

Simulating Access Management Strategies

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Abstract

Many arterial street planning studies use access management strategies to improve safety and operations. Recommending these strategies, however, often places the transportation professional in a defensive position, thus creating a contentious environment. To avoid this problem, transportation professionals need to clearly convey why these strategies are needed to decision makers and the public. If they cannot, the benefits cannot be realized.

Simulation is a tool transportation professionals can use to convey the need for access management. Simulation can compare operations with and without access management, as well as illustrate safety issues.

This paper illustrates how the simulation model, VISSIM, has been used in studies to model and present issues stemming from the lack of access management. It also highlights the benefits derived from access management. Topics presented in this paper include:

- Two-way left turn lanes;
- Mid-block left turn safety issues;
- Medians (including U-turns);
- On- and off-site truck backing;
- On-street parking; and
- “Keep Clear” boxes.

Based on past experiences, simulation can effectively communicate access issues to the public, decision makers and technical audiences. Safety, as well as operational issues can also be conveyed through simulation. The level of difficulty and ultimately the success in developing a simulation model of any particular access issue varies.

Access Management Simulation Examples

Two-Way Left Turn Lanes

Two-way left turn lane (TWLTL) operations are one of the most difficult operations to simulate. The difficulty arises due to the “jog” offset in opposing driveways and the resulting need for opposing lefts turns **to occupy the same space within the TWLTL**. The need for opposing vehicles to occupy the same space creates a conflict area as illustrated in Figure 1. As shown in Figure 2, TWLTL operations are further complicated when a left turn vehicle is waiting in the TWLTL for a gap in opposing through-traffic and an opposing left turn vehicle arrives. The opposing left turn motorist now needs to decide whether to enter before the waiting vehicle at E1 or after at E2. The operational complexity increases as the opposing volume in the TWLTL increases. TWLTL operations are very complicated from a driver behavior standpoint. As a general rule, the more complicated the driver behavior the more difficult it is to simulate.

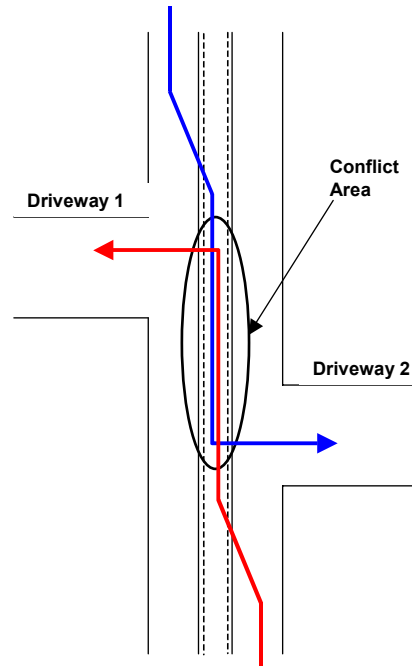


Figure 1: TWLTL Conflict Area

While it is one of the most challenging operations to model, VISSIM can model TWLTL. The ability to model TWLTL is dependent on the volume of opposing TWLTL traffic in the conflict area (see Figure 1). As this volume increases, so does the difficulty to simulate the TWLTL. If the driveway orientation is such that opposing lefts do not have to occupy the same space, then developing a VISSIM model is quite easy. Since the TWLTL geometric and volume conditions can vary considerably by location, specific numerical guidelines informing the user when they will have success building a model of a TWLTL do not exist. In an effort to provide some guidance, the following sections are provided.

High Opposing TWLTL Volume

Building a model for a location experiencing a high volume of opposing TWLTL traffic in the conflict area may only be suitable for visual presentation. Usually, the model can be calibrated (sometime with

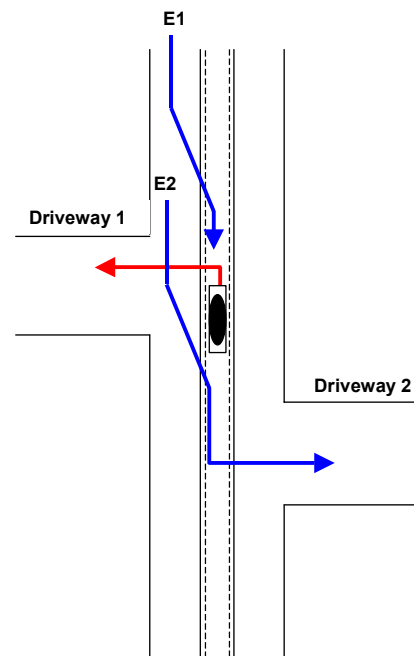


Figure 2: TWLTL Multiple Entry Points for Opposing Lefts

great effort) to a point where a short video of the operations can be produced. If field observations show the TWLTL to be congested to a point where vehicles are side-by-side (refer to Figure 3), it is easier to model this operation in VISSIM. Nonetheless, to produce meaningful results, the “chaos” that can occur in the TWLTL at high opposing volumes requires substantial model calibration. Therefore, it is not recommended to develop a simulation model to evaluate (e.g., delay, travel time) TWLTL with high opposing volumes in the conflict area.

Low Opposing TWLTL Volume

Greater success in modeling TWLTL is possible if the opposing TWLTL volume in the conflict area is relatively low. Even these models can be challenging to calibrate. If the paths of the opposing left turns do not have to occupy the same space (i.e., conflict area) in the TWLTL, then building a VISSIM model of this operation is straightforward and easy.

VISSIM Example

The challenge in simulating a TWLTL is accurately modeling the driver behavior when opposing vehicles want to occupy the same space. First, the simulation model has to have the geometric flexibility to physically allow opposing vehicles to occupy the same space within a TWLTL. Second, the model has to provide some form of control within this space to reduce, or eliminate, potential collisions. VISSIM has this flexibility. The following modeling building elements are used when simulating a TWLTL in VISSIM:

- Links;
- Connectors;
- Priority rules;
- Static routes; and
- Dynamic routes and detectors.

Allowing vehicles to occupy the same space in VISSIM is accomplished by placing links carrying the opposing left turns on top of one another. The connectors are used to define the entry locations to the TWLTL. Multiple connectors can be used to define as many entry points to the TWLTL as desired. Priority rules are then used to control the conflict area and thus avoid collisions between opposing lefts. The priority rules are

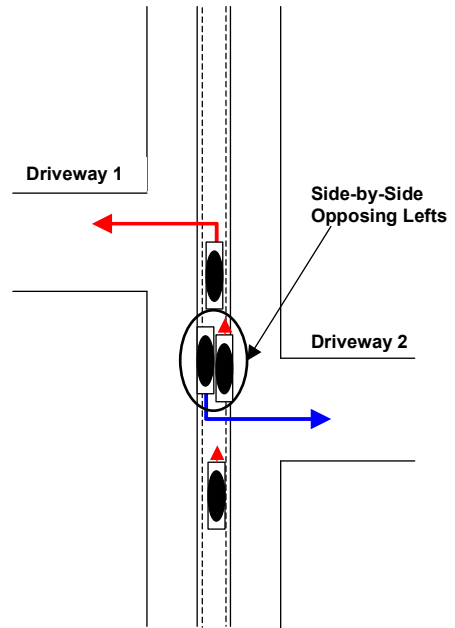


Figure 3: Side-by-Side Opposing Lefts in a TWLTL

also used to define the gap acceptance criteria for the left turn vehicle as it waits for a gap in the opposing through movement. Static routes define the volume of vehicles entering the TWLTL, as well as which entry locations/connectors (e.g., E1 or E2 in Figure 2) to use. If multiple entry points exist, the user can manually assign a fixed amount of traffic to each route. Dynamic routes are used when it is desired for vehicles to enter at E2 (refer to Figure 2) when an opposing left turn is occupying the TWLTL and then enter at E1 when the opposing left is not present. These routes are dynamic because they change based on the presence of the opposing left. Detectors are used to detect the opposing left.

A screenshot of a congested left turn in VISSIM is shown in Figure 4. This model was built for a project in Shoreline, Washington.

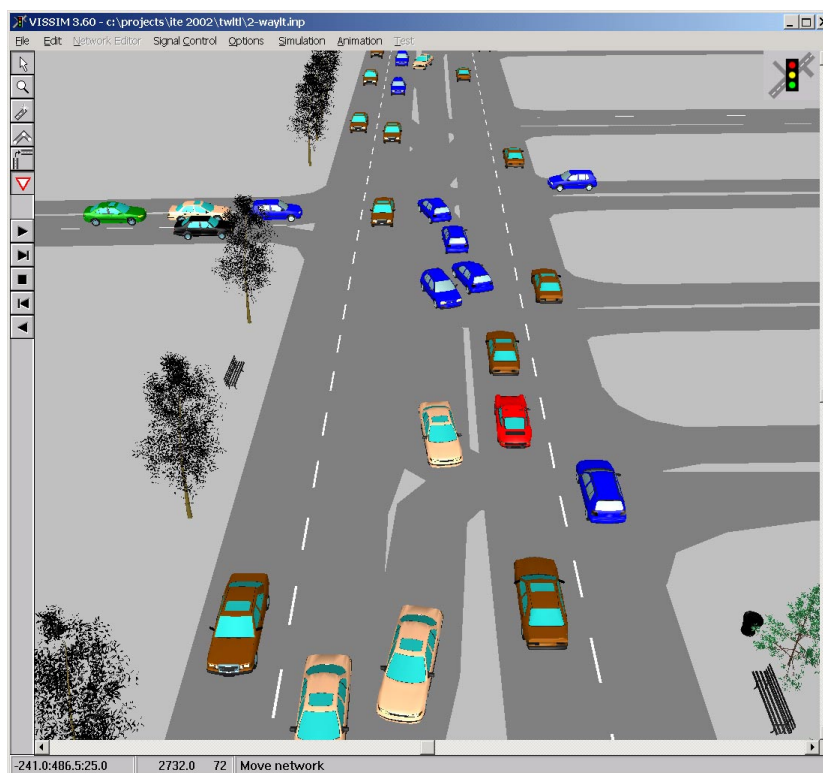


Figure 4: Congested TWLTL

Mid-Block Left Turns

Left turns from uncontrolled locations like driveways and TWLTL lanes can pose some safety concerns, especially when queues extend back to the driveway from a nearby signal. For an example, refer to Figure 5. A queue has formed on the inside lane due to a downstream signal. A “friendly” motorist has created a gap for a vehicle in the TWLTL to make a left. The “friendly” motorist has unknowingly obstructed the line of sight of the left turning motorist. The left turning motorist either impatient or through the polite gesture from the “friendly” motorist begins to make a left turn. Unfortunately, the left turning motorist does not see the vehicle in the outside lane and a collision occurs. This scenario is all too common when driveways are located in close proximity to a signalized intersection.

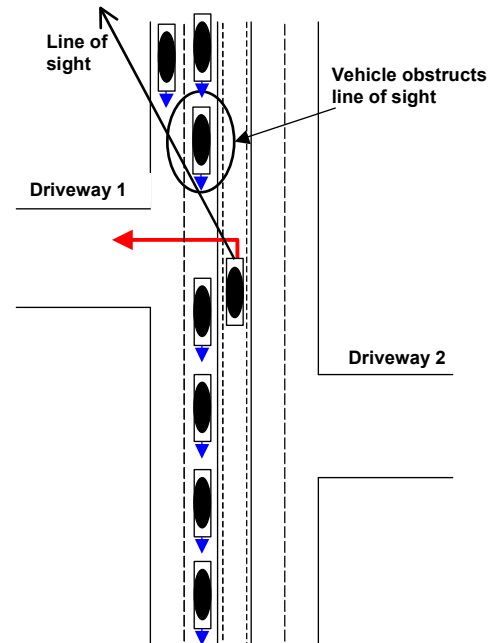


Figure 5: Line Of Sight Obstruction by Queue

VISSIM is an effective tool for illustrating the safety issues associated with this scenario. The model can even be constructed to pause at exactly the point when the vehicles collide thus increasing the dramatic effect. Developing a model of this scenario is relatively easy.

VISSIM Example

Many of the VISSIM elements listed for modeling TWLTL would be used here as well. They include:

- Links;
- Connectors;
- Transit routes; and
- Priority rules.

The links and connectors would be used to build the geometry. Transit routes in VISSIM allow the user to control the exact timing of a vehicle when it enters the network. Both vehicles involved in the collision would be coded as transit routes. Their entry times would be adjusted until the desired scenario is achieved. Priority rules would be used to create the gap between the queued vehicles to allow the motorist in the TWLTL to make a left. The priority rule would be set to yield to all approaching vehicles in the through

lanes, except for the specific vehicle in the outside lane. VISSIM screenshots illustrating the obstructed line of sight and the collision are shown in Figure 6 and Figure 7, respectively.

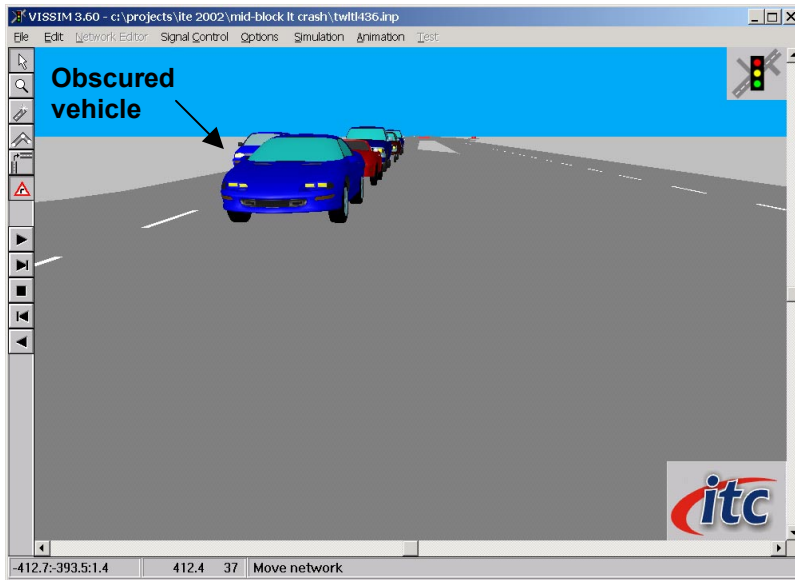


Figure 6: Obstructed Line of Sight

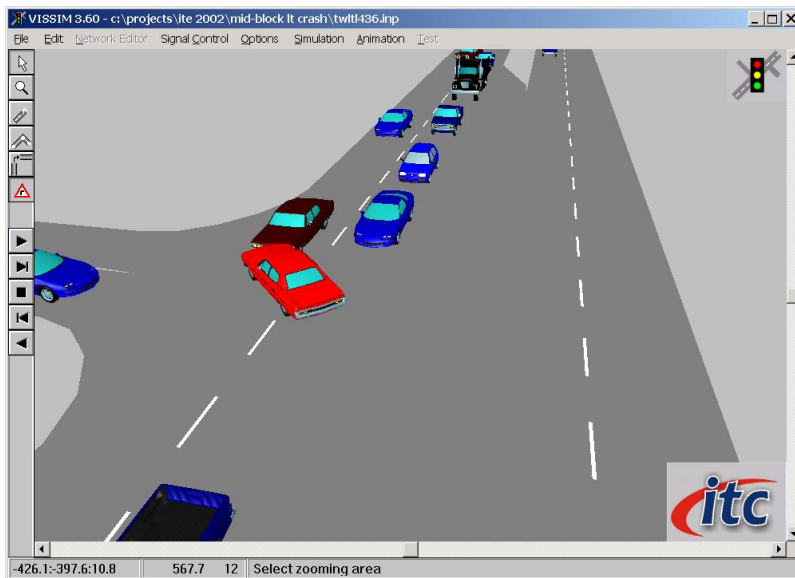


Figure 7: Collision Due to Obstructed Line of Sight

Medians

Most major arterial street reconstruction projects consider access management strategies. If an existing TWLTL exists, it is likely a median will be considered in its place. The median can be designed with designated median breaks to control the location of mid-block left turns. Properly designed medians remove many of the operational issues described under the TWLTL section, as well as the safety issues presented in the previous section. Modeling medians, however, does produce one more requirement for simulation models; the ability to model U-turns. Depending on the design, the median either reduces or eliminates the opportunities for mid-block block left turns. Consequently, a portion of the existing mid-block left turners will be diverted to signals along the arterial and required to make U-turns in order to arrive at their destination. The turning radius of vehicles making a U-turn may require widening the roadway in the vicinity of the signal. Also, right turns on red may from the cross streets will likely need to be prohibited to avoid conflicts with U-turning vehicles. In some locations it may be necessary to prohibit certain vehicles from making a U-turn if their turning radius cannot be accommodated.

Modeling medians is easily done in VISSIM. Besides the location of median breaks, the primary input needed is an estimate of the U-turn volume. VISSIM also has the ability to restrict U-turns to certain vehicle types. The impact of U-turns on the intersection capacity can also be studied in VISSIM. For presentations, side-by-side comparisons can be made with two files running on the same computer simultaneously.

VISSIM Example

Many of the VISSIM elements already discussed also apply to modeling medians. These elements include:

- Links;
- Connectors;
- Priority rules;
- Static routes; and
- Reduced speed areas.

As with any VISSIM mode, the links and connectors are used to build the geometry of the network. Additionally, the connectors will define the path of the U-turning vehicles. If desired, different U-turn paths can be defined for different vehicle types. The priority rules are used to control the left turns from the median breaks. Static routes are used to designate the U-turn volume at the signals. The static routes are also used to define which vehicle types can make a U-turn. Reduced speed areas control the speed of the vehicles as they make a U-turn. It is also important to note that the model builder needs to take care when coding the outputs in VISSIM so they include the U-turns. An example of a vehicle making a U-turn is shown in Figures 7a-7c.

Figure 7a: U-Turn Vehicle (Position 1)

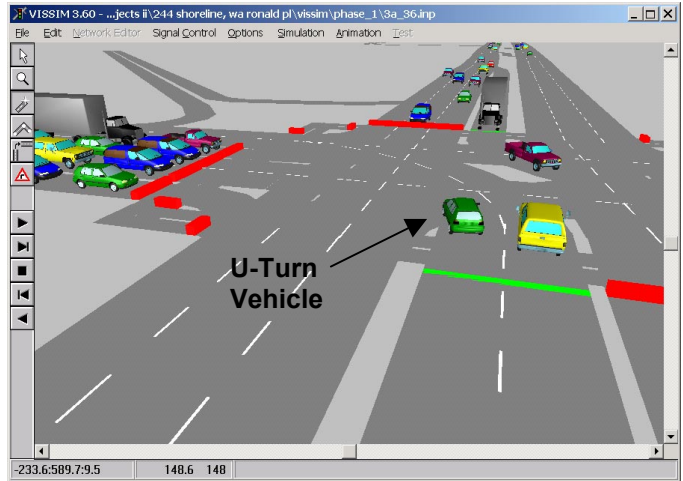


Figure 7b: U-Turn Vehicle (Position 2)

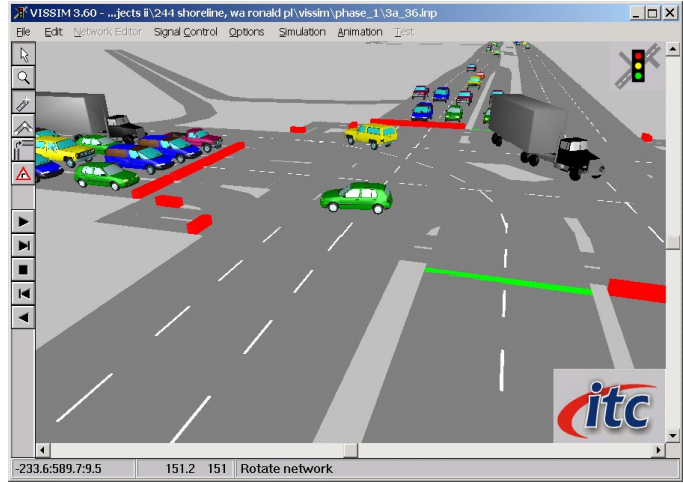
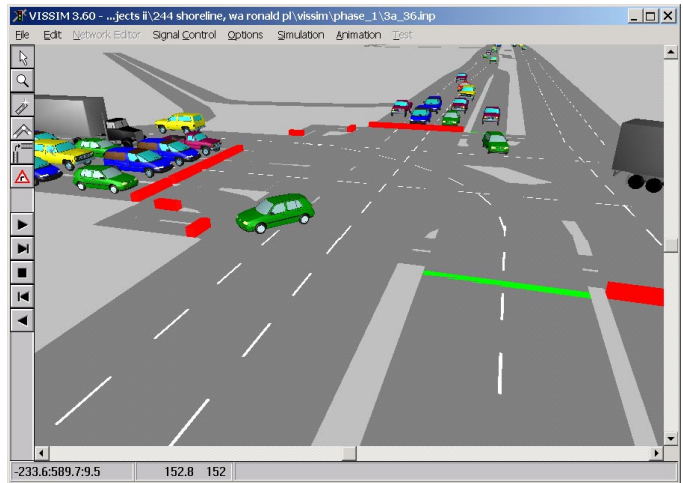


Figure 7c: U-Turn Vehicle (Position 3)



On- and Off-Site Truck Backing

Site access is a primary issue when it comes to a new development. Access for the customers, as well as delivery vehicles needs to be considered. VISSIM has been applied numerous times to study site access issues. A couple of the more interesting applications have included studying the impacts of delivery trucks accessing loading docks. The delivery trucks usually need to make one backing maneuver or a series of backing maneuvers to be properly aligned with the loading dock.

VISSIM can model backing maneuvers for any vehicle type. Although these models have only been built for visual presentation purposes, they can also be used to numerically analyze the impacts. The effort to create a model for numerical analysis is much greater than for a visual presentation. In some instances, it may not be practical from a cost or time perspective to build a model for numerical analysis.

VISSIM Example

Many of the VISSIM elements already presented are used to model truck backing maneuvers. These along with the additional elements include:

- Links;
- Connectors;
- Transit routes;
- Stop signs; and
- Priority rules.

Links and connectors define the network geometry. They also define the path of the backing vehicles. A series of links are needed to model each pulling forward and backing maneuver separately. Transit routes are used to control when the trucks enter and exit the study area. As the truck pulls forward on a link it would stop (due to the placement of a stop sign) and then disappear. A tenth of a second earlier another truck needs to appear on the link below at exactly the same position. This truck is the backing truck. This approach continues until all maneuvers are reflected in the model. The priority rules make the vehicles crossing the truck's path yield to the truck.

When the truck backing studies (described in the following paragraphs) were performed, VISSIM did not have the ability to make any vehicle travel backwards. To overcome this limitation, the hinge point for the backing trucks was oriented to appear as though the truck was backing when in reality it was pulling forward.

Two examples are provided of trucks making backing maneuvers to be aligned with a loading dock. One study analyzed the impacts of the backing maneuvers made on-site, while a separate study analyzed the impact of the backing maneuvers made off-site from a downtown street onto the site. Figure 8 depicts a delivery truck as it makes its series of backing maneuvers on-site. A series of six maneuvers (three forward and three back) were necessary for the truck to navigate the relatively small area to be properly aligned with the loading dock. Notice the traffic backing onto the street as the truck blocks the entry, as well as on-site traffic and pedestrians yielding to the truck.

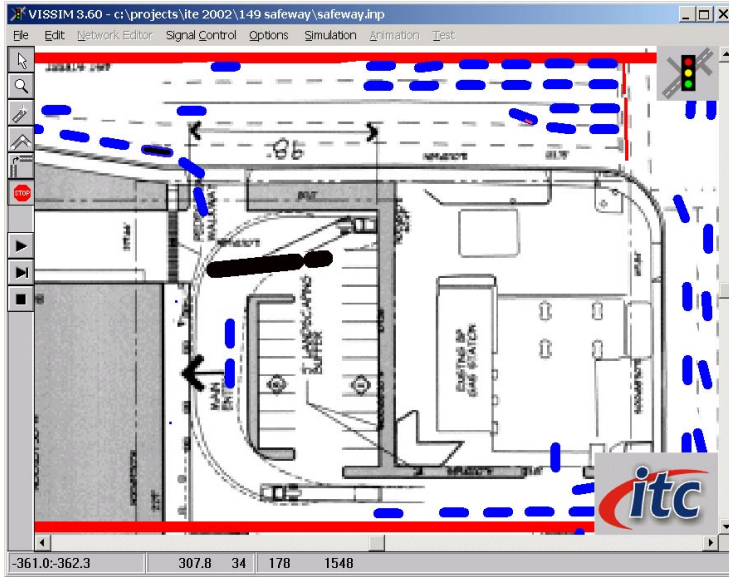


Figure 8: On-Site Truck Backing

Figure 9 is a CAD drawing of the backing path a truck would need to approximate to back from the street into the loading dock driveway. Figure 10 illustrates the truck backing into the loading dock. The truck only required one backing maneuver.

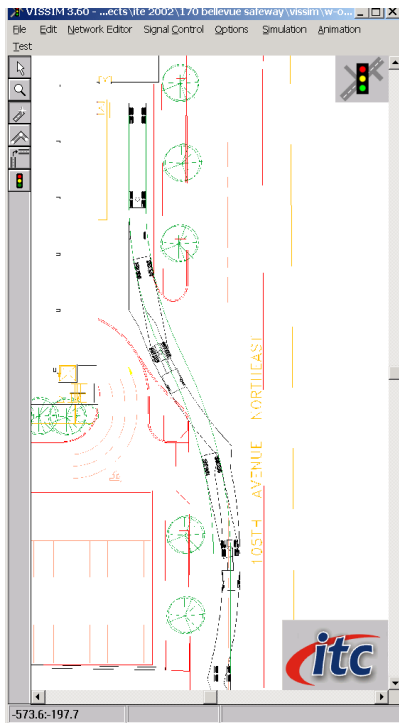


Figure 9: Truck Backing Path

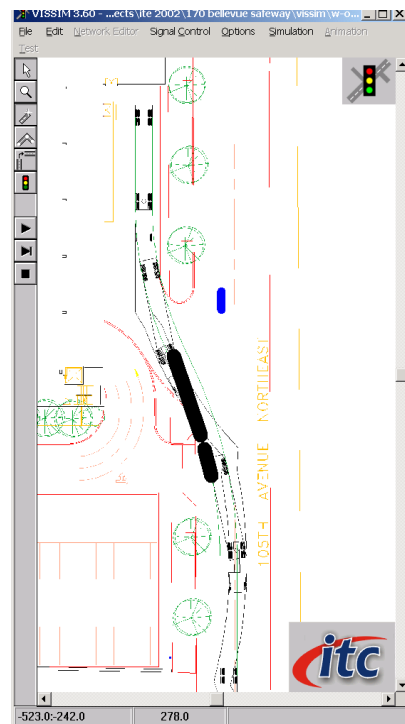


Figure 10: Truck Backing

On-Street Parking

Eliminating on-street parking is another rather controversial issues associated with access management. Many of the reasons for removing on-street parking are related to safety. For example, adjacent vehicles parked in angled parking spaces limit the visibility of motorists as they back out of their parking space. This scenario can result in backing vehicles colliding with vehicles in the travel lanes. Although not as limiting, parallel parking also limits the visibility of vehicles in the travel lanes as a motorist exits a parking space. Parallel parking can also result in vehicles stopped in the travel lanes as they back into a parallel parking space. A vehicle stopped in the travel lanes at an unexpected location (e.g., away from a signal or stop sign) can lead to a rear-end collision. On-street parking, as well as angle parking, also creates “friction” in the traffic stream that can lead to increased delays. These issues and many more are the reasons for removing on-street parking. There are also many compelling reasons to keep on-street parking not discussed in this paper. Both sides need to be considered when deciding what actions to take to limit on-street parking.

It is possible to model angle and parallel on-street parking in VISSIM. It is recommended that modeling angle parallel parking, where backing maneuvers need to be demonstrated, only be done to visually present the safety and operational issues. Developing models of these backing operations to analyze over a study period requires substantial time and effort. A relatively less time consuming approach can be used to analyze the operational impacts (i.e., friction) of angle and parallel parking during a given study period. This approach assumes the need to model vehicle backing maneuvers is not required. For example, a parallel parking maneuver could be modeled in VISSIM by (1) having the vehicle stop short of the space, (2) blocking the travel lane for a user-defined time, (3) pulling forward into the space in one movement, (4) parking for a given duration and (5) then exiting the space by pulling into the travel lane. A similar approach can be performed for angle parking maneuvers. The primary inputs to this approach are the amount of time a parking maneuver blocks the travel lane and turnover rate. Both can be measured in the field and entered in VISSIM. A distribution of the travel lane blockage times can be entered in VISSIM to reflect the randomness measured in the field (e.g., motorists pulling straight into a parallel parking space, as well as those that pull forward and back into the space). The turnover rate would then define the frequency of parking maneuvers during the study period and the duration vehicles are parked. This approach, although time consuming, can be used to measure the improvement in operating speeds resulting from removing on-street parking.

VISSIM Example

The VISSIM elements used to model parking maneuvers involving a backing vehicle are the same as those described in the section, *On- and Off-Site Truck Backing*. The following elements are those needed to model and analyze the operational effects of on-street parking:

- Links;
- Connectors;
- Transit routes;
- Dwell times;
- Stop signs;
- Reduced speed areas; and
- Priority rules.

Links and connectors define the network geometry and the parking space locations. Transit routes are needed to model the parking vehicles. Transit routes control where the vehicles park. Together with the dwell times they control the duration a vehicle is parked. A distribution (empirical or normal) can be used to define the dwell times. The stop signs are used to have the parked vehicle stop in the travel lane before pulling into the space. A dwell time can also be associated with the stop sign to reflect the duration the vehicle blocks the travel lane. Reduced speed areas are used to control the speed of the vehicle as it exits the parking space. Priority rules cause the vehicles in the travel lane to yield to vehicles exiting a parking space.

“Keep Clear” Boxes

“Keep clear” boxes are either marked or unmarked locations on the roadway where vehicles should not stop. One application would be to keep an unsignalized intersection clear of vehicles when a queue forms at a downstream signal. Therefore, vehicles could still enter and exit the unsignalized intersection. Another application would be to prevent vehicles from parking on railroad tracks.

VISSIM provides the flexibility for “keep clear” boxes to be defined anywhere within a network. A VISSIM model can be coded to have either zero or 100 percent compliance with the “keep clear” box or a user-defined percentage based on field observations.

VISSIM Example

The VISSIM elements used to model “keep clear” boxes are priority rules. The priority rules are set to keep a given area clear of traffic. Vehicles will not enter this area until certain user-defined criteria are satisfied. The priority rule settings can also be vehicle dependent to reflect field observations that reveal not all vehicles keep the area clear.

Effectiveness of Simulation in the Public Involvement Process

Over the past decade a much greater emphasis has been placed on involving the public throughout a transportation project. This emphasis is most evident during the planning phase where the public provides feedback on a variety of alternatives. As the level of public involvement has grown, so has the use of simulation. Simulation is a more effective method of explaining operational and safety issues than static diagrams and tables listing the level of service. Although these diagrams and tables are still an essential part of the process, a video simulation can make the point more succinctly and effectively, especially when it involves access management. Simulations have proven extremely successful when explaining controversial and complex transportation issues to the public, technical audiences and decision makers.

The following two projects illustrate the effectiveness of simulation to convey information to the public and decision makers. The first project was the Aurora Avenue North Corridor Project in Shoreline, Washington. Simulation models were developed for four alternatives. The simulations were shown during open house events. Overlaying these simulations on aerial photos was extremely effective in orienting the public to the study area. Moreover, several of the attendees were able to locate their homes and places of business on the aerials, thus providing more credibility in the simulation and analysis results. Simulations of the alternatives were also shown at city council meetings. In this forum, side-by-side comparisons of the simulated alternatives were made to clearly explain the benefits of each from a transit and traffic perspective. For example, the operations in the existing TWLTL were compared to a median concept with designated median breaks. The client project manager believed the simulations were one of the key factors in the project's success.

The second project was performed in Everett, Washington. A screenshot of this project was shown in Figure 8. The city council requested a major grocery store chain to investigate relocating a loading dock as part of their reconstruction project from the south side of the site to the north side. Relocating the loading dock created a number of circulation and access issues. The simulation was presented during a meeting where the city council members were to vote on whether to relocate the loading dock. The simulation was used to present two main issues: (1) traffic backing onto the street (i.e., safety) and (2) the delay to customers as they waited for the truck to perform a series of backing maneuvers needed to align itself with the loading dock. Based on a number of issues, including those demonstrated by the simulation, the council voted to keep the loading dock in its existing location.

These are two examples where simulation proved extremely effective in the public involvement and decision-making processes. Although much of the authors' work with simulation has been successful, a word of caution needs to be made. When presenting a simulation to any audience the transportation professional needs to relay that the simulation is only an approximation of reality. Much care may have been taken in developing the inputs (e.g., volumes based on ITE trip generation rates), but still the simulation is an estimate of what might or might not happen in reality. In addition, if a particular transportation issue is extremely emotional, a simulation may diffuse some of

the emotions. However, if the audience has already made up their mind, neither a simulation nor any other means will change their mind. The authors hope to continue their success using simulation in the public involvement and decision-making processes, but realize much care and effort must be taken to ensure future success.

General VISSIM Simulation Guidelines for Access Management Issues

No hard and fast guidelines exist to know when to use or not to use simulation in a given project. Access management issues are even more complex than traditional simulations. Therefore, Table 1 is included to provide some qualitative guidance about applying VISSIM to model access management issues and strategies.

Conclusions

VISSIM provides an opportunity to simulate, visualize and analyze access management issues and strategies. Some of these issues (e.g., certain TWLTL configurations) and strategies, however, are very complex from a driver behavior perspective. Therefore, some risk exists in being able to develop a VISSIM simulation of certain access related operations. The following are general statements that can provide guidance to transportation professionals considering the application of VISSIM to simulate access management strategies and issues.

- VISSIM simulation models can be developed to visualize safety and operational issues related to the lack of access management.
- VISSIM simulation models can be developed to analyze certain issues and strategies related to access management or the lack thereof.
- The level of effort and likelihood of success in developing a credible simulation model varies according to the access management strategy or issue.
- As the driver behavior complexity increases so does the challenge to build a credible simulation model.

The ability to create videos to illustrate transportation safety and operational issues is an extremely powerful attribute of simulation. This ability provides considerable value when explaining access issues to stakeholders. Access related simulations using VISSIM have experienced a number of successes in the public involvement and decision-making processes. These successes hold promise for other transportation professional undertaking projects where access management strategies may be controversial.

Table 1. Qualitative Guidelines for Applying VISSIM for Access Management Issues¹

Topic	Factors to Consider	Level of Effort		Potential for Success	
		Simulation for Visual Presentation	Simulation for Analysis	Simulation for Visual Presentation	Simulation for Analysis
TWLT	<ul style="list-style-type: none"> • Opposing left turn volume using same space in the TWLTL (i.e., conflict area) • Number of locations where opposing left turn volume uses the conflict area • Left turn volume from driveways that cross conflict area in TWLTL 				
<i>High opposing left turn volumes in TWLTL</i>		High	Extremely High	Low-Medium	Low
<i>Low opposing left turn volume in TWLTL</i>		Medium	High	High	Low
<i>No opposing left turn volume in TWLTL</i>		Low	Medium	High	High
Mid-block left turns		Low	Low	High	High
Medians					
<i>Median breaks</i>	<ul style="list-style-type: none"> • Number of median breaks 	Low	Low	High	High
<i>U-turns</i>		Low	Low	High	High
Driveway proximity to adjacent signal		Low	Low	High	High
Trucks backing	<ul style="list-style-type: none"> • Number of backing maneuvers 	Medium-High	High	Medium-High	Low-Medium
Site access and circulation		Low	Low	High	High
On-street parking	<ul style="list-style-type: none"> • Number of spaces • Turnover rate 				
<i>Angle parking²</i>		Medium-High	High	Medium-High	Low-Medium
<i>Parallel parking</i>					
Back into space		Medium-High	High	Medium-High	Low-Medium
Pull into space	Medium-High	Medium-High	High	Medium-High	Medium-High
“Keep clear” boxes		Low	Low	High	High

1. The relative ranges are based on the perspective of a consultant evaluating the risk-reward related to modeling the particular topic for a consulting project. It is difficult to conclude that modeling any of these items is not possible if given adequate funds and time.

2. If the desire is to model the impact of angle parking on traffic operations, the level of effort and potential success would be similar to the row labeled “Pull into space” under “Parallel parking”.

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