

# Of Mice and Elephants

**AS PRESENTLY IMPLEMENTED, TRANSPORTATION PLANNING MODELS CAN PRODUCE RESULTS THAT ARE SO MISLEADING THAT, IN MANY CASES, WE WOULD BE BETTER OFF NOT USING THEM AT ALL. THREE EXAMPLES ILLUSTRATE THAT THE CURRENT PRACTICE OF LEAVING FUTURE LAND USE PROJECTIONS FIXED LEADS TO SUBSTANTIAL ERRORS IN FORECASTS.**

**BY STUART RAMSEY, P.ENG.**

AS PRESENTLY IMPLEMENTED, transportation planning models can produce results that are so misleading that, in many cases, we would be better off not using them at all. The purpose of this feature is to provide evidence in support of this statement and to suggest avenues for improvement.

Most cities in North America use a transportation planning model for evaluating potential transportation investments. Land use is represented by a zone system and the transportation network is represented by links and nodes. Practitioners put substantial effort into the development and maintenance of these models in a quest to improve their realism and relevance.

However, in our efforts to put the modeling house in order, some would argue that we are focusing on the mice under the furniture while ignoring the elephant in the middle of the living room. This concern is illustrated by three examples.

These examples make reference to “societal benefits.” These are the benefits and dis-benefits experienced by all members of society: travelers and non-travelers alike. Examples include travel time savings, enhanced safety, noise and pollution. This feature focuses on three specific benefits: travel times, vehicle operating costs and safety.

The three benefits are commonly expressed in the unit of dollars, calculated on the basis of consumer surplus theory and aggregated as a present value over the lifetime of a project. Because they are expressed in dollars, they tend to be the benefits that most strongly influence the decision-making process. For the purpose of this feature, they also demonstrate the issues under consideration. This is not to detract from the importance of other societal benefits.

## **EXAMPLE 1: FANTASY ISLAND**

A fictional ocean-side city includes a large island, one kilometer off shore (see Figure 1). The island is linked to the mainland by a small ferry with a capacity of 10 vehicles per hour. Largely as a result of this access constraint, development on the island has been limited to a small number of weekend properties.

However, the council has designated this island for residential use, with 5,000 homes expected over the next 20 years. The city’s transportation model will be used to evaluate the impact of constructing a bridge to the island, replacing the ferry. The modeling analysis is performed for the year 2030, by which time the island is expected to be fully developed.

Therefore, the base case consists of the unimproved ferry service but with 5,000 homes on the island. Delays getting to and from the island are calculated to be enormous. In the proposed case, the bridge has been constructed and delay vanishes. The final report concludes that the proposed bridge will generate \$10 million in societal benefits.

This, of course, is incorrect. Without the bridge, the 5,000 homes never would be built. They would not be marketable due to the site’s poor access. The real effect of constructing the bridge is not to eliminate delay but to facilitate the development of 5,000 homes in this location rather than in another part of the city.

The benefits predicted by the model would not materialize in the real world. Yet, this example illustrates the analytical technique used presently in many jurisdictions: Assume that the future development will happen and, then, calculate the benefits of increasing capacity to serve it.

## **EXAMPLE 2: THE DENSIFICATION OF VANCOUVER**

Today, greater Vancouver, British Columbia, Canada, has a dense urban core and pockets of transit-oriented

development. However, like most North American cities, the larger share of land is given over to lower-density, single-use development such as single-family homes and business parks.

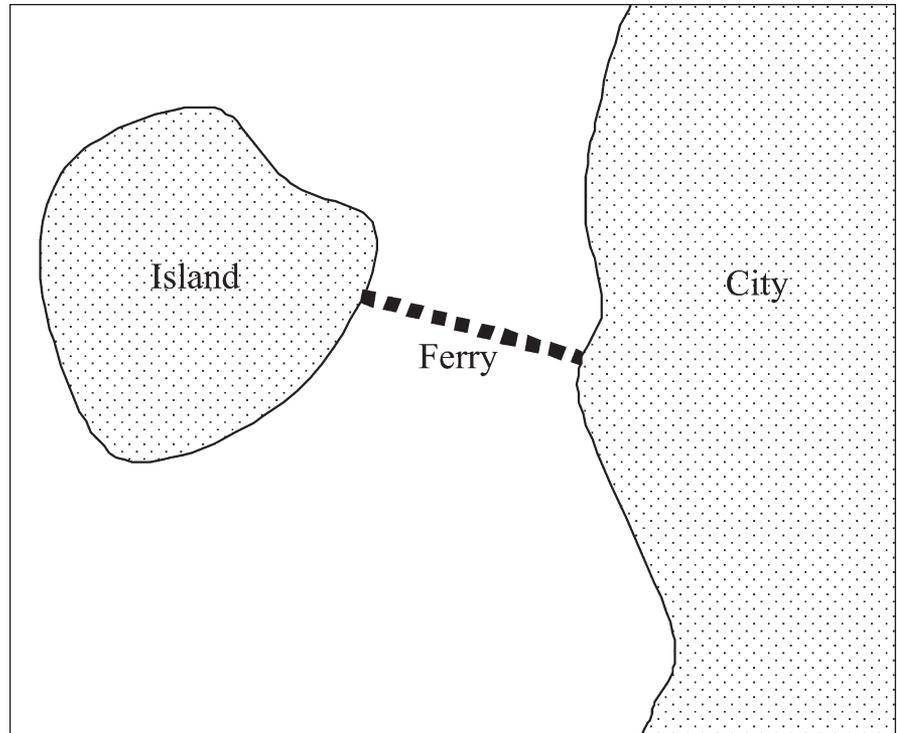
What if that was not the case? What if, early in its history, civic leaders had decided on a more compact, mixed-use form of development? This hypothesis was evaluated using greater Vancouver's regional transportation model. The specific scenario was as follows:

Development was limited to about 30 percent of the presently developed land. However, regional projections for total population and employment in the year 2021 were not changed. Within this compressed urban area measuring about 10 by 20 kilometers, densities were allowed to rise to those already seen in parts of greater Vancouver today. Residential and commercial densities were increased to those of the downtown core (on the order of 200 residents or 600 jobs per hectare). Industrial densities were increased to those of existing higher-density industrial lands (for example, 40 jobs per hectare). Existing parkland in the compressed urban area was retained.

It was recognized that some land uses have specific geographic requirements. They cannot be compressed or shifted to any part of town. These primarily are transportation gateway facilities: port, airport and rail terminals.

Therefore, the port and airport retained their present locations. The rail terminals were sited on flat lands on the periphery of the compressed urban area. This continued the well-established local practice of siting vital transportation infrastructure in locations that are most susceptible to liquefaction during the next major earthquake.

The road network was not changed from what already is proposed. However, dedicated bus lanes were provided within the already-proposed road widths, on all roads with four or more lanes. The transit fleet size was not changed from what already is proposed. However, with a much smaller area to serve and dedicated bus lanes to escape congestion on all routes, much more frequent service was possible: 2-minute headways on all routes.



**Figure 1. A fictional ocean-side city includes a large island one kilometer off shore.**

This alternative land use scenario was analyzed with the same methodology that traditionally has been used to evaluate transportation scenarios. It was modeled with the greater Vancouver transportation model, based on the EMME/2 software. It was found that, over the 20-year analysis period, the new land use pattern was responsible for \$50 billion in societal benefits. This is about two orders of magnitude greater than the projected benefits of a typical major transportation project in greater Vancouver.

Because land use changes are implemented gradually through development, no net construction cost is associated with the compressed urban area. This leads to a theoretically infinite benefit/cost ratio because the \$50 billion in benefits would have been achieved at no cost.

In fact, the true economic performance would be better than that because there are cost savings. Hundreds of kilometers of roads and utilities would not need to be constructed under the compressed urban area scenario, in the parts of greater Vancouver that no longer would be needed for urban development.

Looking in more detail, the compressed urban area scenario achieved a mode split of 65 percent for sustainable

modes (transit, bike and walk), compared with 27 percent in the base case. Total vehicle-kilometers declined by 56 percent and emissions by 53 percent. Even with more congested roads, emissions decreased due to fewer vehicle-kilometers. Truck traffic was left to compete with cars on the more congested road network. In spite of this, trucking costs declined by 11 percent because all destinations were much closer together. Had trucks been allowed access to bus lanes, even better performance could have been achieved for goods movement (although at some cost to transit).

This is not to suggest that cities be redeveloped to uniformly high densities. It suggests that far more effort should be put into evaluating the costs and benefits of alternative land use scenarios than into evaluating proposed transportation investments.

The stated goals of reduced travel times, operating costs and accidents can be achieved in greater measure through land use proposals than transportation proposals. The criteria for transportation investments then would be revised to focus more on the extent to which they support or detract from the desired land use development pattern.

### EXAMPLE 3: THE ROAD TO THE SUBURBS IS PAVED WITH GOOD INTENTIONS

Greater Vancouver essentially has two freeways: Highways 1 and 99. Ostensibly, these serve the role of connecting Vancouver to the rest of Canada and to the United States. In reality, origin-destination patterns indicate that the primary effect of both routes has been to foster low-density sprawl in the outlying parts of the region.

Highway 1 presently has a mixture of four-, five- and six-lane cross-sections. Consider a proposal to widen this highway to eight lanes over a length of 40 kilometers. The objective is to strengthen the region's connection to the rest of Canada and the United States, particularly for goods movement.

This scenario was modeled with the greater Vancouver regional transportation model. When modeled under a traditional approach with fixed land use projections, the freeway widening project yielded a societal benefit of \$500 million over the 20-year analysis period.

The same project then was analyzed with an enhanced model, identical to the existing greater Vancouver model except that it permits and facilitates analyses in which the base case and proposed case have different land use patterns. Among other features, the enhanced model provides a graphic interface for the user to quickly make substantial changes to land

use patterns. The user can indicate the broad pattern of changes graphically and the model handles the details, such as ensuring that regional land use totals and demographics are maintained.

The enhanced model was used to evaluate a range of land use scenarios, involving ever-increasing shifts of population out to the presently undeveloped lands that would be made more accessible by the highway project.

As shown in Figure 2, if only 60,000 people shift to these areas, the societal benefits of the project are reduced by 50 percent. To put this in context, 60,000 people represent only 2 percent of the projected total population of the region, or 7 percent of the new population. Clearly, the project benefits are highly sensitive to future land use patterns. For many transportation projects, a 50-percent reduction in benefits would render the project unviable.

Looking more closely at the modeling results, increased auto dependence has led to greater congestion. As a result, travel time and vehicle operating benefits have declined. At the same time, increased vehicle-kilometers on the road network have raised societal accident costs.

This approach also provides a more realistic estimate of environmental impacts. A traditional calculation leads to the claim that congestion has been "solved," vehicles spend less time idling and emissions will decline. However, the current analysis found that

the shifted land use patterns themselves would produce an increase of more than 1 billion kilograms of harmful emissions. This has obvious policy implications for countries such as Canada, which are signatories to the Kyoto Protocol on greenhouse gas reductions. It also is critical as we become increasingly aware of the public health implications of vehicle emissions.

This example demonstrates the central theme. A traditional analysis of such a project would focus on the details of the proposed design, such as lane capacities and ramp speeds. Some of that modeling effort should be redirected to look at the much more significant variable that is traditionally ignored: land use impacts stemming from the proposed project.

A traditional analysis would report only the \$500-million benefits of the fixed land use scenario, which are not actually achievable. This difference between the \$500-million calculated benefit and the much smaller achievable benefit illustrates the author's contention that traditional modeling approaches are so misleading that, in some cases, we would be better off without them.

### CRITICISMS AND RESPONSES

This feature proposes a significant change in how most agencies practice transportation modeling. Some potential criticisms and corresponding responses follow.

***Land use is controlled by zoning and the official community plan, not by transportation projects.***

This is correct, at least on paper. In the real world, a road project that increases access to certain lands will increase the demand for those lands and the pressure that is put on governments to modify the zoning. Can it really be said that, over the life of a project, in which municipalities will be led by politicians of different beliefs and interests, not one council will allow a significant zoning change? Not one will be tempted by the additional property tax revenues? This is unrealistic. It is inevitable that land use will change as a result of transportation projects. The debate should focus on where, in what way and by how much.

***We do not know how to predict the "correct" land use changes.***

It certainly is true (particularly if one stays within the engineering profession)

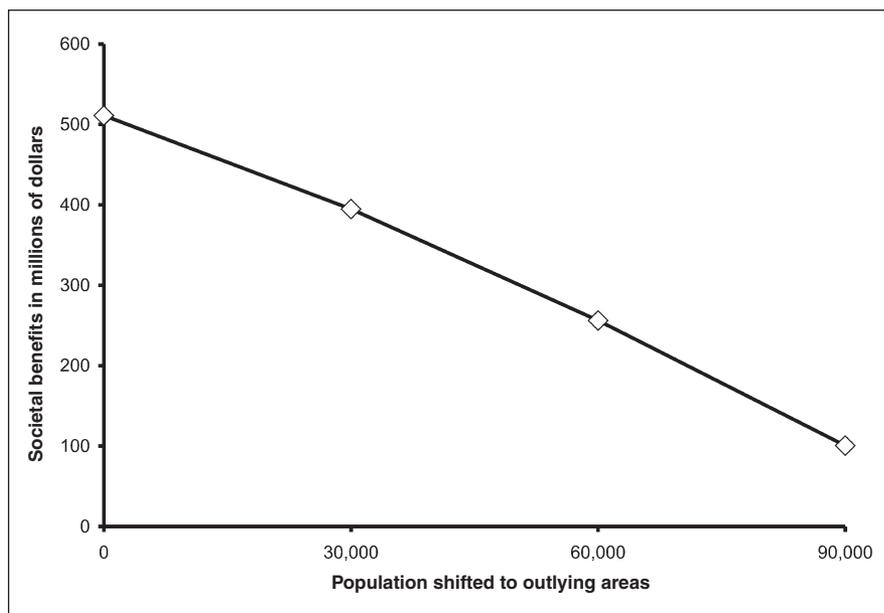


Figure 2. Societal benefit of highway widening in greater Vancouver, British Columbia, Canada.

that far more effort has been put into quantifying and analyzing road capacity than into quantifying and analyzing the corresponding land use changes. However, within any urban area there should be those with sufficient long-term experience in the fields of land use planning and real estate development that a reasonable estimate can be made. Our current estimate (in other words, no land use changes) clearly is incorrect. Almost any other reasonable estimate would be an improvement. The inherent uncertainty that exists in any land use projection can be accommodated through sensitivity analyses to identify the range of possible results.

***This is a Pandora's Box. We cannot look at land use pattern changes without also looking at the corresponding changes to utility costs (such as water and sewers).***

This is incorrect. This feature proposes a technique for improving the analysis of something that already is being calculated (poorly): societal benefits. To do so does not require us to also calculate another impact that has been traditionally ignored. This is not to detract from the importance of calculating service costs, which are significant. A closer review of land use shifts, as proposed by this feature, also would facilitate the calculation of servicing cost impacts. But a failure to calculate servicing cost impacts should not be taken as an excuse to also produce poor calculations of societal benefits.

## CONTEXT

Newman and Kenworthy have stated that: "The biggest force still driving the Auto City to ... accommodate the automobile rather than providing other options is the standard 'black box' transportation/land use model for calculating benefit-cost ratios on road projects. These are based on how a new or widened road will save time, reduce fuel, and lower emissions and road accidents. ... (T)hese benefits are illusory due primarily to 'induced traffic.'"<sup>1</sup>

This feature has attempted to identify and quantify some of this impact. It has focused on land use changes, which are only one part of the larger picture of induced traffic. It has demonstrated that the traditional modeling approach does overestimate the benefits of road projects. Better modeling solutions are available and should be pursued.

## ASSUMING THAT FUTURE

### LAND USE PATTERNS

## ARE FIXED, REGARDLESS

### OF TRANSPORTATION

### INFRASTRUCTURE

## DECISIONS, LEADS TO

### SUBSTANTIAL ERRORS

## IN THE EVALUATION

### OF TRANSPORTATION

## PROJECTS.

This issue is not new to those who have examined this topic. Researchers such as Hansen and Huang have documented the extent of induced traffic under various conditions.<sup>2</sup> Miller, Kriger and Hunt have focused specifically on changes to land use patterns and their integration into transportation planning models.<sup>3</sup> They propose a five-year program of research to develop better, more fully integrated models. Litman provides a comprehensive discussion of the sources and implications of induced traffic.<sup>4</sup>

A few models even are in existence that incorporate land use feedback. For example, the regional government in Portland, OR, USA, is one of the few agencies that has built and used such a model. Future land use projections respond to proposed transportation investments while also reflecting the real estate market, government land use policies, etc.

What still is lacking is an awareness in the larger professional community and among decision-makers that present models may be leading us so far astray. It also is important to recognize that these missed

land use impacts are so large that order-of-magnitude results can be determined with very little effort. There is no need to await the creation of an excellent transportation/land use model, when good results can be obtained through minor refinements to the models we already have.

## CONCLUSIONS

This feature examines the role of land use projections in transportation planning models. In particular, it demonstrates that the common practice of assuming that future land use patterns are fixed, regardless of transportation infrastructure decisions, leads to substantial errors in the evaluation of transportation projects.

Although the development of more sophisticated models obviously is important, better results are possible through minor refinements to existing models. To ignore these issues would be to perpetuate the current practice of dramatically overestimating the societal benefits of major road projects. ■

## References

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