Abstract:
Using System Dynamics Analysis for Evaluating the Sustainability of "Complete Streets" Practices

Primary Author: Nicholas R. Flanders
109 T.W. Alexander Drive
Mail Code: E343-02
Research Triangle Park, NC 27709
919-541-3660
Flanders.nick@Epa.gov

Topic category that best fits this submission:
Sustainable Transportation Systems Development

Recommendation: *Poster format only*

If "complete streets" practices are followed, transportation corridor designs accommodate multiple modes of transportation. When transportation engineers and planners consider implementing these practices, they must decide what portion of a transportation corridor's cross-section will be dedicated to automobile lanes, to public-transit right-of-ways, to bike lanes, and to sidewalks, plus consider the frequency of intersections. The author has explored the usefulness of a system dynamics approach for identifying the interrelated impacts of "complete streets" (as compared to automobile-oriented) roadway designs on sustainability, which includes: ecological health, transportation system efficiency, personal safety, human health, balanced government budgets, energy conservation, and broad-based and on-going economic prosperity. Insights from these interrelationships may lead to schemes by which to identify sustainable options for transportation and community development, and to identify potential tradeoffs. *Vensim* system dynamics simulation software was used to build causal loop diagrams establishing links between how a transportation corridor treats different modes and the efficiency of the transportation system, land use patterns, levels of pollution, the extent of impervious surfaces, the size and sustainability of the local economy, human health, and other factors. These causal loop diagrams highlight the ways in which particular variables change and interrelate with other variables. The diagrams show how, through reinforcing and balancing loops, the usage cross-section of a transportation corridor significantly influences mode shares, accident rates, land conversion, development density, greenhouse gas emissions, concentrations of other air pollutants, energy consumption, the combined cost of housing and personal transportation, the cost of running a business of a given size, noise pollution, impervious surface areas, and local government budgets. The diagrams also show how, for any given variable, certain factors are likely to have stronger impacts than others. Besides the modal usage of a transportation corridor's width, other variables with especially strong and varied influences are intersection frequency, urban density, average travel speeds, and population. However, the magnitudes of these various influences could change over time, as a result of changes in the web of variables affecting them. In many cases, a given variable influences another through two or more chains of intermediate variables. Complex relationships can exist in each of the chains, so that it is not always evident whether a change in one variable will have a positive or negative net effect on

another. The *Vensim* causal loop diagrams can be used by planners and engineers to identify tradeoffs and co-benefits not previously considered and to identify key inputs they do not yet have data for. However, the diagrams demonstrate how the inherent complexity of system dynamics sustainability models impedes their usefulness, even for a limited topic like “complete streets.” Furthermore, the diagrams show how system dynamics models are limited by their inability to express geographic variations in variables.