APPLICATIONS OF 3D VISUALIZATION

Peer Exchange Summary Report

Raleigh, North Carolina
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Prepared for:
Office of Interstate and Border Planning
Federal Highway Administration
U.S. Department of Transportation

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I. SUMMARY

On July 8–9, 2009, the Federal Highway Administration's (FHWA) Office of Interstate and Border Planning sponsored a 1.5-day peer exchange to promote the sharing of information on the use of 3D visualization techniques at transportation agencies. North Carolina Department of Transportation (NCDOT) hosted the peer exchange. Participants included staff from the Baltimore Metropolitan Council, FHWA, California Department of Transportation (Caltrans), Minnesota Department of Transportation (Mn/DOT), New York State DOT, Volusia County Metropolitan Planning Organization (MPO), the U.S. DOT Volpe National Transportation Systems Center, and Washington State DOT (WSDOT).[1]

The purpose of the peer exchange, which focused on select transportation agencies' 3D visualization activities, was to allow participants with noteworthy visualization capabilities, products, and organizational arrangements the opportunity to share their knowledge, experiences, and lessons learned. Challenges faced in creating visualizations and advancing the state of the practice at their respective agencies were also described. This report summarizes the peer exchange's presentations, demonstrations and discussions. Comments, questions, and answers from each participant's presentation session follow the report's presentation overviews. It is expected that this document will be a resource for other transportation agencies seeking to learn more about their peers' 3D visualization activities and practices.

II. BACKGROUND ON VISUALIZATION

Visualization is the process of using visual imagery to convey the complex character of a variety of objects at appropriate and more easily understood scales. Today, visualization techniques often rely on computers to convert data into various image forms, including three-dimensional (3D) representations. Examples of visualization techniques include sketches, drawings, artist renderings, physical models and maps, simulated photos, videos, computer modeled images, interactive geographic information systems (GIS), GIS based scenario planning tools, photo manipulation, and computer simulation. Some useful resources as they relate to these techniques and transportation are:

- TRB's Visualization in Transportation Committee website: www.trbvis.org/MAIN/TRBVIS_HOME.html
- Eastern Federal Lands Highway Division Design's visualization website: www.efl.fhwa.dot.gov/technology/dv.aspx
- American Association of State Highway and Transportation Officials' Visualization in Transportation, A Guide for Transportation Agencies: http://cms.transportation.org/sites/design/docs/VisualizationGuideJuly2003.pdf
- National Cooperative Highway Research Program Synthesis 361: www.trb.org/news/blurb_detail.asp?id=6911

Given the requirement in Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) for visualization to be used in transportation planning as well as visualization's ability to facilitate transportation at all stages of delivery and implementation, FHWA supports a number of technical assistance and outreach activities related to visualization, such as case studies[2] and training courses. This peer exchange report is expected to be another similar resource.

III. PRESENTATIONS AND DISCUSSION

Welcome and Introductions

Ben Williams, FHWA Resource Center

[1] Candidate participants voluntarily submitted responses to an electronic questionnaire that FHWA developed. The questionnaire, which was distributed to select agencies based on FHWA knowledge of the field, requested information on the ways that transportation agencies use 3D Visualization. Appendix A provides a complete list of participants and attendees.

[2] Three case studies are available at: www.gis.fhwa.dot.gov/reports.asp.

Mr. Williams welcomed participants to the peer exchange and thanked the North Carolina DOT for hosting the event. Mr. Williams provided an overview of visualization and its role throughout the transportation decision-making process. Visualization can be applied to a variety of business processes, from helping in the design of roadway projects to facilitating communication of project plans to the public. Visualization also encompasses a variety of formats, ranging from traditional paper maps to more advanced 3-dimensonal animations, with the format being geared to the intended audience. Mr. Williams noted that agencies need to make tradeoffs on where to invest visualization resources in order to reach the needs of the diverse audiences.

FHWA recognizes the value of visualization to transportation decision-making. In 2007, FHWA's Office of Interstate and Border Planning published case studies on transportation applications of visualization.[3] In addition, in the past several years FHWA has conducted several peer exchanges focused on the use of geospatial technologies in transportation, including the use of GIS for right-of-way planning.[4] Finally, Mr. Williams noted that FHWA continues to disseminate state-of-the-practice information on uses of geospatial and visualization techniques through the GIS in Transportation website[5] and the "Visualization in Planning" website.[6]

Common Challenges

All participants

To begin the peer exchange, participants gave an overview of challenges their agencies faced in conducting visualization activities. Some challenges mentioned include:

- Devising appropriate visualization job titles and determining where visualization activities should be located organizationally
- Sustaining upper management buy-in
- Determining how to best disseminate data when the organization is data rich
- Ensuring that end users understand how to use and/or apply the visualizations created
- Evaluating the effectiveness of visualization tools
- Acquiring the skills necessary to develop visualizations, especially given the limited availability of in-house training opportunities
- Ensuring that visualization engages, not just informs, the public in planning processes
- Improving how to determine what projects need visualization
- Creating standard approaches for developing and implementing visualization tools

It was expected that through the presentations, participants would share their agencies' respective insights and lessons learned in confronting the obstacles discussed.

Demonstrations and Presentations

North Carolina DOT

David Hinnant, Manager NCDOT Visualization

In the late 1990's, a few individuals spread across various business units within North Carolina DOT (NCDOT) began developing visualization products as part of their day-to-day job duties. These staff members' own personal interests in visualization and the associated technologies were the primary drivers for any visualization that were developed. Over time, other units started requesting visualization products and a more widespread need for the tools was identified. In 2000, NCDOT created the Enterprise Visualization group to help meet this need. Having established itself in NCDOT over time by creating better visualizations more quickly thus securing upper management support, the group's goal now is to provide high-quality service to all units within NCDOT by staying current with the rapidly growing

[3] Visualization Case Studies: A Summary of Three Transportation Applications of Visualization: www.gis.fhwa.dot.gov/documents/visual.pdf
[4] Geographic Information Systems Applications for Transportation Right-Of-Way: www.gis.fhwa.dot.gov/documents/rightOfWay.asp
[5] FHWA GIS in Transportation Website: www.gis.fhwa.dot.gov
[6] FHWA Visualization in Planning Website: www.fhwa.dot.gov/planning/vip/index.htm

state of the practice in visualization. To date, visualization services have been provided to a number of NCDOT's business areas, including its Transit Division, Division of Highways, Division of Motor Vehicles, and Attorney General's Office.

The Enterprise Visualization group, which is organizationally located in NCDOT's Information Technology (IT) section, manages a majority of the department's visualization internally. While staff members in the group have varied backgrounds, including structure design, GIS, design services, photogrammetry, and roadway design, all need to contribute some degree of creativity. This has sometimes been a challenge for NCDOT because the job titles for visualization specialists require civil engineering backgrounds, a requisite that might not attract candidates with more artistic qualifications. In any case, a majority of NCDOT visualization projects originate from design data, engineering plans, cross-section graphics, geometry measurements, and terrain maps. By using as diverse and comprehensive set of data inputs as possible, Enterprise Visualization group tries to avoid developing visualizations that inaccurately illustrate transportation projects and/or outcomes that likely will not happen.

There is no policy mandating that NCDOT's units use Enterprise Visualization to develop needed project-level visualizations, and some visualizations get sent out to contract due to a lack of availability of Enterprise Visualization staff. Additionally, there has not been one consistent approach to making a request for visualization services. Since requests are accepted from all groups within NCDOT, it is sometimes difficult to prioritize the order that visualizations get created. Historically, a majority of the demand for visualization resources has come from the need to support public meetings and workshops and, typically, units approach Enterprise Visualization staff on a project-by-project basis. After describing the potential visualization products, Enterprise Visualization staff will ask the customers to describe what would be useful given the project's time constraints.

One challenge that NCDOT's Enterprise Visualization group has faced is that it has not always collected feedback on visualizations once they are produced. The group has also not always taken time to estimate the time and cost associated with developing visualizations. To address this, Enterprise Visualization has started tracking its time better now. Because consultant firms often have access to more resources, time and cost estimates are compared from a perspective of: "if all the required staff and resources are available, then the visualization would cost $X." It is expected that by being able to produce more precise cost estimates, as well as follow up with customers once a project is complete, the Enterprise Visualization group will continue to be a viable alternative to consultants who provide visualization services.

For more information on NCDOT's Enterprise Visualization group, visit www.ncdot.org/it/visualization.

Comments, Questions, and Answers

- **Question**: Does the visualization staff develop NCDOT's websites?
  Answer: The visualization staff maintains its own website but is not involved with those of other bureaus. There is a website group that is responsible for managing NCDOT's websites. The visualization staff ensures that the visualization website is consistent with NCDOT's web standards.

- **Question**: Given that NCDOT has a YouTube site (www.youtube.com/NCDOTcommunications) for its visualizations, how are disclaimers handled?
  Answer: The department will draft a disclaimer and seek approval from project managers. On a recent high profile project, the consultant on contract for the design, provided the disclaimer

- **Question**: Does NCDOT do statewide flyovers to acquire aerial imagery?
  Answer: Aerial imagery has been flown for the entire state. The most current imagery however, is normally maintained by the individual counties. The Enterprise Visualization group will acquire this imagery through NCDOT's Photogrammetry Unit or www.NCOneMap.com. This website compiles all GIS and orthophotography data for the state. If the data that are posted on NCOneMap are out of date, NCDOT will contact counties to determine whether there are more current data. GIS data that NCDOT develops itself are all delivered to the NC Center for Geographic Information and Analysis (CGIA). After the severe flooding that occurred with Hurricane Floyd in 1999, North Carolina's

Floodplain Mapping Information System (FMIS) [7] was tasked with improving the flood information and flood forecasting system for North Carolina. FMIS allows users to download LIDAR data for any county in the state.

Comment: Caltrans has been able to acquire high resolution Public Domain aerial photography from the U.S. Geological Survey (USGS). USGS has been very responsive and willing to provide data if Caltrans provides a hard drive onto which the data can be transferred. There is a considerable amount of nation-wide Public Domain imagery available from the USGS.

- **Question**: Has NCDOT tried a 64-bit computer?
  Answer: NCDOT Enterprise Visualization is testing one. Implementation is currently difficult since no other groups are using a 64-bit system. A 32-bit system will also need to be maintained for some applications such as plotting, due to the lack of 64-bit servers. With the current inability to purchase additional system memory, the full benefit of a 64-bit system would not be realized.

- **Question**: Does NCDOT use a Bentley System?
  Answer: NCDOT uses Bentley Microstation and Geopak to produce all highway design data. Enterprise Visualization uses these same products to prepare the design data for import to Autodesk 3dsmax to create models for visualization. Post production work is done with the Adobe Production Studio.

- **Question**: From where does NCDOT's visualization group obtain vehicle and person models for its visualizations? This can pose a challenge if a consultant delivers an animation that used proprietary software to render the vehicles and/or people in it.
  Answer: NCDOT has used ArchVision's Rich Photorealistic Content (RPC) to incorporate complex objects into 3D computer graphics environments. A challenge has been that RPC objects are sometimes difficult to animate and adding too many can create computer processing problems. Content has also been purchased from Dosch Design and Turbo Squid. Permission has also been given to use a recent model delivered by a consultant including some vehicles.

- **Question**: Has NCDOT experienced a situation where the constructed transportation project did not look like what the visualization initially portrayed?
  Answer: With visualization being done so early in the project lifecycle, very few projects that have utilized the Enterprise Visualization group have actually been completed to date. Of those that have been completed, the visualization was a very accurate representation. In terms of aspects such as the inclusion of trees and other aesthetic treatments, the Enterprise Visualization group often leaves these elements out. At the time the visualization are being created, it is often not known whether there will be funding to actually implement what is illustrated or there may not be design specifications yet. In some cases, when these elements are not included, the public will ask why the visualization omits the particular item. This leads to discussion with stakeholders. NCDOT has viewed this as positive engagement.

- **Comment**: The Baltimore Regional Council Baltimore documents the specifications for all visualizations developed so that when similar projects arise in the future there is institutional knowledge for how to recreate the effort.

New York State DOT
Bob Dudley, Senior Drafting Technician, Office of Environment

Visualization activities at New York State DOT (NSDOT) headquarters have been reorganized several times. Initially, visualization staff were part of Landscape Architecture Bureau, than were moved to the Design Services Bureau, and recently, have moved back to the Office of Environment/Landscape Architecture Bureau. The NYSDOT visualization staff currently consists of three members.

[7] North Carolina's FMIS: www.ncfloodmaps.com

Having developed expertise in creating two-dimensional photosimulations, 3D renderings, and 3D animations, the visualization group is moving towards an environment where simulations are developed based on real traffic data and that incorporate a time element—a fourth-dimensional component—into models. The group is also working to bring two-dimensional visualization capabilities (e.g., using Adobe's Photoshop) to all NYSDOT staff. Given the varied roles the centralized visualization group has taken over recent years, staff members are experiencing an evolution from being a production only unit to adding a support-side team responsible for quality assurance and keeping the Regions up-to-date with training and new standards.

Challenges
Primary challenges that visualization professionals at NYSDOT have faced include:

- Treating visualization as an afterthought. Sometimes visualization staff members are not involved in the early planning stages of a project but are later asked to prepare a visualization on very short turnaround. This can make creating a comprehensive and accurate visualization tool difficult.
- Public critique at the computer-generated people, cars, and landscapes. In many cases, the people rendered are young, attractive, fashionable people, while the cars are fast-looking sports cars. Often skies are blue, and flowers are blooming. The public has sometimes questioned the authenticity and credibility of the visualization given a perceived misrepresentation of their "real world."
- Answering the question: "How important is it to know certain information?" Junk in Junk out. You need to do your home work when it comes to your Data. "Data Mining" is incredibly important. I work closely with the people in the Photogrammetric section for 3D ground data and for Hi-Resolution Ortho images. Depending on the project, you will have to research bridge details, Guide Rail, Signs, Stripping, Material textures, Lighting, Planting plans, ADA specs. and the list goes on. Since Visualization encompasses every aspect of Transportation you need to have a working knowledge of multiple Design Criteria.
- Compromised data fidelity due to moving back and forth across different software and platforms.

To see examples of NYSDOT visualizations of a single point interchange for Interstate 87, visit www.nysdot.gov/portal/page/portal/regional-offices/region1/projects/i87-exit6.

Figure 1: Route 7 over I-87 (Exit 6) Bridge Replacement Project

Comments, Questions, and Answers

- **Question**: Does NYSDOT use VISSIM?
  Answer: NYSDOT generally creates models in MicroStation V8 - than exports to 3D Studio Max - then imports to VISSIM 3D Modeler - and finally the 3D element is imported into VISSIM.

Minnesota DOT
Kai-Jurgen A. Huot-Link

Using Visualization for the St. Croix River Project
The development of in-house visualization expertise within MnDOT was driven by the St. Croix River Crossing project. The St. Croix River Crossing project will replace the Stillwater Lift Bridge, which spans the St. Croix River, which is designated as a Wild and Scenic River. Consideration of a replacement bridge crossing over the St. Croix River near Stillwater began in the early 1970s, but was not pursued because of a lack of funding. By 1995, a Final EIS was completed for a replacement bridge. However, because the St. Croix River was designated as a National Wild and Scenic River, the National Park Service (NPS) evaluated the project under Section 7(a) of the Wild and Scenic Rivers Act. The NPS and found that the project, as proposed, would have a direct and adverse effect on the river. As a result of the finding, the project was not allowed to proceed.

Following the finding, an independent review of the project was conducted to analyze potential bridge alignment alternatives. Internal staff at MnDOT developed animations for the four different alignments. The animations were used throughout the NEPA public involvement process, which ultimately resulted in the selection a preferred alternative. Once the preferred alternative was chosen, MnDOT staff created additional animations showing the details of the proposed project. The final product was a computer-generated animated video that depicted the project's recommended concepts.[7] The animated video, which presented views from the river, the roadways and aerial views, included a voice over that provided information on the project and why the project elements were chosen. In addition to the animation, staff also created a variety of visuals that were included in the project's Visual Quality Manual.[8]

As the St. Croix River Crossing project progresses, MnDOT staff have continued to develop visualizations for the project.

Figure 2: Screen shot for St. Croix River Crossing animation

[7] St. Croix River Crossing Project visualizations: www.dot.state.mn.us/metro/projects/stcroix/vqpp.html
[8] St. Croix River Crossing Visual Quality Manual: www.dot.state.mn.us/metro/projects/stcroix/vismanual.html

Benefits of Visualization
The visuals created for the St. Croix River Crossing project helped to generate a great deal of discussion regarding the project's design and facilitated decision-making. For example, draft visuals helped an internal committee make design decisions.

Future Projects
MnDOT staff are currently working on developing animations for a proposed dynamic-toll project on I-35W.[9] The animations are intended to depict the signage that will be used to display the changing toll rates. Unlike the St. Croix project, where the 3D animations were all computer generated, the I-35W 3D animations will be created with the use of video. In order to do this, staff shot video from a vehicle as it drove down I-35W, and is using SynthEyes software to create a virtual camera and track the 2D features in the video. SynthEyes calculates 3D points from the tracked features which are then exported into 3ds Max to be used as reference points for developing the 3d model.

Comments, Questions, and Answers

- **Comments**: The descriptive narration throughout the St. Croix project video makes it a useful for the visually impaired community as well.
- **Question**: How long did it take to develop the animation for the St. Croix River Crossing project?
  Answer: The animation was created as part of the Visually Quality Manual. Overall it was a year long process.
- **Question**: Where did the background music in the animation come from?
  Answer: The music was chosen from a studio library.
- **Question**: What are the benefits of using a video instead of computer generated images?
  Answer: Shooting the video provides an element of realism and also saves some time in not having to generate the base layers.

California Department of Transportation
Karen Koklich, Geospatial Projects Coordinator, Office of Land Surveys

The California Department of Transportation (Caltrans) is comprised of headquarters staff and 12 district offices. The department does not have a formal visualization group. Instead, the majority of the visualization work is performed at the district level and is typically driven by project need. Visualization has historically been used by the landscape architects, bridge aesthetics and planning. Recently the engineering department has begun to use visualization throughout its work processes.

In addition to the visualization work done at by the districts, at the Headquarters level Caltrans has a CADD and Engineering GIS Office and an Office of GIS. The Engineering GIS office manages the CAICE engineering software, Microstation and Engineering GIS. The Office of GIS includes data and mapping branches, and also manages the ArcGIS Software. The GIS Office is in the process of rolling out Google Earth Enterprise. Caltrans is populating its virtual earth using its aerial imagery and local domain imagery.

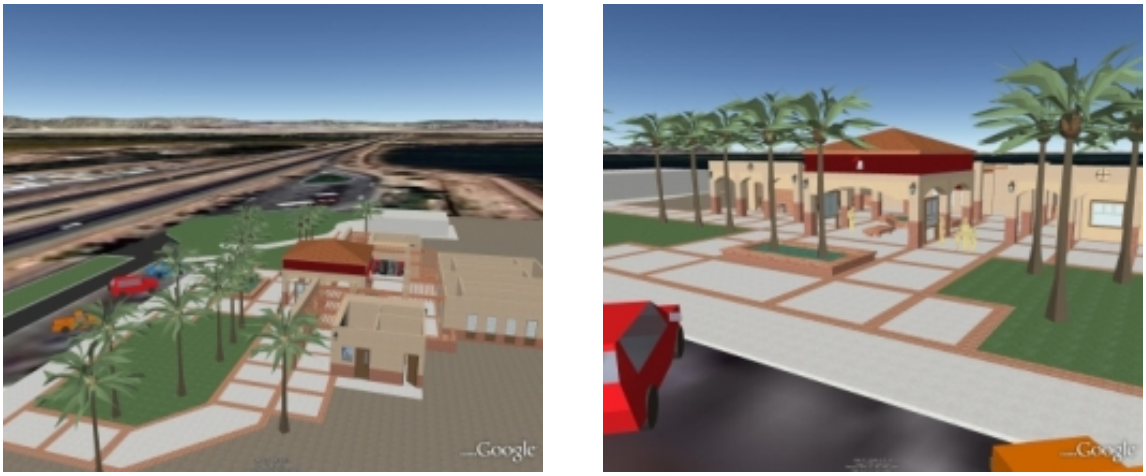
Examples of Visualizations
Caltrans has utilized visualization in a variety of applications, including as a working tool, to facilitate collaboration on projects, and as public media communication tools. The following are examples of the variety of visualization software used and applications developed at Caltrans.

1. **CAICE – 3D Visualization Tools**. Caltrans utilizes CAICE for its engineering software. CAICE enables true 3D modeling, and includes features such as shading, texturing, image draping and the ability to define and apply smart objects, such as guardrails. Caltrans utilizes CAICE to develop digital designs.

[9] I-35W Urban Partnership Agreement video: http://www.dot.state.mn.us/upa/animation/UPA_video.html

2. **Google Sketch-up**. Google Sketch-up enables a 3D model to be developed and exported to Google Earth for visualization. The Sketch-up application also allows you to lay down a design plan and create a true 3D model. This application provides downloadable models of numerous existing objects. The most notable use of Google Sketch-up is the 3D buildings that are available to the public in Google Earth.

Figure 3: Google Sketch-up 3D model of a roadside rest area in southern California



3. **ESRI GIS Animation**. Visually compares speed of highway segments before and after project construction. The simulation pulls actually speed data from a database. The software allows you to record a video clip of the animation, which can then be incorporated into PowerPoint or presentations with Adobe Flash.
4. **Google Earth**. Google Earth is useful for those who do not need a great depth of 3D and GIS information. Caltrans has purchased and intends to use Google Earth Enterprise for those projects that do not need as much refinement, for example, when sharing information with partner agencies that are familiar with transportation concepts. Caltrans did note that the vertical datum of the design terrain differs from Google Earth's terrain. This application can provide not only the graphics, but database information can be exposed by the user by clicking on objects. A good example of this is a Right of Way project where the acquisition acreage is available to the presenter via a mouse click. This puts tools as well as presentation graphics in the hands of the presenter.
5. **Consultant Work**. In addition to visuals created in-house Caltrans also utilizes consultants to develop media products to inform the public of transportation projects. For the San Francisco – Oakland Bay Bridge Project Caltrans worked with PB to create an animation depicting the construction phasing. The video depicted each construction phase and showed the associated lane closures and detours that would be in effect during each phase. The animation was successful in helping the public understand the need for lane closures and was critical in managing traffic concerns. In addition to its usefulness as a public outreach tool, the animation also helped the contractor detect scheduling conflicts and better manage the project.

Figure 4: San Francisco – Oakland Bridge Construction Phasing Simulation

Future of Visualization at Caltrans

The Caltrans' engineering and surveying divisions are looking to integrate 3D models throughout the entire life cycle of a project, from design through construction. For example, 3D models would first be developed in DTM, then carried through into design, construction and ending with the creation of an as-built survey. By using models throughout the process Caltrans hopes to improve productivity and quality. The need for 3D models is, in part, being driven by Machine Guidance construction techniques.

Comments, Questions, and Answers

- **Question**: Does Caltrans have Google Earth Enterprise?
  Answer: Caltrans currently has two Google Earth Enterprise servers that can each support 250 simultaneously users. We are in the process of populating our GEE servers with various aerial imagery sets, an elevation model and other data sets.

Baltimore Metropolitan Council

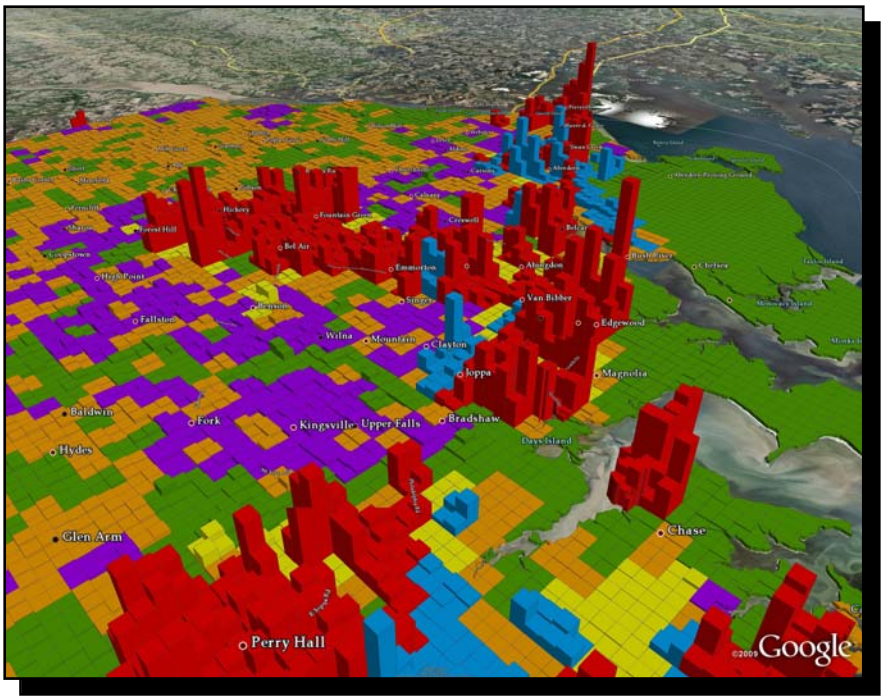
Brad Spittel, GIS Coordinator and Monica Haines Benkhedda, Public Involvement Coordinator

Primarily focusing on transportation planning activities, the Baltimore Metropolitan Council (BMC) works to improve the quality of life and economic vitality in the Baltimore region. Over recent years, visualization has played an increasingly prominent role in that effort. Specifically, decision-makers at the agency now use the outputs of the visualization tools to answer many regional planning questions: "Are proposed transportation projects aligned with the problems that are out there?"

The visualization tool that BMC uses most often is Google Earth Pro, which has offered an inexpensive, ArcGIS-compatible way to organize and distribute information to the public. From the inception of its use, the use of Google Earth Pro has been a success at BMC. It has offered those with fewer GIS skills a convenient way to analyze, present, and/or view data. In one recent application, the BMC GIS staff contributed to the discussion and analysis of a regional transportation vision effort which is currently in the development phase. BMC allocated household counts (displayed by varying heights) and land uses (displayed by varying colors) to a grid that overlapped traffic analysis zones (TAZ). In the application, users can click on a square in the grid to obtain all of the information from the travel demand model. Staff also utilized Google Earth technology in the development of the 2007 Baltimore Regional Long Range Transportation Plan - *Transportation Outlook 2035.* Users of this online visualization tool can view transportation projects from the draft *Transportation Outlook 2035* plan, as well as many other useful layers such as average travel times, congested roadways, building permits valued over 1 million, bike

pedestrian level of service, and drivable tours that are near their residences. The tool has helped members of the public understand where they each fit into the bigger, regional transportation picture as well as to develop a sense of ownership over decisions that will likely affect them. A downside to the software is that given the complex data sets being stored, more powerful computers that many may not have are needed. This can slow the development of visualization tools and create funding issues. To combat this issue the BMC GIS staff has developed interactive maps using Google Maps API. To view BMC's visualization techniques visit http://www.baltometro.org/content/view/729/495/.

Figure 5: Screen shot of total households by intention use used in BMC's vision effort.



Public Outreach

A major motivation for BMC's continued visualization effort is public outreach. BMC aims to keep the public *involved* in the transportation planning process, as opposed to simply *informed*. Visualization has given the agency a way to help increase a sense of ownership and personal relevance among the public regarding proposed transportation projects in the region. It has helped BMC intuitively demonstrate that transportation concerns do not end at city or county lines. While planners and engineers may have technical knowledge, the public may have a more robust understanding of "community fabric"—two complex sides that that visualization can instantaneously connect.

BMC recommendations for using visualization in public outreach efforts are:

- Incorporate visualization techniques into communications and public participation plans
- Give voice and listen. Implement visualization methods that not only share information but that also gathers feedback for planners and decision-makers to directly use.
- Collaborate and integrate. Leverage limited funding through collaboration and integration into existing systems. Find out who at the transportation agency (or elsewhere, such as libraries and local universities) is working with visualization techniques or has access to computer equipment to avoiding duplicating effort and wasting resources.
- Make applications accessible. Visualization can be a good tool for engaging Limited English Proficiency (LEP) and low-literacy populations. Adding an audio element to visualizations might help those who are blind.

Ms. Haines Benkhedda noted the importance of always keeping the public user in mind when developing technical visualization tools and corresponding public engagement processes and shared the following useful public participation resources:

- American Planning Association's Ethical Principles in Planning: www.planning.org/ethics/ethicalprinciples.htm
- International Association for Public Participation: www.iap2.org
- Open Government Initiative: www.whitehouse.gov/Open

In addition, the following visualization examples were highlighted:

- BaltiMorphosis.com: www.baltimorphosis.com. The website is intended to generate collaborative community design ideas for the city's Franklin Mulberry corridor. It allows visitors to download a 3D model and design their own plans for redeveloping the corridor.
- Bike Baltimore: www.citypaper.com/news/bikes/map.asp. Bike Baltimore is an interactive map that shows the city's completed bike paths, bike lanes, and sharrows. It allows users to mark places to ride and/or avoid.

BMC Challenges

Some challenges that BMC has faced in implementing visualization tools include moving beyond 2D visualization, getting staff training in visualization techniques, and maintaining funding for necessary computer software and hardware. In some cases, it has also been difficult to illustrate regional, longer-term projects versus actual short-term projects that are being or will be built. For example, the *Transportation Outlook 2035* plan includes approximately 80 projects. There is some debate as to whether all of these planned projects should be visualized. On the other hand, TIP projects, like bridge repairs or road repaving, tend to be more generic and nature and may be less appealing transportation projects to represent through visualization. BMC tries to balance the tension between creating visualizations without having all of the project's discrete details and maintaining credibility, managing expectations, and avoiding potential controversy.

Comments, Questions, and Answers

- **Question**: How does BMC address SAFETEA-LU's requirement to include visualization in planning? **Answer**: BMC's Public Participation Plan, which was issued just after SAFETEA-LU, does not have many details on using visualization in planning. The plan will be updated again soon and more specific information on how the requirement will be met may be added when revisions are made.

Volusia County MPO

Karl Welzenbach, Executive Director

The Volusia County MPO utilizes a variety of visualization techniques to expand public participation throughout the transportation planning process. The MPO developed an interactive Transportation Improvement Program (TIP), which is a clickable map that provides details on projects. The interactive map (available at http://volusiatip.edats.com/) is a way for the public to identify what transportation projects are planned in their area. As part of the TIP development, the MPO and the Florida DOT funded the creation of animations for four projects included in the TIP. Each animation shows the existing condition as well as the proposed improvements. The MPO and the DOT relied on a consultant to create the animations. The consultant produced 20 animations for a total of $100,000.

Following the success of the TIP animations, the Florida Metropolitan Planning Organization Advisory Council (MPOAC) passed a resolution that directed the Florida DOT to develop similar animations anytime a PD&E is developed for a capacity adding project or for a major redesign of an existing project. To date only FDOT's District 5 has adopted the policy; however, the ongoing budget shortfalls facing the DOT many limit the district's use of animations.

Figure 6: Screen shots of an animation of the Bascule Bridge Replacement project

In addition to the interactive TIP, the Volusia MPO also created a series of visuals to showcase realistic examples of the basic transit-oriented development (TOD) principles described in the Transit Development Design Guidelines. The images demonstrate how existing automobile-oriented streets can be transformed in stages into pedestrian-friendly, transit-oriented streets.

IV. CONCLUSIONS AND KEY FINDINGS

A number of important observations emerged from peer exchange presentations and roundtable discussions regarding the use of 3D visualization in transportation decision-making:

Enhancing Communication with a Variety of Stakeholders. Visual techniques and products facilitate communication with a wide variety of stakeholders, including the general public, local government decision-makers and regulatory agencies. Visualizations not only help transportation agencies convey information externally, but they also serve as powerful tools for gathering input and feedback.
The types of visualization products and the level of detail of the visuals should be appropriate for the intended audience. For instance, the visuals used to share information with partner agencies that are very familiar with transportation concepts may not need to be as polished as those used to present information at public meetings.

Evaluating the Effectiveness of Visualizations. Developing visualization products requires an investment in monetary and staff resources. In order to justify continued investment in these technologies agencies seek ways to quantify the benefits generated from the use of visualizations. However, because visuals are created as a means to share information and facilitate communication, the impacts are subjective in nature and do not warrant themselves to quantification. Instead, a more qualitative approach to evaluating the benefits of visualization products may be necessary. Such qualitative evaluation techniques include distributing surveys at public meetings to gauge the audience's reaction to the visuals, and collecting feedback from the staff who presented the visualizations regarding how the visuals affected their communication with the public.

Participants noted the importance that the success of the visualizations be separated from the success of the project itself. The public could oppose a project, but if the visualization helped the public to more accurately understand the project then the visualization should be considered a success.

Developing Visualizations Internally Versus Hiring a Consultant. The decision of when to utilize internal visualization units versus relying on consultants to develop products is often made on a project-by-project basis. Deciding factors include:

- Whether the roadway design work is performed internally or by a consultant - If a consultant is completing the design work then most often the visualization work for the project is added on to the consultant's contract.
- Turn-around time – Because the visualization units typically operate with limited staff and available resources, complex projects that have short schedules are often completed by a consultant, who has access to larger staff and equipment.

Participants noted the advantages that internal visualization units have over consultants, namely that they are more responsive, and identified a need to better track the staff time and costs associated with projects in order to determine the costs savings associated with developing the products in-house.

Hiring and Retaining Qualified Staff. State DOTs do not have a visualization job classification category; instead agencies typically classify visualization positions as either IT or transportation technician positions, which require civil engineering experience. These limited classifications make it difficult to recruit and hire staff that possesses the appropriate skill sets to actually perform the job, such as those with graphic or visual design backgrounds. Visualization staff members need to understand transportation design concepts and possess creativity. However, participants noted that while technical skills can be developed on-the-job, creativity is not something you can teach.

In addition to making recruitment challenging, the job classification structure also limits staff advancement. Participants noted that the work experience gained in a visualization position is not typically relevant to other divisions within the DOT. For instance, when visualization staff members are classified as IT they do not typically have the skills and qualifications to advance within the IT classification.

Training and Information Sharing. Transportation is one small component of the larger visualization industry. Much of the training and vendor provided information is focused more on the gaming industry. There is a strong interest in developing transportation specific trainings and transportation community forums where staff can share best practices, software/technology recommendations, etc.

Appendix A. Participants and Other Attendees

Participants

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Appendix B. Agenda

Wednesday, July 8

8:00	*Meet in hotel lobby to travel to NCDOT Central Office*
8:30 – 9:00	**Welcome and Introductions** *Ben Williams, FHWA*
9:00 – 9:45	**Participant Introductions and Expectations** - Brief summary of each agency's 3-D visualization activities - Needs and challenges - What would you like to learn?
9:45 – 12:15	**Demonstrations/Presentations, *approx. 45-min each –*** *Breaks as necessary* - North Carolina DOT - New York State DOT - Minnesota DOT
Lunch (provided)	
1:30 – 4:00	**Demonstrations/Presentations, *approx. 45-min each –*** *Breaks as necessary* - Caltrans - Baltimore MPO - Volusia County MPO

Thursday, August 9

8:00	*Meet in hotel lobby to travel to NCDOT Central Office*
8:30 – 10:00	**Roundtable Discussion**
10:00 – 11:00	**Peer Exchange Re-Cap, Key Points, and Wrap-Up** *Mark Sarmiento/Ben Williams, FHWA*
Adjourn	

Appendix C. Useful Links

The following lists web links included in the report as well as other resources mentioned at the peer exchange.

- American Association of State Highway and Transportation Officials' Visualization in Transportation, A Guide for Transportation Agencies: http://cms.transportation.org/sites/design/docs/VisualizationGuideJuly2003.pdf
- Baltimorphosis: www.baltimorphosis.com
- Bike Baltimore: www.citypaper.com/news/bikes/map.asp
- Eastern Federal Lands Highway Division Design's Visualization: www.efl.fhwa.dot.gov/technology-dv.aspx
- Ethical Principles in Planning: www.planning.org/ethics/ethicalprinciples.htm
- FHWA GIS in Transportation Website: www.gis.fhwa.dot.gov
- FHWA's Visualization in Planning: www.fhwa.dot.gov/planning/vip
- GIS Applications for Transportation Right-Of-Way: www.gis.fhwa.dot.gov/documents/rightOfWay.asp
- International Association for Public Participation: www.iap2.org
- Open Government Initiative: www.whitehouse.gov/Open
- National Cooperative Highway Research Program Synthesis 361: www.trb.org/news/blurb_detail.asp?id=6911
- NCDOT Example Visualizations: www.ncdot.org/it/visualization and www.youtube.com/NCDOTcommunications
- North Carolina's Floodplain Management Information System: www.ncfloodmaps.com
- NYSDOT Interstate 87 Visualizations: www.nysdot.gov/portal/page/portal/regional-offices/region1/projects/i87-exit6.
- St. Croix River Crossing Project Visualizations: www.dot.state.mn.us/metro/projects/stcroix/vqpp.html
- St. Croix River Crossing Visual Quality Manual: www.dot.state.mn.us/metro/projects/stcroix/vismanual.html
- Transportation Research Board Visualization in Transportation Committee: www.trbvis.org/MAIN/TRBVIS_HOME.html
- Volusia County MPO Interactive TIP: http://volusiatip.edats.com/
- Visualization Case Studies: A Summary of Three Transportation Applications of Visualization: www.gis.fhwa.dot.gov/documents/visual.pdf
- Wordle.net: www.wordle.net