, and eventually all three communities. In effect, each equation was fitted “manually” to data from the three communities. Rather than using a least- squares measure of fit, we considered the percentage error of prediction for the variable and for its sub-sector, the degree to which the equations influenced predictions of other parts of the model, and the degree to which the equations conformed to the model outline provided by the workshop.

It was necessary to consider more than simple statistical fit in specifying our equations because “everything is connected to everything else” both in the real world and in the model. Variables in the model are generally interdependent rather than dependent or independent as assumed in statistical estimation. For instance local population migration depends in part on local unemployment rates, and local unemployment rates depend in part on the size of the labor force, which in turn depends in part on local migration. We generally had to fit several equations simultaneously rather than one at a time.

For example, the final equations were able to predict the 1990 total population of each community within about 3%, given the communities' 1980 population and full knowledge of unemployment rates for the entire period. COMTRI estimates the population of each age class separately, and it predicted the population of each age class for each community within about 12%, except the 18-24 year age class in one community was overestimated by 21%. The communities' experiences in the period ranged widely, so we have reason to believe that the fitted equations will also predict well for other Michigan communities. The population of one of the communities, Reed City in northern lower Michigan, grew by nearly 6% during the period, while its unemployment rate remained below the state average. Another, Manistique in the Upper Peninsula, lost about 5% of its population while unemployment was higher than the state average, whereas the third, Lapeer in southeastern Michigan, grew by over 7% in population while experiencing below average unemployment rates through 1985, then above average.

The workshop did not specify some equations needed in the model. In such cases we generally asked practitioners or academic experts to help specify them, and then we followed the above equation fitting process. However, no one could definitively explain rural community-level population migration and school funding decisions, so we tested several possible explanations using data from communities statewide. For instance, we concluded that rural migration of high school graduates (18-24 year age class) responds more to the weighted average of community (20%) and county (80%) unemployment rates than to absolute or relative state or national unemployment rates. Specifically, we rejected hypotheses (1) that increased migration out of cities during periods of high statewide unemployment would increase migration of this age class to rural areas, and (2) that rural residents of this age class migrate significantly to other states when local unemployment rates are much higher than the national average. The next two age classes (25-44 and 45-64) also respond to the same factor, but are less sensitive to it and are influenced by other factors as well.

Data for several qualitative indicators and relationships were not available through normal statistical sources. In these cases, we asked community representatives to rate their communities on a percentile scale relative to other Michigan communities over the time period. We assumed that these ratings were accurate and used them to estimate equations predicting change in indicator levels over time. We also asked community members to critique COMTRI results and forecasts, particularly considering these qualitative variables.

As a final stage of model development, we are testing the model as a practical decision support tool in three other rural Michigan communities for which new highway projects are proposed. Predictions that differ from expected outcomes will be reexamined and respecified if appropriate.

Geography; Road Network and Land Use

The road network in COMTRI is highly simplified, consisting of ten nodes and links representing the major intersections and traffic flows. Through-traffic forecasts are exogenous, but changes in local auto and commercial traffic volumes are endogenous. COMTRI models community responses to masses of through and local trips, not trip generation or assignment to a network. One link may represent more than one actual road in a corridor. Transportation alternatives are represented to the model by designating the percentages of through and local auto and commercial utilizing each link. Links not existing in an alternative have zero traffic. Level of service is represented by the travel time through the community.

Land use is also highly simplified. Only retail-sector land use is predicted, in each of five business districts. Each designated business district is associated with one or more road links. The retail sector is both influenced by and influences traffic volume on those links. Because land-development impact is an issue in road improvement, we considered modeling land-use allocation in more detail in COMTRI, but we decided that would unnecessarily complicate this edition of the model. Since COMTRI estimates employment by economic sector, number of households and commuting, its land-use allocation sector could be expanded later.

Modeling Software

COMTRI was written in a systems analysis and simulation software, STELLA II®. It and its competitors, such as Powersim® and Vensim®, provide graphic tools representing systems components and processes, and are adept at handling calculations and graphing output. Its arrows and circles represent variables and relationships, and the process forms its own flow chart.

Unlike a spreadsheet, this software is designed to deal with circular (co-dependent) relationships. Feedback loops are handled by timing delays and iterations (commonly used in biological models), rather than by simultaneous equations (commonly used in economic models). Users specify the number and frequency of iterations. (COMTRI cycles quarterly for 16 years.)

The software helps one explore and clarify fuzzy or poorly-understood relationships. Functions can be entered as equations or graphs (tables of data points). If the equation of the curve is not known, or if only a few data points are known, the user can draw a proposed curve and the program will supply the missing data points. Variables or sectors can be held constant for one run, and allowed to change in the next. It also provides for easy sensitivity testing of individual variables.

Comparing Outcomes For Transportation and Community Options: COMTRI as a Decision Support System

Each community is unique. To depict a specific community, COMTRI must be initialized with data describing local conditions. Then it predicts *changes* in those conditions over time under any given scenario for the future. Therefore, initialization in effect creates an unique model specific to that community. Table 3 lists the major types of initial data and their sources. These data are similar to data typically assembled in the environmental-scan phase of community strategic planning. Data include qualitative self-ratings by community members as well as statistical data.

Table 3: Local data needed to initialize COMTRI (sources in parentheses)

Current population by age (Census, Mich Dept Mgt & Budget)
Current employment & earnings by sector (BEA)
Current property values (SEV)
Current housing and occupancy, recent construction (Census, building permits)
Community street/highway system schematic of primary routes (mapping guidelines provided)
Traffic flow volumes, patterns & related data (MDOT)
[Optional: Earnings per work projections (derive from BEA)]
Transfer payment projections (derive from BEA)
Current & expected competitive position & econ conditions (guidelines provided)
Current & expected public budget allocations, LDFAs, DDAs, etc.
Current & expected school funding allocations
Self assessment of quality-of-life indicators (guidelines provided)

The process of assembling these data can in itself provide useful insight for community members, and may help them understand the model's workings and gain confidence in its results. It may also help prevent the public-involvement process from involving only persons with specific complaints about a project. We hope the model will help limit undue focus on relatively small but highly-visible impacts such as on a block of bypassed businesses or a neighborhood subjected to increased traffic or detours. Such issues must be considered, but undue focus can prevent due consideration of much larger community-wide benefits and costs.

Figure 1 illustrates some impacts of a highway realignment (freeway bypass) completed in early 1987 at Reed City, Michigan, one of our three case-study communities. Bypasses tend to redistribute retail sector activity from former thoroughfares to new bypass intersections. Average daily traffic on the downtown corridor (Variable 1, ADTDnTn) drops in 1987, followed by the downtown corridor's volume of traffic relative to that in other districts (Variable 2, DnTnTrafShr), and

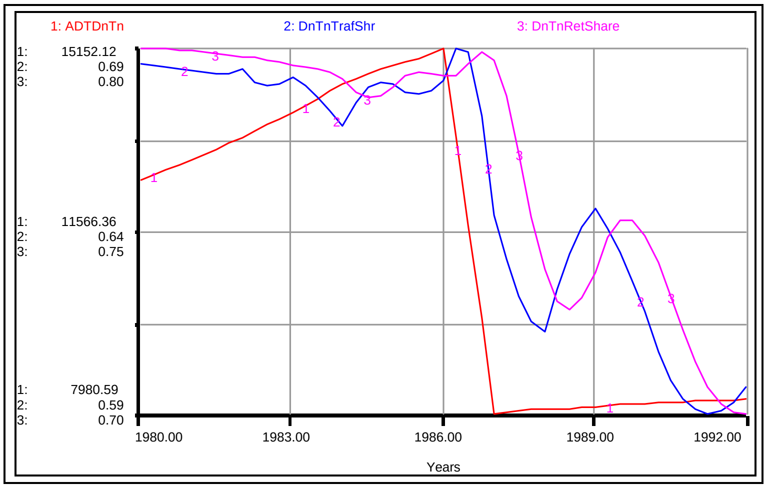

Figure 1: Traffic volume and retail employment share for Reed City's downtown district, 1980-1992

by the downtown business district's share of retail activity (DnTnRetShare). Traffic share and retail share actually dropped at the same time as traffic volume, but delays built into the model result in the lags in predictions. COMTRI predicts retail employment in each of five designated business districts as a function of traffic volume and other factors. Retail employment in turn influences traffic volume. Other economic development also follows eventually, further influencing traffic volume and flow.

The following example explores community options for responding to changes such as these. Local strategies for increasing retail sales can increase local employment, which in turn increases population and local expenditures for education and other services. Changing tax revenues and demands for services create pressures to increase or decrease property-tax rates. By exploring a variety of options, communities can identify strategies that are more likely to produce the outcomes they prefer.

Skillfully used, such information can help unify community efforts, which should increase the community's chances of reaching its goals. Further, with the model, MDOT's formal economic and environmental impact assessments can now specify how the impacts of a given realignment may vary depending upon the community's response to the change.

Our example explores the development of a mall or similar outlying retail complex at a new, heavily used intersection created by a bypass. COMTRI predicts "mall" development as a function of (1) a rule-of-thumb employed by developers, (2) community policies toward mall development, and (3) the influences of competitors. The rule-of-thumb is that development is not feasible unless the potential market (MallPop in Figure 2) — the population within 15 minutes' drive (AreaPop) plus 1.5 times average daily traffic (ADT...) adjusted for competition — exceeds a threshold of 45,000 (MallThreshold). The adjustment for competition (MallMktPosition) assumes that people utilize the closest retail anchor stores, so all residents of the 15-minute zone

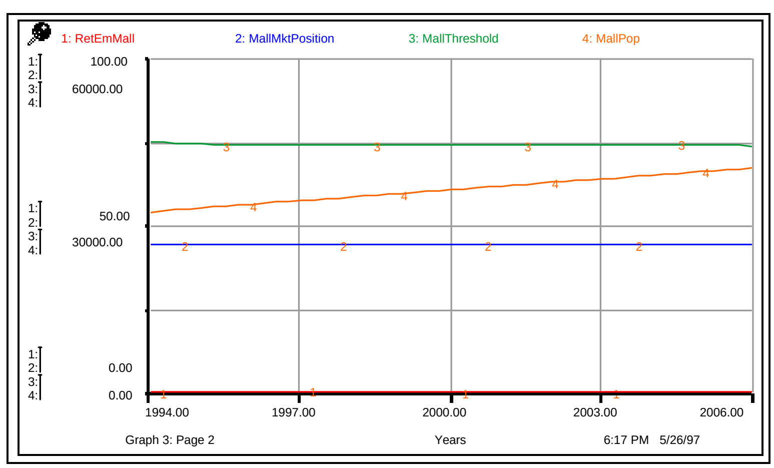

Figure 2: Mall development variables under baseline assumptions

closer to a competing anchor store are subtracted from AreaPop. This subtraction is also modified by the size of the competing malls or stores. I.e., larger competitors reduce AreaPop more. Also, MallThreshold is a moving target, rather than being fixed at 45,000. It is influenced by community ability to accomplish goals (the *community competence index*), zoning laws, and the availability of water and sewer lines to the mall site. According to practitioners, anti- mall zoning and water and sewer restrictions can delay, but not stop, mall development.

In COMTRI, these restrictions raise (or lower) the mall development threshold. Figure 2 illustrates COMTRI's baseline prediction for Reed City, in which MallPop does not reach MallThreshold by the year 2006, so retail employment at malls (RetEmMall) remains zero. Figure 3 illustrates Scenario 1, in which one of the competing anchor stores moves away and is not replaced, reducing competition, and thus opening the market to mall development in Reed City. MallPop crosses MallThreshold, and mall employment begins soon after. By comparing baseline projections of indicators — such as the community's annual unemployment rate (AnnUnemp), total retail and wholesale sector employment (RetailEm) and resident population (TotalResPop) — to their levels under each scenario, users can evaluate the impacts of specific actions or conditions affecting the community (Figures 4 and 5).

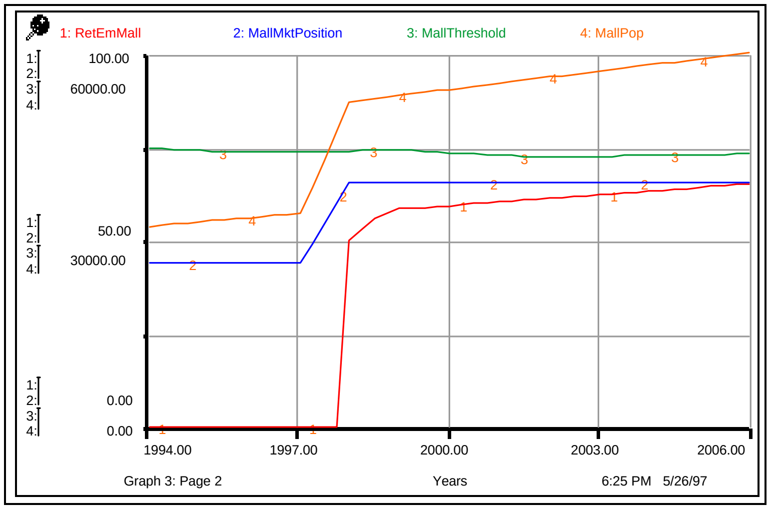

Figure 3: Mall development under Scenario 1: loss of competing store

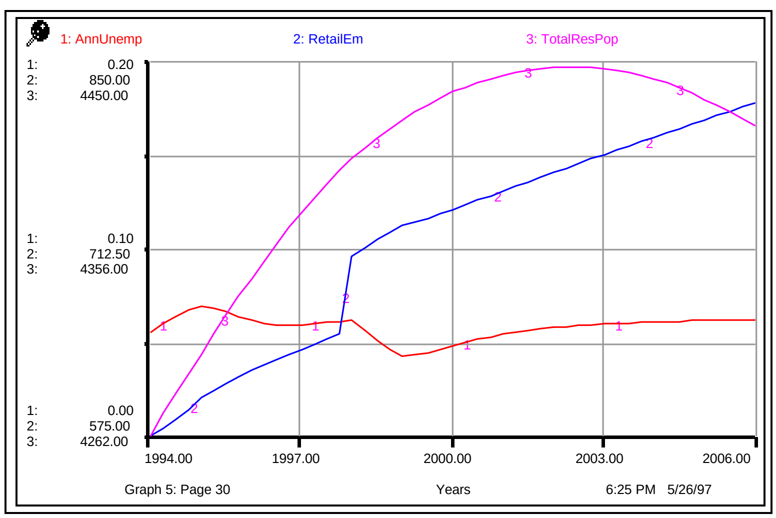

Figure 4: Baseline projection of unemployment rate, retail employment and population

Figures 6 and 7 illustrate the impacts of the new retail development on five other indicators: PedestrianCirc and DnTnCongestion are indicators of the suitability of the downtown district for pedestrian use and of the apparent level of congestion in the downtown district; both are based on community self-ratings of the two indicators on a percentile scale (0 to 100) compared to other similar Michigan communities. DnTnDrTime is an estimate of the average number of minutes required to drive a designated length of the main corridor through the downtown district during peak traffic; SEV Total is the estimated total (for the community) state-equalized assessed value of tax able prop-

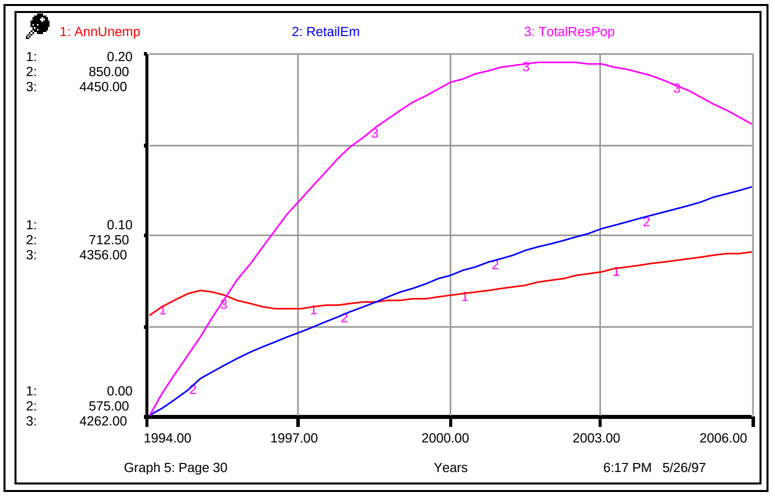

Figure 5: Unemployment, retail employment and population in Scenario 1

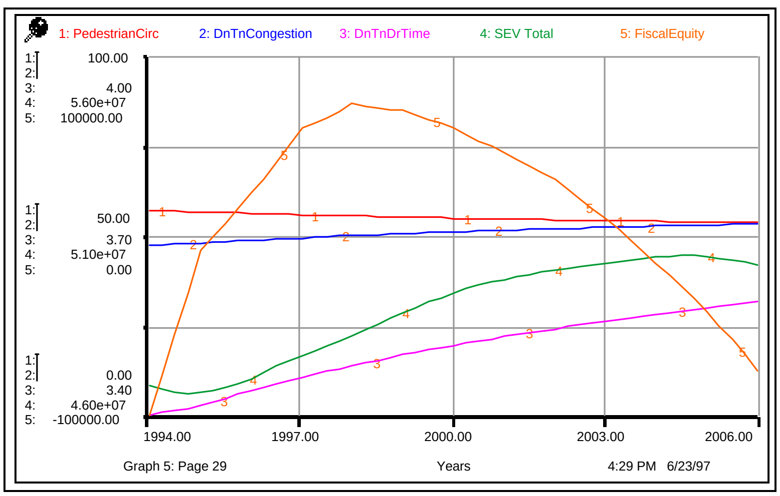

Figure 6: Five indicators estimated under Baseline assumptions

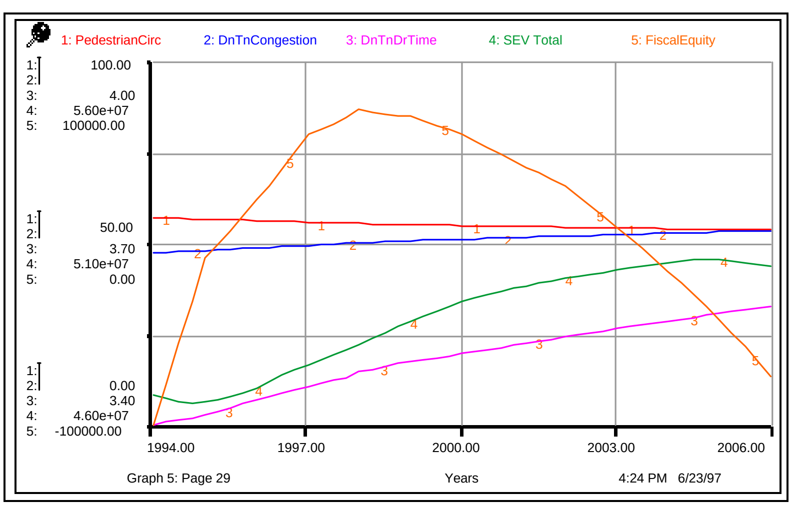

Figure 7: Five indicators estimated assuming Scenario 1

erty; and FiscalEquity is the accumulated fiscal position of all governments in the community, in which positive numbers represent net savings and negative numbers represent net borrowing in dollars. Figure 6 predicts these five indicators under Baseline assumptions, and Figure 7 predicts the same indicators assuming Scenario 1. COMTRI estimates about 400 indicator variables, though communities would usually examine more than a few indicators only for scenarios in which they are particularly interested.

COMTRI as a Decision-Support Tool

COMTRI was designed to address the often-intense public interest in the outcomes of highway improvements. Our intent is that COMTRI be integrated into the project-development process, helping simultaneously to predict impacts and inform debate. We believe this information can provide a common ground for resolving competing interests and views within an agency or a community.

COMTRI is intended to be operated by the state highway agency, but could also be used by a city government, planning commission, consultant, or advisory agency. COMTRI's initialization process — compiling a description of the community's socio-economic environment and a self-assessment of qualitative indicators by community leaders — would ideally be a cooperative process between the agency and the community. This *cooperative* process and initial review of the community's socioeconomic environment is important in itself, in some cases perhaps more so than the results. Input from a variety of community groups will help widen and promote public-involvement.

The model's impact estimates can substitute for a state agency's or consultant's, although they may not be accurate enough to be the sole guide for local investment decisions. The many outputs from the model can enable a community to see all the major impacts of a highway project at once, or the lack of impacts. We hope use of the model will reduce the tendency of debates to focus on single, highly-visible impacts.

MDOT is committed to cooperative planning of projects within communities, and we think this model has potential to provide a common ground on which such debates can be resolved.

Profiting from Change — Use of the Model by Communities

Use of COMTRI makes it obvious that outcomes depend both on the nature of the highway project and on the community's response to the project. Conventional impact assessment is a *ceteris paribus* process in which the proposed project is the only variable, and analysis stops when construction starts. But for the community, construction of the project marks the beginning of an infinitely-variable future. Before the project is built, COMTRI lets communities start visualizing alternative ways to ameliorate impacts, exploit improved access, and see the results of different growth or growth- reduction policies and other public investments. Highway alternatives are not the only alternatives that can be tested; the model is equally suited to testing alternative —

- local public investments
- levels of taxation and public services
- policies that encourage or discourage growth, and
- tourism marketing schemes.

A community can test the outcome of alternatives given different conditions. For example, the model is well suited to foreseeing the impact of the opening or closure of a large employer. The impacts of the public project can be tested given a rosy forecast of the future (with the employer), or a worst-case scenario (without the employer), or anywhere in between. Local-government investments can also be tested in tandem with the highway project. The model is adept at testing the impact of schemes to increase tourism, and predicting the ability of a town to compete with similar destinations for recreational trade.

Conclusions

COMTRI represents a new approach to socioeconomic impact assessment of highway projects: a computer program for desktop computers that can instantaneously estimate project impacts on hundreds of indicator variables. One can quickly evaluate a variety of project development scenarios, plus a variety of possible community responses to the projects.

Three relatively recent developments have collectively made it feasible to create and utilize such models. First, two new approaches to model estimation make it possible to estimate detailed models involving hundreds of interrelated equations. We utilized expert knowledge to design the overall model framework, then fitted its equations or equation sets to time series data from diverse case study communities. The experts narrow the focus of the model to the most relevant aspects, and contribute rules-of-thumb and other understandings of community social and economic life. The equation fitting process contributes a relatively objective assessment of individual relationships.

Second, commercial simulation-modeling software greatly facilitated model development and statistical fitting.

Third, people are becoming more capable of understanding and utilizing graphical data and other kinds of indicators produced in COMTRI. The widespread use of personal computers, use of the worldwide web, and media use of such data and indicators have familiarized many people with these kinds of information.

The stage now seems set for socioeconomic impact assessment to become an effective, real-time decision support system for transportation agencies as well as for communities. Perhaps equally important, such models permit communities to independently examine the impacts of proposed highway projects and their own options for responding to them. This could strengthen and help unify community efforts to cope with and take advantage of the changes caused by highway projects. However, the models' most widespread use may be as decision support systems for community development in general: Communities can proactively explore a wide variety of community development options that may or may not involve transportation system changes.

COMTRI also appears to be a great learning tool. The model specification and development processes were quite educational to participants. So far, users of the model also have consistently found its perspectives on cause and effect to provide interesting insights. It should prove valuable to students in formal educational settings as well. Explorations can range from practical questions about options for managing a community's future, to academic questions about the processes by which communities develop their unique characteristics over time.

Finally, we recommend that socioeconomic impact assessments estimate a range of possible impacts de pending upon possible community actions, rather than assuming there can be only one set of impacts. Use of the model makes it obvious that community responses help determine the impacts of a highway project. That is, the same project could have one set of impacts when the community responds in one way — such as encouraging economic growth — and a different set of impacts when the community takes a different tack.