CASE STUDY

Effective Use of Visual Traffic Simulation to Illustrate Transportation Solutions & Influence Decisions

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Abstract

The use of microscopic traffic simulation models has recently become more commonplace in the study of transportation problems and the development of transportation solutions. This paper will discuss a case study where microscopic visual simulation was highly effective in illustrating proposed transportation solutions including:

- Comparative operation of two transportation alternatives
- Operation of a roundabout under special event traffic with police-officer-controlled traffic flows
- Operation of a proposed high volume pedestrian crossing

The purpose of this paper is to describe, in basic terms, the methods and tools used for the visual simulations, the conditions simulated, the benefits of simulation, challenges, and lessons learned.

The visual simulation was presented to stakeholders from the City of Athens, Ohio, including the City Streets Director, City Mayor, City Safety-Service Director, City Police Chief, City Fire Chief, Ohio Department of Transportation officials, Ohio University officials, and the general public.

Visual simulation helped all parties better understand the proposed transportation alternatives, significantly influenced the opinions of decision makers, eased the concerns of stakeholders, provided valuable technical analysis that was used in formulating engineering recommendations, and educated and influenced the opinion of the general public. The visual simulations served as a tool for building public support of the project.

Introduction & Background

The use of microscopic traffic simulation models has recently become more commonplace in the study of transportation problems and the development of transportation solutions. This paper will discuss a case study where microscopic visual simulation was effectively used to illustrate proposed transportation solutions including:

- Comparative operation of two transportation solution alternatives
- Operation of a roundabout under special event traffic and police control
- Operation of a proposed high volume pedestrian crossing

Parties that were engaged by the use of the visual simulation included:

- City Streets Director
- City Mayor
- City Safety-Service Director
- City Police Chief
- City Fire Chief
- State Department of Transportation Officials
- University Officials
- General Public

The project that will be discussed herein is the Richland Avenue Improvement Project in the City of Athens, Ohio. The City of Athens is home to Ohio University. The population of the City is 21,000.

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Figure 1 – Hazardous Intersection Location

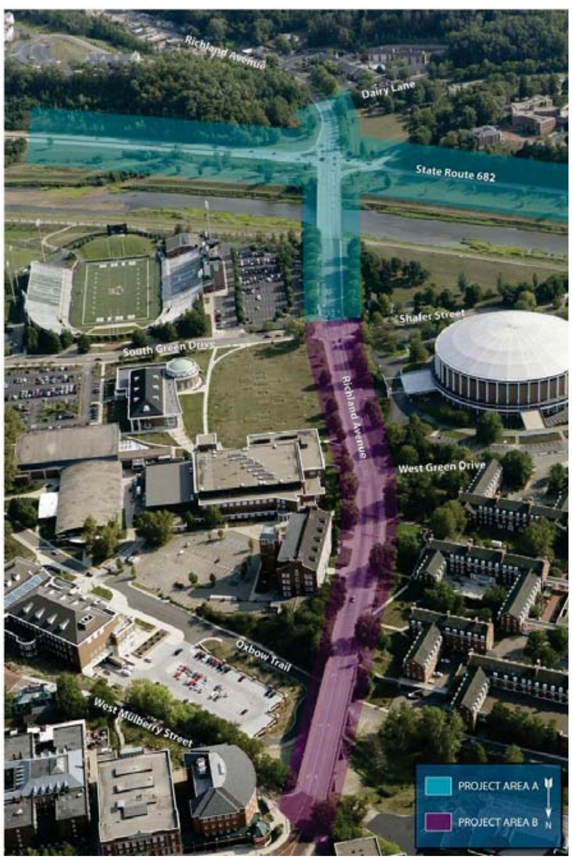

Figure 2 – Project Areas

Introduction & Background *(Continued)*

Visual simulation was used for the study phase of this project, which began in October 2007 and ended with the selection of the City's preferred alternative in May 2008. The primary purpose of this project was to develop solutions to address a hazardous intersection at State Route 682 (SR682) and Richland Avenue. **See Figure 1** for a map illustrating the location of the hazardous intersection.

The City obtained a grant from the Ohio Department of Transportation to implement a safety improvement at this location. The study area for the project was expanded by the City to include Richland Avenue to the north of the hazardous intersection. In this expanded area, issues related to the mixing of pedestrians, bikes, and motor vehicles were studied. **Figure 2** illustrates the two project areas with "Area A" representing the intersection safety improvement limits and "Area B" representing the expanded project area.

Microsimulation was initially included in the scope of the project primarily for the purpose of illustrating to the general public a proposed roundabout intersection solution. If a roundabout solution were chosen, it would be the first in the City of Athens. However, additional uses for the model became apparent as the study process unfolded.

The author would like to note that a more effective means of discussing and describing experiences with microscopic visual simulation would be an oral presentation with video capabilities, but this paper will provide some static images of these simulations. It also will describe, in basic terms, the methods and tools used for the visual simulations, the conditions simulated, the benefits of simulation, challenges, and lessons learned.

Methods & Tools Used

Two primary tools were used for all of the visual simulation for this study, MicroStation (1) and VISSIM (2).

The software package VISSIM was used to do all visual simulations for this project. VISSIM is a stochastic microscopic simulation model developed by PTV AG, Germany. It uses the Wiedemann psycho-physical car following logic to model traffic on the road network. It is a time-step and behavior-based simulation tool developed to model urban traffic and public transit operations.

The inputs in VISSIM include:

- Lane assignments and geometries
- Travel demands
- Distributions of vehicle speeds
- Acceleration and deceleration
- Signal control timing plans

The model is capable of producing measures of effectiveness commonly used in the traffic engineering profession such as total delay, stopped-time delay, stops, queue lengths, fuel emissions, and fuel consumption. VISSIM provides an ideal platform for the analysis of roundabouts due to the amount of flexibility incorporated into the model structure. The 3D-engine of VISSIM is a powerful tool for visualization of traffic operations.

While VISSIM has some graphics capabilities, it cannot generate detailed and attractive graphics for items such as roadway curbs, medians, and pavement markings. It is vital to display pavement markings in 3D-animations of traffic operations at roundabouts to illustrate the lane use on each approach. When using different visual tools at public involvement meetings, it is beneficial to have a common underlying image so as not to confuse the audience. Such an image must also be imported into VISSIM for traffic operations visualization.

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Figure 3 – Signalized Intersection Alternative Graphic

Figure 4 – Roundabout Intersection Alternative Graphic

Methods & Tools Used *(Continued)*

For the purposes of drawing various transportation solutions, high quality, to-scale, aerial photography was obtained and used as a background for the drawings. The proposed solutions were drawn and color rendered using the MicroStation software package.

Figures 3 and 4 illustrate the design and basic rendering of the two alternative solutions for the intersection safety improvement using these tools. The final images were converted to a JPEG image format and exported to VISSIM as a background image. 3-D animations of traffic operations for the study area were displayed on the imported background image.

Occasions of Use of Visual Microsimulation

Project Team Meetings

Throughout the project there were various meetings with the project team, which is defined as the consultant's staff, City staff, Ohio Department of Transportation staff, and Ohio University staff (Ohio University was a co-sponsor of the study). In these meetings, visualization models were used to illustrate the more technical aspects of the alternatives being considered and to preview simulations to be shown at the public meetings.

At larger meetings the simulations were projected onto a large screen. At other, smaller meetings, simulations were viewed on a laptop computer monitor. AVI formatted files were at times posted on an ftp site to allow the City's Streets Director (and Project Manager) to view the simulations prior to upcoming

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Occasions of Use *(Continued)*

meetings. A combination of simulations directly using the VISSIM software and AVI files using Windows Media Player were shown at these meetings.

Stakeholder Meetings

Stakeholders who were shown the simulations included the City Mayor, City Safety-Service Director, City Police Chief, City Fire Chief, Ohio University staff, Ohio Department of Transportation officials, and a City Police Lieutenant. The simulations were projected onto a large screen for discussion with stakeholders.

Public Meeting

The general public was invited to a meeting at which a simulation of the corridor was shown for both alternatives that were under consideration. The simulations were projected onto a large screen, and each was part of a "station" for each alternative that described the characteristics, costs, benefits, etc. of that alternative. A simulation AVI file was prepared for both morning and afternoon peak hour conditions and run on a continuous loop using Windows Media Player. Each video was approximately two minutes long (one each for a.m. and p.m. peak hours). The videos depicted a "fly through" that paused at each intersection then panned around at different 3-D angles to demonstrate the project from various overhead, oblique, and ground level perspectives.

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Occasions of Use *(Continued)*

City Council Meeting

The City Streets Director gave a presentation to City Council to make the final recommendation that the roundabout should be selected as the City's preferred alternative. During his presentation to Council, a continuously looping visual simulation of the roundabout alternative played on a screen on the council chambers wall.

City Website

After the public meeting a "clickable" side-by-side version of the visual simulation (a linked AVI file) was posted on the City's website. This allowed those who did not attend the public meeting to review the simulations of the two alternatives.

Conditions/Solutions Modeled

Figure 5 – Screenshots of Corridor VISSIM Simulation

Corridor Operations for Two Alternatives

The primary use of the simulation modeling was to illustrate the operation of two alternative solutions for the hazardous intersection, and the traffic interaction with the intersections immediately north and south of this intersection (Dairy Lane – south, and Shafer Street – north). **Figure 5** shows screenshots of the VISSIM simulation for the Richland Avenue and SR 682 signalized and roundabout intersection alternatives, respectively.

The simulations were effective in showing how each alternative would look in the current physical landscape; the movement and speed of the vehicles; and operational characteristics such as vehicle queues and interaction with adjacent intersections. The

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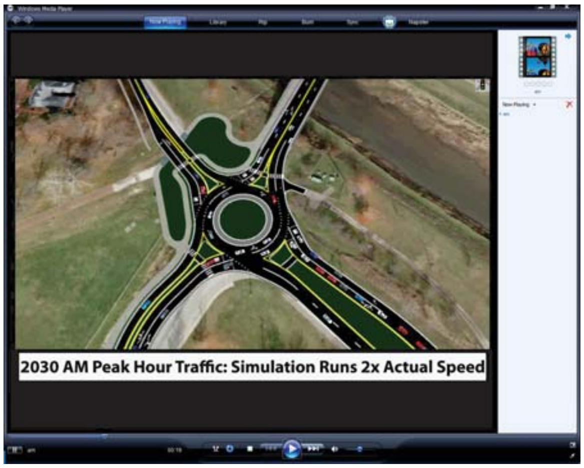

Figure 6 – Screenshot of Roundabout Intersection Simulation

Conditions/Solutions Modeled *(Continued)*

visual simulations clearly showed the operational characteristics of the modern roundabout alternative to those who had never seen a roundabout operation.

Based on comments received, the people who watched the simulation found the roundabout to be much smaller and traffic to move much slower than they expected. The model also was useful in explaining how to drive a roundabout since individual vehicles could be pointed out and their allowable movements described. **Figure 6** shows a screenshot of the simulation of the proposed roundabout solution. The simulation also illustrated the size and complexity of the proposed signalized alternative, in comparison to the roundabout alternative. Topics such as traffic conflicts and pedestrian safety could be fully explored just by watching and discussing the simulation.

One important finding that was determined through the use of the visual simulation was that the currently non-signalized adjacent intersection to the south, at Dairy Lane, would no longer operate acceptably with a roundabout at the SR 682 intersection. This is due to the basically continuous flow of traffic exiting the roundabout to the south in the afternoon peak hour.

The model showed that there would not be sufficient gaps to allow Dairy Lane traffic to enter Richland Avenue. Conversely, if the SR 682 intersection were signalized, the upstream signalization would create gaps in Richland Avenue traffic that would allow Dairy Lane traffic to enter Richland Avenue. The visual simulation clearly illustrated this, and thus, a recommendation of the study was that if a roundabout was built at SR 682 and Richland Avenue, the intersection of Dairy Lane must be signalized. Related to this, the visual simulation also

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Conditions/Solutions Modeled *(Continued)*

was used to illustrate that southbound traffic queues on Richland Avenue at Dairy Lane under the signalized condition would not back up into the roundabout at SR 682.

Maintaining Special Event Traffic at the Roundabout

Because roundabouts were new in their community, the Police and Fire Departments were understandably anxious about how the roundabout would operate during special event traffic. Since the intersection is located near the campus of Ohio University, there are numerous special events throughout the year (i.e. football games, basketball games, graduation, move-in day).

To address this issue, visual simulation using VISSIM was presented to the City Fire and Police Chiefs and other City and University representatives in a special meeting to illustrate the roundabout operation under a hypothetical worst case "football Saturday" condition.

Ohio University's football stadium and associated parking is located just north of the proposed intersection. A conservatively high estimate of traffic was used in the modeling, which assumed that all available event parking would go from empty to full in an approximately one-hour duration prior to the game, and from full to empty in an approximately 45-minute duration after the game. It was assumed that almost all of the game traffic would go through the roundabout intersection.

For this meeting, the simulations were shown using the VISSIM software directly instead of showing AVI files, so that changes in volumes and/or operational characteristics could be made on the spot in response to comments from the stakeholders.

After some internal testing prior to the meeting, it was decided to prepare VISSIM model files for two scenarios. The first

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Conditions/Solutions Modeled *(Continued)*

scenario assumed that there would be no officer control at the intersection. The second assumed that an officer would stop the south leg of the roundabout periodically to allow the east leg to clear. The first scenario was allowed to run for a few minutes (running at four-times real speed). It showed that, for the arrival (pre-game) period, traffic would significantly back up on the east leg of the roundabout if no officers controlled traffic. This was because heavy northbound traffic entering the roundabout limited the number of gaps for the also heavy volume of traffic entering the roundabout on the east leg.

In the departing (post-game) period for the first scenario (no control), the roundabout was shown to work well, primarily because there were no high volume conflicting movements at the roundabout, since all heavy traffic is approaching on the north leg.

An initial response from viewing the simulation was from a police officer. The officer confirmed that traffic estimates were conservatively high. He stated, "We have never had that much traffic on that leg of the intersection," referring to the leg to which the majority of the game traffic was assigned. He was also able to confirm that the "background" traffic assumed for other legs was reasonable.

For the second scenario, the act of an officer stopping the south entry leg of the roundabout for a short duration (60-120 seconds) was simulated by coding a hypothetical traffic signal on that leg, and allowing the other three legs to operate normally. This simulation illustrated that this simple strategy would allow traffic on the east leg of the roundabout to clear. Those in attendance seemed to concur that the roundabout could work well under most, if not all, special event conditions, and no additional scenarios were even tested.

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Figure 7 – Screenshots for Existing and Proposed Pedestrian Crossing Simulation

Conditions/Solutions Modeled *(Continued)*

High Volume Pedestrian Crossing

Richland Avenue north of Shafer Street has a significant level of pedestrian activity due to Ohio University students. This includes a high number of student pedestrians that cross Richland Avenue in short durations during class change periods. Currently, there is some confusion about where students should cross Richland Avenue. Students currently cross in a fairly non-uniform pattern over an area spanning several hundred feet. They are not given the right-of-way at a marked crosswalk. Included in the scope of the study was to investigate alternatives for pedestrians to cross Richland Avenue. One such alternative involved marking a designated crosswalk on Richland Avenue and requiring students to cross at this point. One concern is the potential impact that channeling pedestrian traffic into one crossing would have on vehicular traffic operations. The concern is that there will be large backups of vehicles waiting for a gap in crosswalk traffic.

A VISSIM model **(Figure 7)** was developed to test this condition. An extensive count of pedestrian volumes was performed in the subject area of the corridor. These pedestrians were then assumed to cross at this single crosswalk location. A meeting was held with the Streets Director and the Safety-Service Director to observe the simulated operation of the proposed crosswalk. Predicted vehicular queues could be observed through the simulation. This information was useful in the ultimate decision to implement this solution for one university quarter in 2008-2009 as a test period. Actual operations will be observed and compared with the model.

Summary of **Benefits** & **Challenges**

Benefits

The City Streets Director expressed the following: "I think the simulation is the key thing that convinced some of the most skeptical decision makers." He said this with respect to the formal decision to construct a roundabout at the intersection of Richland Avenue and SR 682. In general, the visual simulation became the determining factor in many of the decisions made and in forming opinions about the transportation solutions. The benefits of the visual simulation can be summed up as "seeing is believing" or "a picture is worth a thousand words." Concepts and ideas that transportation professionals often find difficult in explaining to stakeholders, politicians, and the public can be simply "shown" to them through the use of realistic visual microsimulation models overlaid on good aerial photography.

An additional benefit of visual simulation is that technical staff can also observe the hypothetical operation of transportation concepts and make decisions and recommendations based on those observations. This is especially beneficial for situations that cannot adequately be evaluated using static methods of analysis (i.e. the interaction of two closely spaced intersections, or the operation of pedestrian crossings).

A benefit in terms of time and cost was that project mapping and drawings that were already created in *MicroStation* for general study purposes could easily be used as a background for the simulation. These graphics were simply converted by *MicroStation* to file formats that could be directly imported into VISSIM.

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Summary *(Continued)*

The ease of creating AVI files of the simulations in VISSIM allows anyone with a computer to view the simulations. This was highly valuable in obtaining reviews and input from members of the project team.

Challenges

While the modeling for this project did not present many difficulties, there are challenges that can arise when a client wants to use visual simulation for a project.

One challenge for the use of visual simulation is obtaining an adequate project budget to create the needed models. Creating these models is not inordinately expensive, but such models have not traditionally been included in scopes of services for traffic and transportation studies. The benefits can be well worth the cost; however the initial budget for the study portion of the project may have to be increased to provide visual simulation. This investment will likely be recovered later due to better project decision making and reducing the chance of having to revisit prior decisions in the process. For this case study, the City and the consultant included simulation modeling in the initial scope of the study.

Finding a modeler with adequate expertise to develop such models is critical and can be a challenge. Modeling special conditions can be complicated and requires a modeler with adequate education, training, experience, and understanding of the model to assure the model is realistic. Displaying poorly prepared, unrealistic simulations to stakeholders and/or the public can discredit the entire project team. In this case study, the consultant had a qualified individual to develop the necessary models.

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Summary *(Continued)*

The software required to generate 3-D visual simulations can be relatively expensive. The purchase of such software can likely only be justified if the agency or firm intends to regularly use the software. Finding a consultant (if a consultant is to be hired) who has invested in this modeling capability can be challenging and should be considered in the requirements for firms proposing to work on the study. The consultant for this study owns and maintains the VISSIM software and the necessary licenses required to produce the 3-D simulations.

Another challenge can be that AVI files created from the simulations can get very large in size. AVI files with adequate resolution can easily reach 100 megabytes of memory and can exceed 1.0 gigabytes of memory for some highly complex, long duration, and/or high resolution models. Adequate computer memory, speed, and network connections are important. External hard drives and FTP sites are useful in transmitting these large files.

One specific challenge for this project was that, due to the capabilities of the VISSIM software, AVI files cannot be created that simulate the "real speed" of the vehicles. Approximately two times real speed is the minimum speed at which an AVI can be recorded in VISSIM and maintain a quality image. For most transportation studies, this may be adequate and actually preferred. However for this study, when simulating the roundabout operations, it would have been advantageous to show real speed traffic to illustrate the relatively "calm" nature of traffic at a roundabout. Real speed traffic simulation can be accomplished by running the simulation in the VISSIM software; however, only computers that have the VISSIM software can be used for this purpose. The result was that AVI models shown on

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Summary *(Continued)*

the project website, at the public meeting, and at the City Council meeting had to be shown at two times real speed.

Conclusions

As illustrated by this case study, visual simulations using microsimulation software can be highly effective in communicating transportation improvement concepts to a variety of audiences. A wide range of concepts can be modeled using the VISSIM software, including unconventional intersections like roundabouts, temporary conditions such as special event traffic, and the interaction of vehicles and pedestrians in a crosswalk setting.

The benefits of visual simulation include providing a better understanding of the operation of transportation alternatives for the project team, stakeholders, and the public. Additionally, detailed technical aspects of transportation alternatives can be evaluated simply through the observation of the visual simulation. Challenges to visual simulation can be cost, finding adequate modeling expertise, and the size of AVI files of recorded simulations. These challenges can be overcome if considered early in the study scoping process.

Overall, for this case study, the visual simulation model was the "difference maker" in terms of gaining public and stakeholder support of the ultimate recommended solution. It was considered well worth the cost and effort to produce.

Acknowledgment

We would like to sincerely thank Mr. Andrew Stone, the City of Athens City Engineer and Director of Public Works, for including visual simulation in the project scope. Mr. Stone's leadership, vision, courage, and professionalism resulted in the implementation of significant transportation improvements for the City of Athens.

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