Roundabout Feasibility Study for West Memphis

MBTC 2072

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Contents

ABSTRACT

Transportation agencies are often faced with questions from communities concerning the safety and aesthetics of off/on ramps and intersections located below aging and unsightly interstate overpasses in the many rural-to-rapidly-urbanizing areas in Arkansas. A key issue is the challenges encountered by the citizens in their attempts to implement economic development projects, a crucial need for the Arkansas Delta. These challenges are routinely intertwined with those facing the Arkansas Highway and Transportation Department because communities and citizens have substantive issues but may not understand AHTD technical and regulatory needs and constraints.

The project studied the feasibility of interstate bridge and intersection design solutions—including roundabout feasibility —and developed a model for community-based transportation planning that can facilitate the interface between community stakeholders and the agencies implementing infrastructure modifications. Phase 1 included analysis and presentation (for community and agency approval) of formal design options for the I-40/I-55 bridge intersection with state Highway 77 in West Memphis, Arkansas, to advance transportation efficiency, public safety, and visual enhancement as a response to increasing population growth and economic development in the area. Phase 2 focused on development and documentation of a community-based expert-system planning model that could be used to address similar transportation issues throughout the Arkansas Delta and beyond.

Introduction

The I-40/I-55 and State Highway-77 (Great River Road) intersection is a major access to both the City of West Memphis on the south and the Marion Intermodal Transportation facility on the north and is one of the busiest intersections in the South. The intersection and bridge (and bridges to the east) act as part of an "eastern gateway" into the state of Arkansas from Tennessee. The overall project evaluated the safety, relative cost, and visual preference for four alternative bridge and intersection treatments: 1) disguise/hide, 2) distraction, 3) celebration, and 4) innovation. The first three intersection/bridge treatment strategies were site-specific landscape designs by University of Arkansas landscape architecture students with input from a University of Arkansas senior civil engineering student during the Fall of 2004 (Appendix A). The present project (July 2005-July2007) investigates a multi-disciplinary "innovation" approach that considered the use of roundabout designs to ease congestion and give the intersection more legibility and prominence as the Great River Road Scenic Byway entry into West Memphis, Arkansas, while providing increased interest and safety for residents and visitors alike.

The process developed through the implementation of the study project can form the basis of a practical model for other Arkansas communities engaged in economic development, since incorporating public safety through updated highway exchange designs can lead to aesthetic, social, and economic benefits such as:

- heightened community visibility within transportation corridors
- strengthened community identity and marketability
- improved quality-of-life and safety from functional landscape enhancements that emanate from state-of-the-art intersection design.

The roundabout study project was implemented through a partnership of the City of West Memphis, the Arkansas Highway and Transportation Department (AHTD), the Mack Blackwell Rural Transportation Center, and three university groups: the Department of Civil Engineering at the University of Memphis; the Department of Landscape Architecture, and the UA Economic Development Institute (UAEDI), both at the University of Arkansas, Fayetteville. West Memphis hosted students and facilitated involvement of citizens in the process. A senior civil-engineering design student evaluated the relative cost, safety, and regulatory issues of potential roundabouts and their viability for use at the location under study. Landscape Architecture students provided landscape design alternatives for both existing and proposed intersection improvements, community assessment, and public information research. AHTD provided data on the intersection under study, through preliminary intersection proposals by the Parsons Engineering Firm of Memphis, as well as guidance on planned modifications to off/on ramps with additional bridges to deal with issues related to the Union Pacific railroad that passes under the interstate bridge. The public relations model and economic development issues were addressed by UAEDI.

Project Objectives

The mission of the project were to develop a model for engaging a multidisciplinary planning and design process that included students from landscape architecture and civil engineering and community stakeholders that support economic development in the Arkansas Delta. Project objectives were:

1. Create and present several student-generated options (including a roundabout) that address safety and visual enhancement while facilitating a more pedestrian- and cyclist-friendly environment around the rapidly urbanizing target interchange.
2. Evaluate participation and response from project stakeholders and solicit feedback from stakeholder-participants.
3. Package data and documentation to assist West Memphis in proceeding with implementation of the redesign, including identification of funding opportunities and other resources.
4. Develop a model that other communities can use to facilitate transportation development at the rural-to-urban interface.
5. Explore the multidisciplinary potentials between civil engineering, and landscape architecture students as a Mack Blackwell Rural Transportation Center supported effort.

Project Organization and Process

As a profession, landscape architects have a strong history of working collaboratively with civil engineers on a variety of projects ranging from the well known Blue Ridge Parkway to the recently renovated Columbus Circle in New York City yet the professional relationship at the undergraduate level of education has yet to mature. While retention has increased in engineering schools where freshmen across all the engineering disciplines experience working on projects together, there is little evidence of upper level civil engineering undergraduates working with related disciplines that have a strong public service component such as architecture and landscape architecture.   Originally, the project was anticipated to involve a full class of civil engineering students who could work with landscape architecture students in a lab setting. However time constraints of civil engineering students in a lab setting led to identifying a senior civil engineering student at the University of Memphis who lived in close proximity to the project site in West Memphis.

A class of twelve Landscape Architecture Design VI students and the senior civil engineering student reviewed the work of the previous Landscape Design III studio who had provided landscape alternatives for the existing intersection (Appendix A) and identified several circulation problems. The circulation problems identified were reviewed as follows:

- The intersection below the bridge is difficult for visitors to interpret as drivers heading north on 77 from the south of the Interstate bridge have to turn east before being rerouted west to intersect with I-40 and I 55.

- There is no provision for pedestrian or bicycle circulation.

- During the study it became apparent that the increased railroad traffic is causing queues that occasionally back car and truck traffic up onto some of the interstate exit ramps.

One question was repeatedly asked: How does a roundabout work with the close proximity of the railroad? In O'Fallen, ILL, engineers suggested,

> "The roundabout will not solve the problem of traffic congestion due to trains sitting idle for long periods of time at the crossing. However, the roundabout will improve the situation when compared to: (1) the current status of the intersection, (2) traffic signals, or (3) stop signs." See photo in figure 3.

http://www.ofallon.org/Public_Documents/OFallonIL_Administration/Articles/January_2006/Engineering_PublicWorks?textPage=1

Why consider a roundabout?

> "Traffic engineers recognize the reluctance of drivers to accept roundabouts as a traffic management device and believe that educating the public about the benefits of a roundabout is vital to its successful implementation on the roadway.

Roundabouts save lives...

- Up to a 90% reduction in fatalities
- 76% reduction in injury crashes
- 30-40% reduction in pedestrian crashes
- 75% fewer conflict points than a 4-way intersection

Slower vehicle speeds mean...

- Drivers have more time to judge and react to other cars or pedestrians
- An advantageous situation for older and novice drivers
- A reduction in the severity of crashes
- A safer situation for pedestrians

Efficient traffic flow...

- 30-50% increase in traffic capacity

Reduction in pollution and fuel use...

- Improved traffic flow for intersections that handle a high number of left turns
- Reduced need for storage lanes

Money saved...

- No signal equipment to install and repair
- Savings estimated at an average of $5,000 per year in electricity & maintenance costs
- Service life of a roundabout is 25 years, compared to 10 years for a traditional traffic signal"

Source: http://fcgov.com/traffic/eng-roundabout.php

Roundabouts also provide important visual urban or community design focal points.

Students studied several roundabout case studies (Appendix B) and two major approaches to roundabout use at interstate intersections as a replacement for the existing intersection realizing that "roundabouts need to fit into a network of intersections, with the traffic control functions of a roundabout supporting the function of nearby intersections and vice versa." (Federal Highway Administration, *Roundabouts: An Informational Guide* (USDOT 2000) .

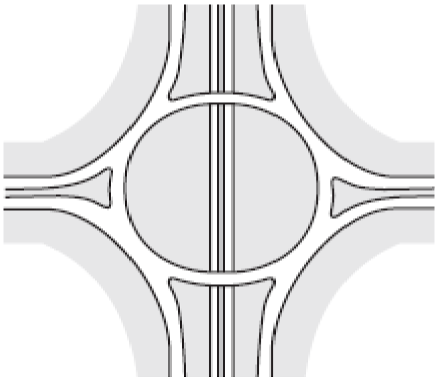
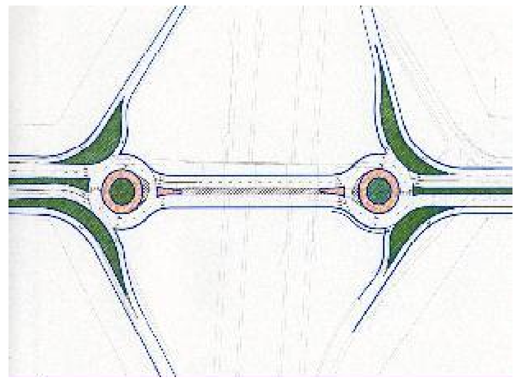


Figure 1. Two bridge roundabout over or under interstate
(*Roundabouts: An Informational Guide* (USDOT 2000)



Single bridge roundabouts over or under Interstate
(members.cox.net/…/MaltaNY-Interstate-Exit JPG)

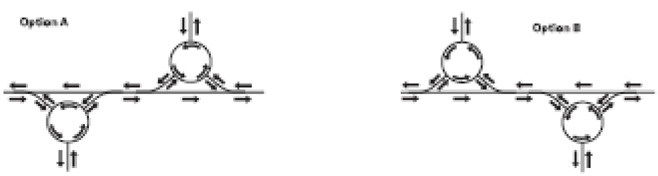


Figure 2. Offset T-intersections often improve roundabout capacity because of bypass lanes.
(*Roundabouts: An Informational Guide* (USDOT 2000).

Railroad interaction with roundabouts was also studied for potential solutions.

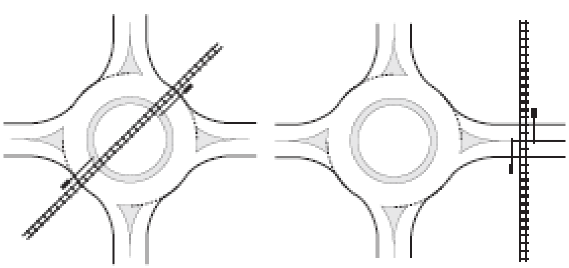


Figure 3. Railroads may penetrate the roundabout but the preferred solution is to have the railroad cross the intersection legs as shown on the right. (*Roundabouts: An Informational Guide* (USDOT 2000). Photo source: http://www.ofallon.org/Public_Documents/OFallonIL_Administration/Articles/January_2006/Engineering_PublicWorks?

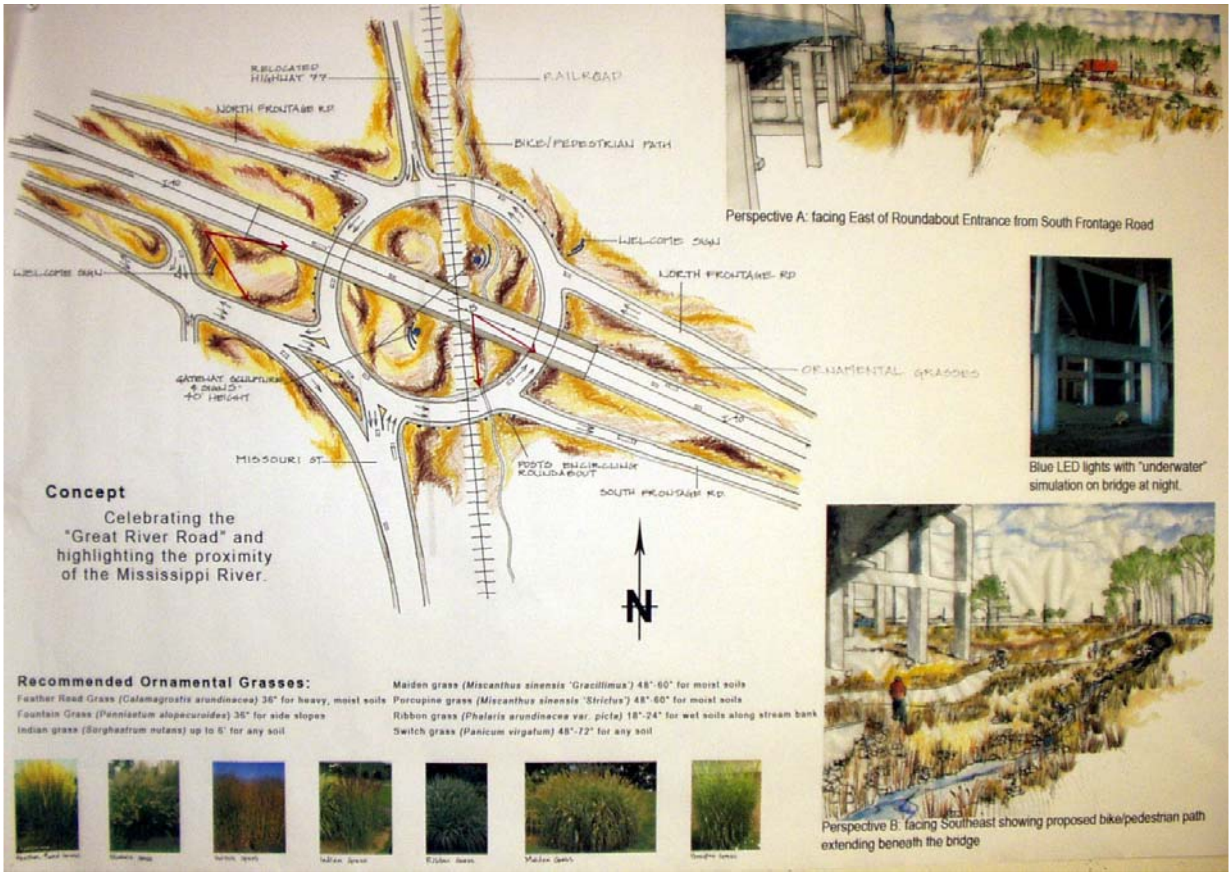


Figure 4. Student preliminary sketch of possible large roundabout replacing the existing intersection with railroad through the middle. This approach is only possible where short trains use tracks on an occasional basis. Highway 77 from Marion has been moved west of track in this preliminary study but is too close to the exit ramp. Notice pedestrian access under bridge and use of ornamental grasses to minimize maintenance. Shannon Wallace

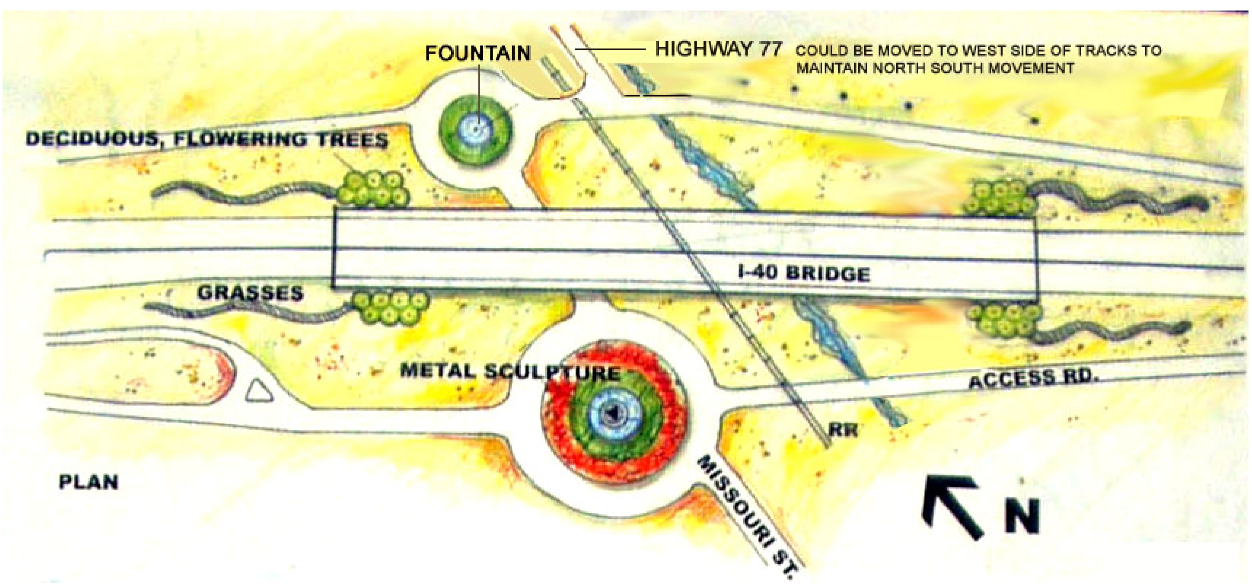


Figure 4. Landscape Architecture student preliminary study of double roundabout replacing existing intersection. The railroad crosses one leg of each roundabout which is preferred over the above solution but does not resolve excessive queuing on existing access/exit roads due to an increasing number of long slow trains. Shannon Shrum

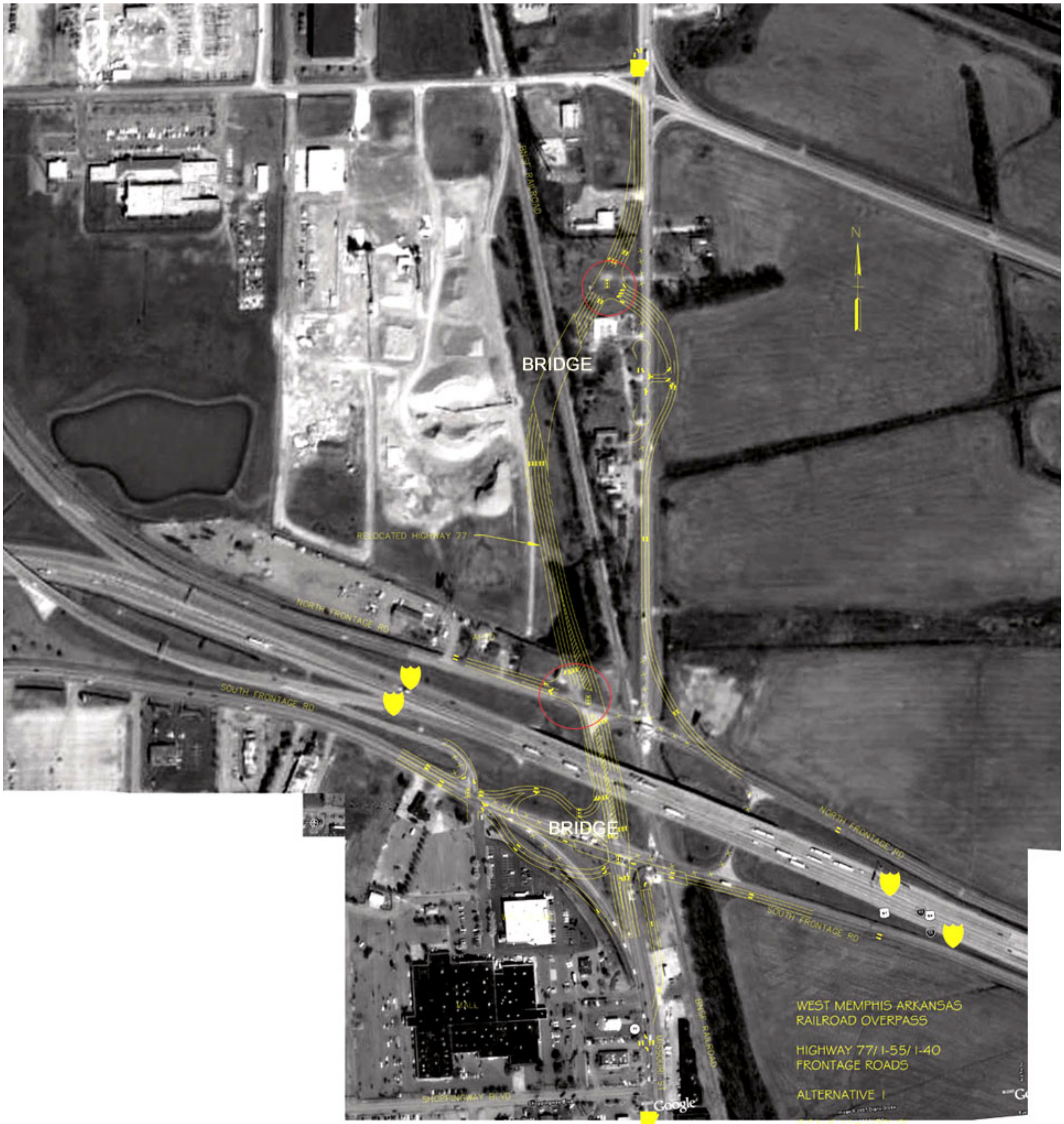


Figure 6- Parson Engineering Alternative 1 with roundabout study locations marked with red circles. Note proposed bridges over the railroad to mitigate present queuing problems . (Plan source: West Memphis – Marion Area Railroad Overpass Study for AHTD by Parsons Corporation, Memphis, Tennessee, November, 2005)

AHTD provided a preliminary study by the Parsons Engineering Firm of Memphis, Tennessee, that recommended the interstate ramps and access roads bridge the railroad to avoid safety problems created by increasing train traffic that causes unacceptable auto and truck traffic queuing. Presently there are nine long and slow freight trains a day with double that number projected over the next twenty years.

Roundabout Feasibility Study for West Memphis, Arkansas Jonathan Griffin

Project Definition

The roundabout design project for West Memphis, Arkansas is a component of the greater research project MBTC- 2072 sponsored by the Mack-Blackwell National Rural Transportation Center at the University of Arkansas. The Mack-Blackwell center is a national study center for education and research in rural transportation. MBTC-2072, or the Roundabout Feasibility Study for West Memphis, Arkansas as a Prototype for Intersection Improvements around Interstate Overpasses, was developed by Dr. John Crone, Dr. Otto Loewer, and Dr. Carolyne Garcia. MBTC-2072 is a two phase project consisting of a feasibility study of design alternatives at Interstate and local route intersections and the development of a model for community based transportation planning projects. One design solution is the installation of a roundabout system at these intersections. The roundabout was chosen for further analysis because of the fundamental benefits including: increased efficiency, safety, and potential for aesthetic improvements, which result from putting roundabouts in place at existing intersections. The roundabout design for the West Memphis, Arkansas project will consist of a feasibility study and development of design alternatives for the installation of roundabout systems at interstate overpasses.

Literature Review

Modern roundabouts have existed in the United States since 1990 with the first installation in Summerlin, a residential Las Vegas suburb. The modern roundabout was first established in England in 1963 and there are now 60,000 in use world wide (Baranowski 2006). Roundabouts are different from rotaries and traffic circles in that they give right-of-way to the traffic in the circle, are small in scale, and feature raised entry islands. Roundabout installation is on the rise in the United States with 528 existing and 52 currently planned for installation (Kittleson 2006). The increase in roundabout use is due to the increase in capacity, reduction in vehicle conflicts, and aesthetic benefits of roundabouts as compared to traditional intersection designs.

Statistically, 45% of automobile accidents resulting in injuries in the United States occur at intersections (Doctors 1997). Roundabouts reduce the potential for crashes by reducing the number of path conflicts that exist at an intersection, see Figures 1 and 2 from the design document developed for the Federal Highway Administration, *Roundabouts: An Informational Guide* (USDOT 2000).

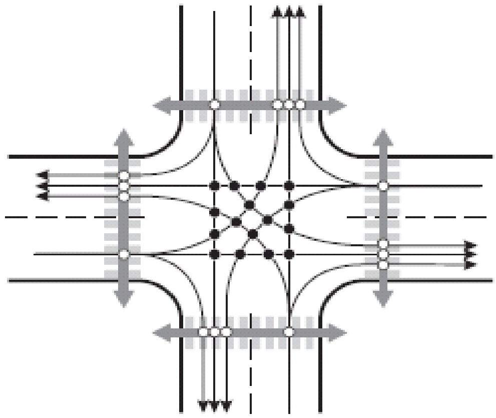


Figure 1: Typical Intersection Conflicts

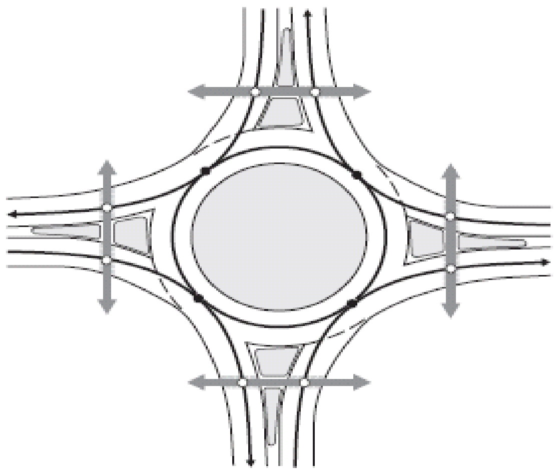


Figure 2: Roundabout Conflicts

Intersection accidents are a growing and very serious problem in the United States. A study conducted by the Insurance Institute for Highway Safety in 2000 found that in 24 newly constructed roundabouts crashes decreased 39%, injury crashes decreased 76%, and there was a 90% reduction in fatal or incapacitating crashes (USDOT 2006). Additionally, the National Cooperative Highway Research Program determined that roundabout installation reduces crash occurrences by 35%, and injury causing accidents by 76% (USDOT 2006). Other features of roundabouts that greatly reduce the potential for accidents are the single direction of travel, elimination of left turns, and entries which are tangent to the direction of flow which force the driver to reduce their speed. Although proven to be safer and to increase capacity, American designers are hesitant to use roundabouts because there is a belief that the typical American driver would not understand how to properly use a roundabout.

The difference between traditional signalized and unsignalized intersections and roundabouts is the assignment of right-of-way. In a traditional intersection, when one direction group is passing through the intersection, the opposing direction group is waiting. When the second group has the opportunity to use the intersection, the first group is stopped and waiting. This system creates a scenario where one directional group is always experiencing delay. With roundabout operation, there is not any signal or traffic control device which assigns right-of-way, the right-of-way is yielded to the traffic in the circulating roadway. Drivers at the approach entries find gaps in the circulating traffic stream and merge into the traffic. This system greatly reduces the delay experienced by users.

All roundabouts consist of the same major features. These features include a raised central island which is closed to through traffic and pedestrians but has been used to accommodate rail crossings. Roundabouts also possess a circulatory roadway surrounding the central island which is used by the traveling vehicles and commonly includes an inner apron to separate vehicles on the roadway from the central island but can be used to accommodate the wide turning radius of tractor trailers. Each approach has a yield line at its entry with the circulatory roadway and a raised splitter island to separate entry and departure traffic and to control driver movements and speed. Because no pedestrian or bike traffic is allowed on the center island, most approaches also include a pedestrian crossing downstream of the yield line. Roundabouts can be single or multilane; in all formats weaving should be discouraged (Ahlschwede 2004).

The majority of the literature on roundabouts is based upon the United States Department of Transportation Federal Highway Administration (FHWA) manual *Roundabouts: An Informational Guide* (USDOT 2000). This guide provides a step by step method for the design and implementation of roundabouts in the United States. This will be the primary reference used for this project. All of the additional literature used includes valuable information which will be incorporated into the project and has greatly advanced my knowledge of roundabouts, their use, and considerations when designing them. In addition to the Transportation Research Board (TRB) Highway Capacity Manual (TRB 2000), American Association of State Highway and Transportation Officials (AASHTO) Roadway Design Guide (AASHTO 2004), Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD) (USDOT 2003), and Roundabout Informational Guide, further research was conducted on Arkansas and West Memphis design, marking, and safety standards. Research was also conducted on volume and usage for the existing structure and future land usage plans for the surrounding area.

Background

The I-40/I-55/SR-77 Intersection in West Memphis, Arkansas is one of the busiest intersections in the United States serving heavy volumes of commercial and passenger vehicles in addition to a major rail line. An aerial photo of the current intersection is shown in Figure 3.

Figure 3: Aerial Photo of Existing Intersection

Due to the intersection's key location on the western side of a major Mississippi River crossing it is viewed by many as a "gateway" to the west as well as the primary entrance into the City of West Memphis and the state of Arkansas as a whole. The intersection has the 21st highest collision rate in West Memphis. Two hundred feet downstream of the intersection is the 10th highest location and directly upstream are the 4th and 1st highest crash rate intersections in West Memphis. Recently, a significant increase in railroad traffic has drastically increased the delay experienced by roadway users at the intersection of North Frontage Road and Highway 77 which has greatly reduced the operational performance of the facility. Rail line use has increased from 4 trains a week to 10 trains per day. The Parsons Consulting Group was contracted by the Arkansas Highway and Transportation Department (AHTD) to generate design alternatives for the overpass of the rail line at this intersection. The objective of this project is the redesign of the planned intersection to provide a more efficient, safe, and aesthetically pleasing intersection, facilitated by the installation of a roundabout, to aid economic growth and meet increased traffic demand in the region. The focus of this research is to conduct a feasibility study and to provide design alternatives on a potential roundabout installation at the intersection.

Scope of Work

The West Memphis, Arkansas roundabout design project is composed of three phases. The three phases are each a compilation of tasks which all contribute to the successful completion of the project. Project success will be achieved with the submission of roundabout design alternatives complete with design rational and supporting data contained in a fully developed research project report. The three phases are research and data collection, feasibility and design, and report preparation.

The research and data collection involves a review of scholarly and government literature on the design and implementation of modern roundabouts and the collection of data necessary to complete the feasibility and design phase. Sources for the research include the United States Department of Transportation, Federal Highway Administration, American Association of State Highway and Transportation Officials, Transportation Research Board, Arkansas Highway and Transportation Department, and the West Memphis City Engineer. Data collected includes existing flow rate, existing traffic volumes for all approaches, anticipated area growth, future land use for surrounding area, existing capacity, existing level of service, existing average delay, existing signal timing, impact of heavy rail, existing signal coordination, survey of existing intersection, distribution of vehicle types using existing intersection, capacity and delay for design alternatives, impact of alternatives on surrounding area, and operational circulating and entry flow rates for design alternatives.

The feasibility and design phase includes the examination of the collected data to determine the viability of installing a modern roundabout. Design alternatives will be created using multiple lane roundabouts placed at the interstate off ramp and local route intersection. Design alternatives will be evaluated based upon performance measures including degree of saturation, delay, and queue length using 20 year forecast traffic volumes.

The report preparation consists of developing the project definition, literature review, background, scope of work, data presentation, design schedule, and final design sections required for a fully developed report. In addition to the formal report, a Microsoft PowerPoint presentation will also be developed for presentation to University of Arkansas landscape design students.

Roundabout Design

The geometric design process was conducted using the procedure outlined in *Roundabouts: An Informational Guide*, published by the Federal Highway Administration. The roundabout design process is an iterative process that requires several revisions to the design while completing the design process. The initial design process is defined by the determination of the required roundabout size, placement, and approach alignment.

The initial step in the design process is to identify the design vehicle. Depending on the primary use and location of the intersection, the design vehicle can vary (Ali 2006). Once this has been determined, the geometric design, through speed, alignment details, and signing and striping of the roundabout can be determined. Additional thought should be given to non-motorized users, including pedestrians and bicyclists, and Americans with Disabilities Act (ADA) requirements (Hughes 2006). Once the geometric design has been completed, the sight distances, capacity, and level of service can be determined and the design refined as needed. See Figure 4 obtained from the Roundabout Informational Guide (USDOT 2000).

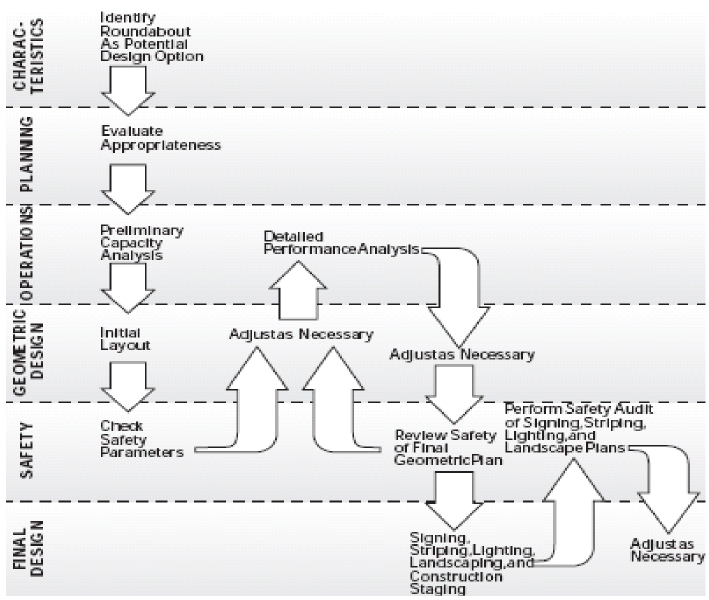


Figure 4: Basic Design Process

For this project other major considerations exist. This roundabout is intended to serve as a gateway to the city and therefore will receive a large amount of use and visibility. Aesthetic issues such as landscaping and lighting are very important. Another major consideration for the project is the rail crossing which exists at the intersection. Two options for the rail exist. The options are one, to relocate it, and two, to overpass it using additional bridges and modifications to the current geometric layout.

The basic geometric features of a roundabout are the same as can be seen in Figure 5 obtained from the

Roundabout Informational Guide.

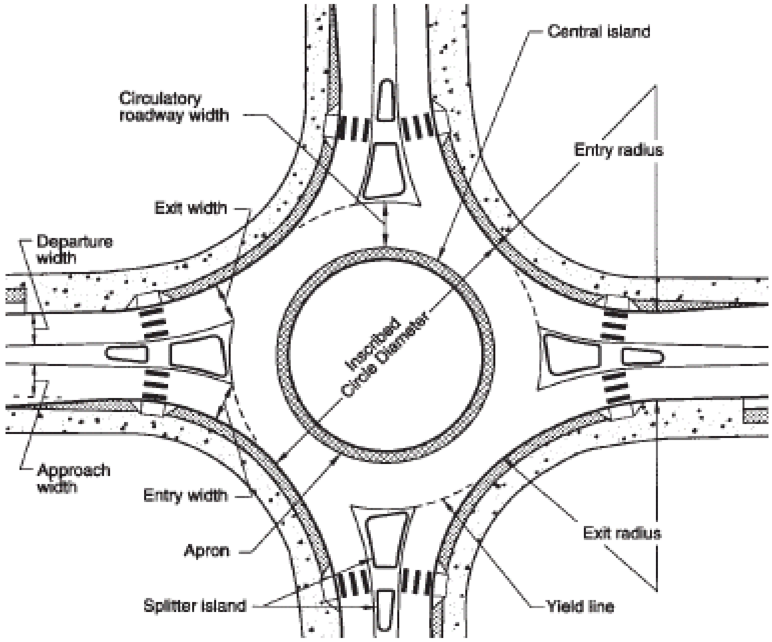


Figure 5: Basic Roundabout Geometry

The size of the roundabout is determined by the inscribed circle diameter. Typical inscribed circle diameters for double lane roundabouts in urban areas range from 150ft to 180ft. The roundabout is then placed at the location of the intersection where the benefits of the inherent safety and capacity improvements are most desired. The approaches are then aligned to ensure that the centerline of the approach passes through the center of the inscribed circle, which is recommended, or slightly to the left, which is allowed. The approach centerline should never pass through the inscribed circle on the right side of the center.

The intermediate design process activities include the design of the entry width, circulating roadway width, central island diameter, and entry and exit curves. The capacity of the roundabout is primarily determined by the width of the approach entry lanes. The entry width is measured from the left edge of the approach roadway to the right edge of the approach roadway, parallel with the right curb line. The typical entry width for a multilane roundabout is 20ft. Wider widths increase speed and capacity, but also increase the probability and severity of traffic collisions. The design width of the roundabout is a trade-off between safety, capacity, and the needs of the design vehicle. The circulating roadway width should be the same as the largest entry width and should be constant throughout its length. As recommended in *Roundabouts: An Informational Guide*, it is good practice to provide a large enough width in the circulating roadway to accommodate the design vehicle and a passenger vehicle traveling side by side (USDOT 2000). The diameter of the central island is determined by the geometry of the inscribed circle and the required roadway width. The size of the central island determines the deflection of vehicles around the roundabout and largely determines the flow speed through the roundabout. A slower speed generally requires an increase in central island diameter, which results in an increase in inscribed circle diameter as well. Entry curves also serve the purpose of controlling the speed and capacity of the roundabout by determining the deflection of the vehicles' path around the roundabout. The left edge of the roadway entry should be tangent to the central island, and the right edge is tangent to the inscribed circle. The radius of the curve transferring vehicles from the approach to the circulating roadway is determined by the design speed of the roundabout. The exit curve design does not affect the operational performance of the roundabout. The radius of the curve is determined by safety considerations stemming from controlling the speed of exiting vehicles. Similar to the design of the entry curve, the outside edge should be tangent to the inscribed circle, and the inside roadway edge is tangent to the central island. With the basic geometry of the roundabout established, the operational performance of the design must be determined.

The primary methods of determining the performance of a roundabout are degree of saturation, delay, and queue length. Due to the small amount of performance data for multilane roundabouts in the United States, the Transportation Research Board Highway Capacity Manual (TRB 2000) only provides provisions for the analysis of single lane roundabouts with demand volumes below 1200veh/hr. Therefore, for the evaluation of higher demand, using multilane roundabouts, the methods outlined in the Roundabout Informational Guide should be consulted.

The degree of saturation is the ratio of demand to capacity. The demand is determined using projected peak hour daily volumes for each approach. These current peak hour daily volumes can be determined by conducting traffic count studies as outlined in The Institute of Transportation Engineers, *Manual of Transportation Engineering Studies* (Robertson 1994). When combined with historical traffic data, projection of traffic volumes can be made using the average growth trend observed in the data. Typically the forecast volumes used in analysis are for 20 years in advance of the operational date of the design. The capacity of a multilane roundabout is determined by the conflicting circulating flow and geometry, as discussed above. The roundabout operates with the entering traffic yielding to the traffic in the circulating path. Therefore, the conflicting circulating flow is determined by summing the volume of traffic movements which would prevent entry into the roundabout at any approach. For multilane roundabouts designed in accordance with the Informational Guide recommendations, with entry widths equal or greater than 20ft, the capacity can be determined using Equation 1,

$$Q_{Entry} = 2424 - 0.7195 Q_{Circulating} \quad 1$$

where Q_{Entry} is the projected volume of traffic using the approach in vehicles per hour, and $Q_{Circulating}$ is the projected volume of traffic using the roundabout and preventing entry into the traffic stream by the analyzed approach in vehicles per hour.

The delay experienced by the user of each approach is a measure of performance for all intersections including roundabouts. The average time spent by a user behind the yield line waiting for a gap in traffic to enter the circulating roadway is the delay, and should be determined for each approach. The delay calculation is based upon the capacity and demand for each approach as shown in Equation 2,

$$d = \frac{3600}{c_{m,x}} + 900T * \left[\frac{v_x}{c_{m,x}} - 1 + \sqrt{\left(\frac{v_x}{c_{m,x}} - 1 \right)^2 + \frac{\left(\frac{3600}{c_{m,x}} \right)\left(\frac{v_x}{c_{m,x}} \right)}{450T}} \right] \quad 2$$

where d is the delay experience by the approach being analyzed in seconds, v_x is the flow rate for the approach movement in vehicles per hour, c_{mx} is the capacity of the movement in vehicles per hour, and T is the analysis time period in hours, typically 0.25 for a 15min period.

The queue length is the amount of vehicle hours of delay experienced on a single approach during the peak hour period. The queue length is calculated using the demand and average delay as shown in Equation 3,

$$L = v * \frac{d}{3600} \quad 3$$

where L is the queue length in vehicle hours, v is the approach demand flow in vehicles per hour, and d is the delay experienced by the approach in seconds per vehicle. Once the performance measures, degree of saturation, delay, and queue length have been determined, the roundabout design can be compared to other intersection alternatives, or using the iterative process. Improvements can be made to the current design. If satisfactory performance can not be achieved, other intersection control devises should be considered.

The final stage in the roundabout design process is to design the operational details of the intersection. The operational details including sidewalk design, pedestrian and bicycle provisions, signing, marking, lighting, and landscaping. Sidewalks should be designed to accommodate pedestrians, bicyclists, and meet ADA accessibility requirements. Sidewalk users should be encouraged to only cross the approaches at the designated locations and never to cross the circulating roadway to access the central island. A minimum distance of 2ft should be used to set back sidewalks from the roadway and 5ft is recommended by the Roundabout Informational Guide. The design of pedestrian accommodations is a trade-off between serving the pedestrian user and impacting the vehicular traffic. Pedestrian crossings should be placed upstream of the yield line for every approach, measured using car lengths to prevent queuing across the crosswalk. Refuge should also be provided in the splitter islands, and the crossings should be at grade to fulfill ADA requirements. It is important in the design of pedestrian accommodations to allow pedestrians to cross as conveniently as possible without affecting a high impact of vehicular traffic or creating high potential for pedestrian-vehicle conflicts. Bicycle users should be provided with the option of circumnavigating the roundabout as either vehicular traffic, in the circular roadway, or as pedestrian traffic, using the sidewalk. A good approach is to provide shared use sidewalks which are wide enough to accommodate a bicycle passing a pedestrian. If bicycle lanes are used, ramps should be provided to transition bicyclists onto the shared use sidewalk and then back down to street level.

The final phase of the roundabout design process is the traffic design and landscaping. This includes the signing, striping, lighting, and landscaping of the intersection. Regulatory, warning, and guidance signing is required in accordance with the Manual on Uniform Traffic Control Devices for Streets and Highways (USDOT 2003). Placement of the signage should allow for easy visibility for drivers without interrupting the path of pedestrians and bicyclists. Roundabouts are relatively new intersection control strategies in the United States and provisions should be made to accommodate the unfamiliarity of American drivers with this system of operation. The pavement markings should clearly delineate the approach lanes, yield line, and circulatory roadway. Additionally, the pedestrian crossings should be clearly marked and discernable by both pedestrian and vehicular traffic. Guidance for the illumination of roundabouts is provided in AASHTO Informational Guide for Roadway Lighting (AASHTO 1986). Adequate lighting is required for the driver to be able to determine the best course for circumnavigating the intersection at night. Additionally, there are aesthetic design approaches and benefits associated with the lighting plan. The opportunities for landscaping in the central island, splitter islands, and in the sidewalk setback provides options for aesthetic improvements not found in typical intersection designs. Other safety and enhancement benefits of landscaping include clearly delineating the central island and splitter islands for drivers, discouraging pedestrians from venturing out to the center island, leading pedestrians along sidewalks, and inspiring further development investment in the area.

The current intersection layout will be modified as recommended by the Parsons Consulting Group. Parsons, at the request of the Arkansas Highway and Transportation Department, conducted the railroad overpass study to evaluate design alternatives to reduce the impact of increased rail activity in the area, on the existing vehicular traffic infrastructure. Per the West Memphis City Engineer, Eddie Brawley, any modifications to the existing system will be in accordance with the railroad overpass study recommendations proposed by Parsons. The current layout is shown in Figure 6 and the modified layout as a result of the Parsons study is shown in Figures 7 and 8, north and south of the overpass respectively.

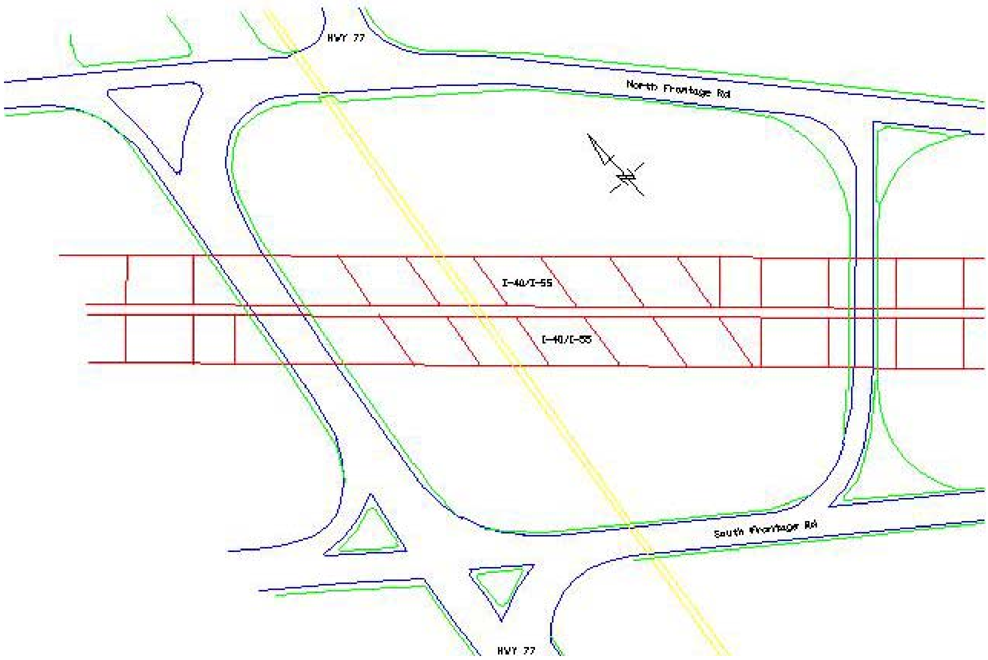


Figure 6: Current Layout

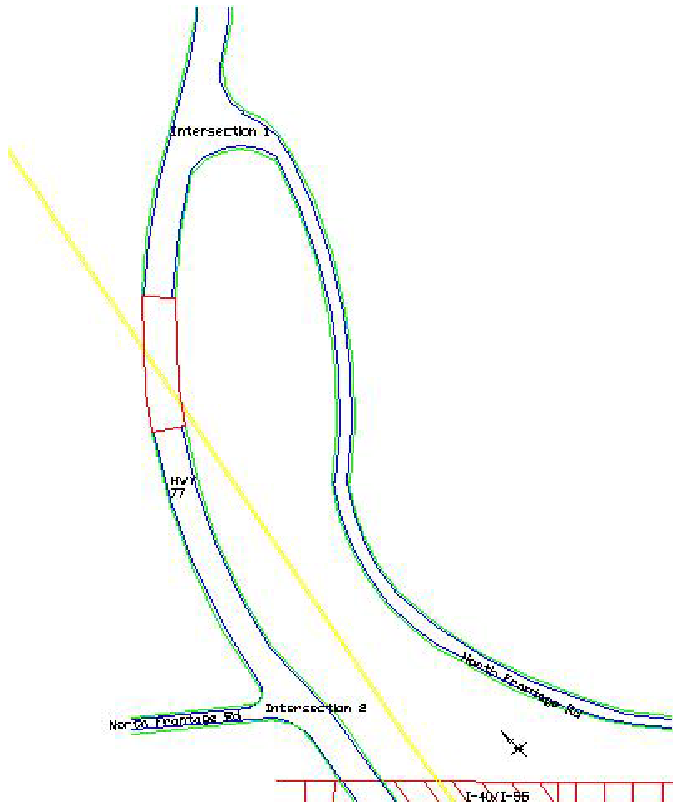


Figure 7: Future Layout North of Overpass

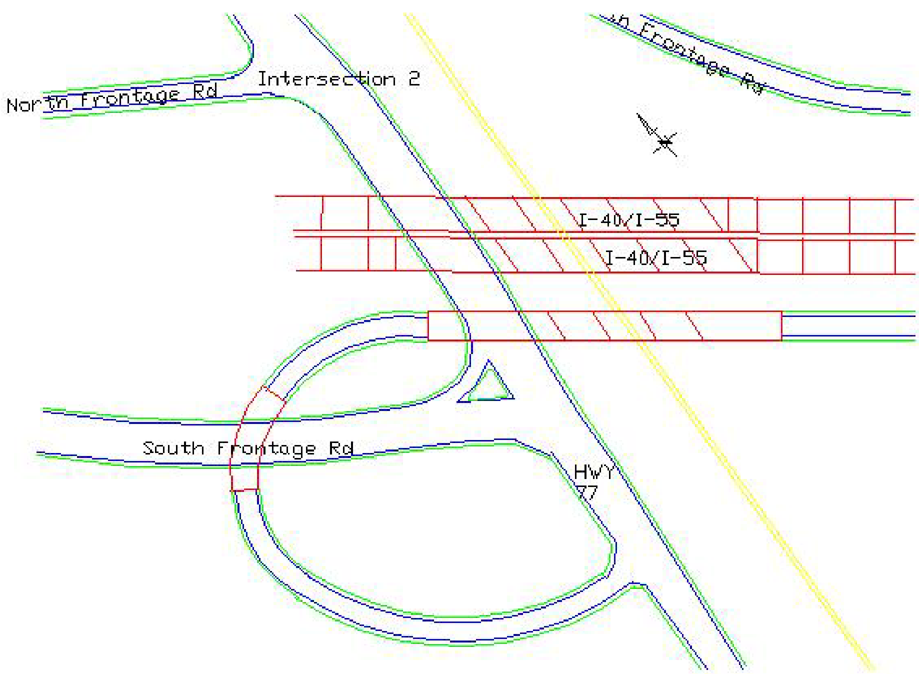


Figure 8: Future Layout South of Overpass

For this roundabout design project, two locations for the placement of roundabout alternatives were considered. The first, at the northern intersection of Highway 77 and North Frontage Road, east of the railroad tracks, and the second at the southern intersection of Highway 77 and North Frontage Road, on the west side of the railroad tracks.

Using the design methodology defined above, roundabouts were located and designed for Intersection 1, east of the rail line and Intersection 2, on the west side of the rail line. The geometric layouts for the alternatives are shown in Figures 9 and 10.

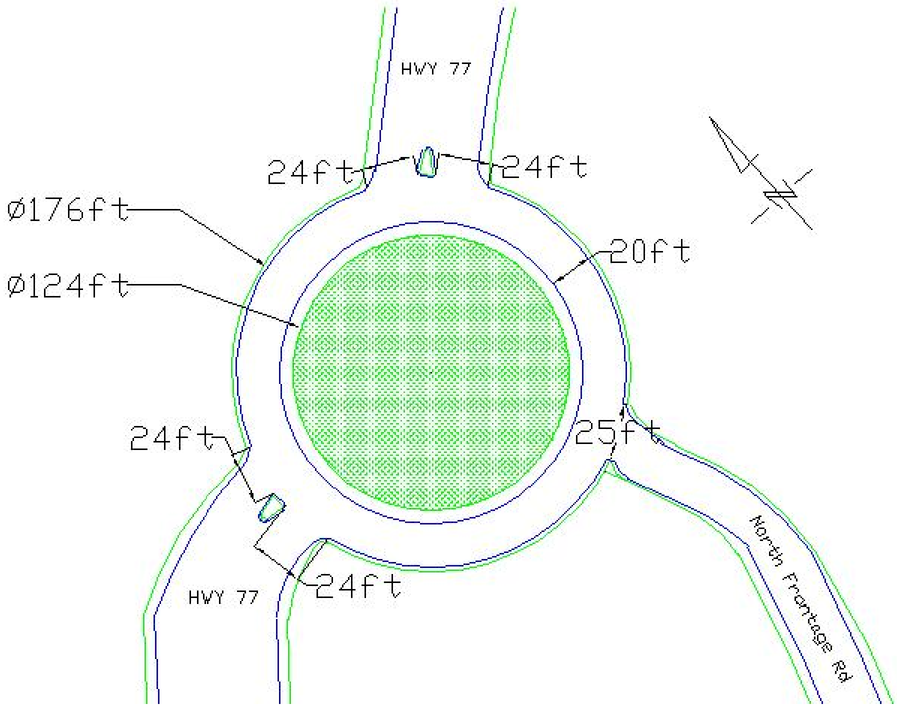


Figure 9: Roundabout Layout at Intersection 1

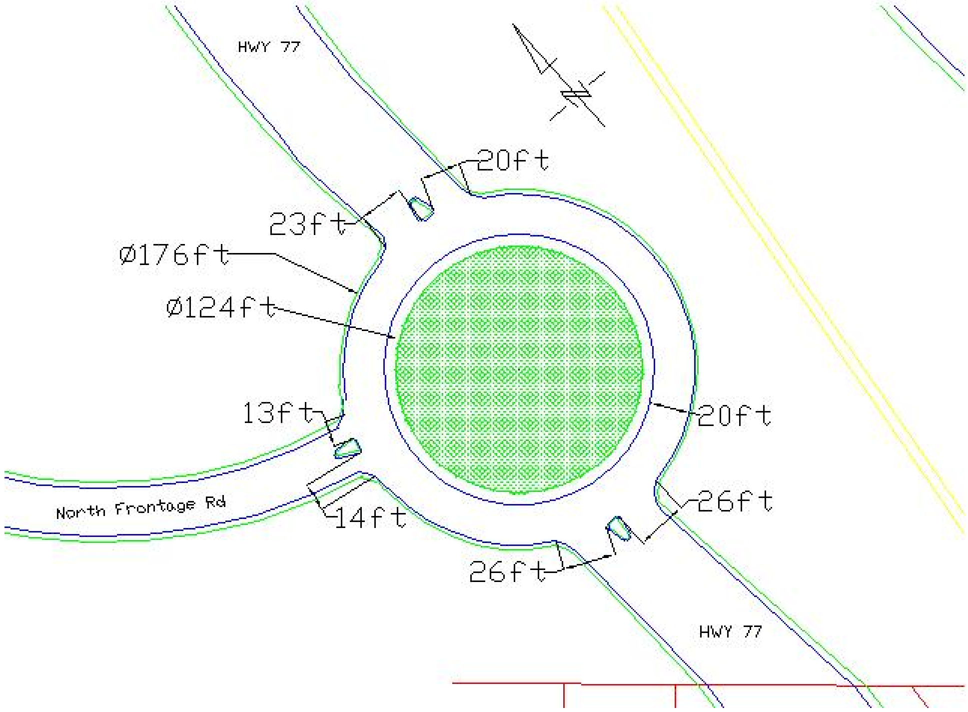


Figure 10: Roundabout Layout at Intersection 2

The performance analysis procedures were conducted on both design alternatives per the discussion above. After evaluation, it was determined that the design alternative at Intersection 1 experiences its critical delay of 373 seconds during the PM peak with a queue length of 307 vehicle hours on the westbound approach. The analysis was performed using forecast peak traffic volumes for 2028 by applying a peak hour factor of 0.90 to the forecast daily hourly volumes as shown in Table 1.

Table 1: Performance Analysis of Alternative 1

	Westbound		**Northbound**	**Southbound**
	Left	Right	Thru	Thru
AM DHV (veh/hr)	448	713	475	966
PM DHV (veh/hr)	1958	707	472	993
AM Peak (veh/hr)	498	792	528	1073
PM Peak (veh/hr)	2176	786	524	1103
Circulating Flow				
AM Peak (veh/hr)	1073		0	498
PM Peak (veh/hr)	1103		0	2176
Capacity				
AM Peak (veh/hr)	1656		2424	2068
PM Peak (veh/hr)	1634		2424	867

v/c			
AM Peak	0.779	0.218	0.519
PM Peak	1.812	0.216	1.273
Delay			
AM Peak (sec)	9	2	4
PM Peak (sec)	373	2	144
Queue Length			
AM Peak (veh-hr)	3	0	1
PM Peak (veh-hr)	307	0	44

The design alternative for Intersection 2 was determined to experience a delay of 163 seconds with a queue length of 124 vehicle hours during the PM peak on its southbound approach. The detailed results of the performance analysis for alternative two are contained in Table 2.

Table 2: Performance Analysis of Alternative 2

	Eastbound		**Northbound**		**Southbound**	
	Left	Right	Thru	Left	Thru	Right
AM DHV (veh/hr)	166	331	475	301	961	151
PM DHV (veh/hr)	107	213	472	485	2223	243
AM Peak (veh/hr)	184	368	528	334	1068	168
PM Peak (veh/hr)	119	237	524	539	2470	270
Circulating Flow						
AM Peak (veh/hr)	1068		184		334	
PM Peak (veh/hr)	2470		119		539	
Capacity						
AM Peak (veh/hr)	1660		2292		2185	
PM Peak (veh/hr)	656		2339		2038	
v/c						
AM Peak	0.333		0.376		0.566	
PM Peak	0.542		0.454		1.344	
Delay						
AM Peak (sec)	3		3		4	
PM Peak (sec)	12		3		163	
Queue Length						
AM Peak (veh-hr)	0		1		1	
PM Peak (veh-hr)	1		1		124	

Conclusion

The results of the performance analysis show that due to the high volume of traffic serviced by both intersections during the PM peak hour a roundabout intersection is not feasible, and a traditional signalized intersection should be considered.

If it is determined that the safety and aesthetics benefits of the roundabout are significant enough that the level of delay calculated is acceptable, the second alternative, at Intersection 2 west of the rail line, should be further considered. Analysis procedures currently do not exist for 3 or 4 lane roundabouts installed in the United States, but as interest in roundabouts and acknowledgement of the inherent benefits becomes more widely known, analysis techniques will be developed (Akcelik 2004). The addition of 1 or 2 lanes to the second alternative will increase the capacity of the roundabout and enable more traffic volume to be satisfactorily serviced. The roundabout intersection alternative should be revisited for Highway 77 and North Frontage road when more detailed analysis techniques become available. The proposed four lane roundabout alternative for installation at Intersection 2 is shown in Figure 11.

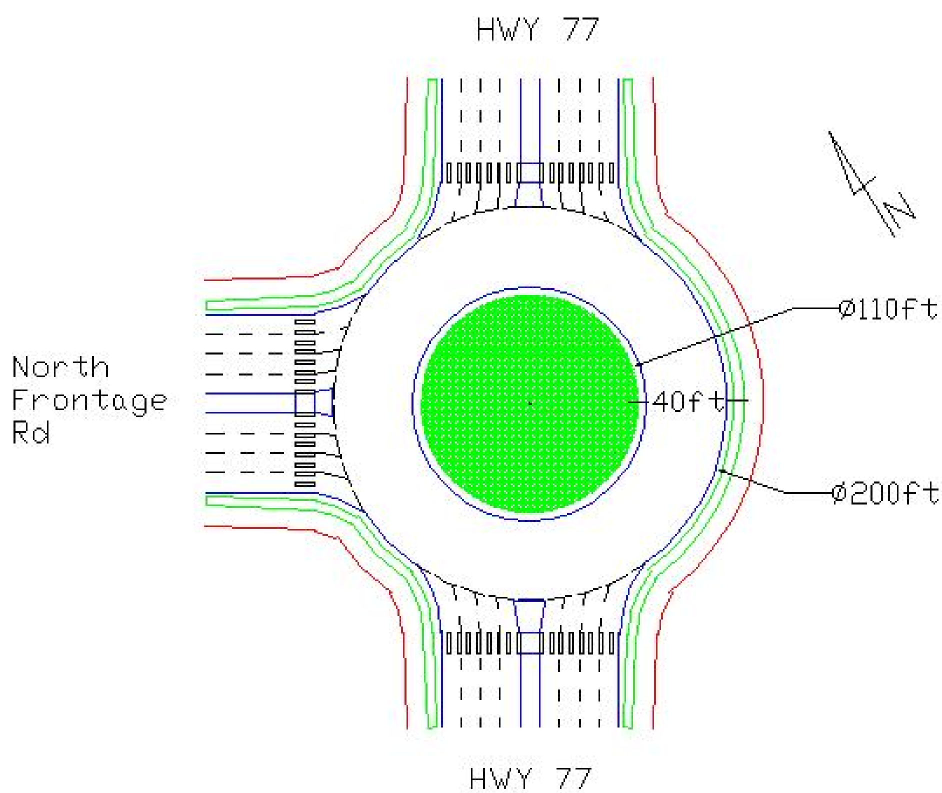


Figure 11: Proposed Roundabout Layout

Design Schedule

Completion Date	Activity
November 8, 2006	AutoCAD drawing of existing intersection
November 15, 2006	Redesign of existing intersection to meet specifications determined by Parsons Railroad Overpass Study
November 22, 2006	Design of Intersection 1 with multilane roundabout installation
November 28, 2006	Design of Intersection 2 with multilane roundabout installation
November 29, 2006	Selection of best alternative using delay and queue length based upon 20 year forecast volumes
December 13, 2006	Submission of Final Research Report

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Building Painless Public Partnerships- A Participatory Model

Design and deployment of changes to highways, intersections, and access roads can produce tension between the Arkansas Highway Transportation Department (AHTD) and the affected citizens. Often this relationship can become difficult, even to the point of delaying or disrupting the project entirely. While AHTD has a well-established public information system for apprising the public of road projects, such programs are not able to address many of the issues that arise when government agencies deal with the public.

The West Memphis feasibility study provides an opportunity to examine issues that arise when community goals and values intersect AHTD's responsibilities. Through developing a partnership with communities, AHTD can make its work more efficient and effective, gain insight that will facilitate future projects, and enhance its ability to meet its objectives.

Background

Americans have a unique relationship to highways; they are tied to building of the nation and ingrained in the national psyche. For many, highways exemplify a love of adventure and the ability to overcoming obstacles; Folk hero Woody Guthrie sang about "the ribbon of highway" in his classic *This Land is Your Land*; Hwy 66 memorabilia is collected by Americans who weren't even alive when that was the place to "get your kicks"

Americans, have a sense of ownership of "our roads" that extends far beyond just tax input. They are part of us, they impact our lives daily, and we want a say in what happens to them. This may be even truer of Arkansans, who retained local control of state highways far longer than most states. When the federal government began contributing money to each state for highway construction in 1930, Arkansas was forced to create the AHTD and put designated highways under state control to receive the funds. Before that time, highway construction and maintenance in Arkansas was the responsibility of each county (*Roads and Highways 2007*).
A lot has changed since the 1950s when most Arkansans were grateful for pavement, any pavement. Once the interstate system was fully deployed and the economic impact was obvious (towns "spread out to the highway, business on old roads died), many entities, from cities to major corporations wanted a say in where the roads went, how they were maintained, and even how they were constructed. Now it isn't just a matter of growth – highways are an integral part of economic development at the regional level, which brings a new set of stresses and demands. In addition, the relationship between government agencies and the public has changed dramatically in the last half of the 20th century. The pre-WWII era of "let the public be damned" has given way to and understanding that by partnering, each group can achieve its goals (Cutlip 2007). But this change in relationships requires anew approach. Just telling the public what is going to happen will not give agencies the information and public support they needs.

A Changing Landscape

In 2000 the Nevada State Transportation Board and the Department of Transportation agreed to develop and implement a master plan to define a vision for landscape and aesthetics in the state. Working with the Landscape Architecture program at the University of Nevada Las Vegas (UNLV), they developed a vision, policies and procedures for the state's highway system that was quickly authorized and funded by the state legislature. However, when they started to implement the plan, they soon encountered opposition from rural communities, who felt they were not addressing local issues.

Rather than ignore the public relations issue or allow it to escalate, the Nevada agencies brought together an advisory board of key stakeholders and developed several key program elements to address the communities' concerns and promote local tourism. Shifting the focus to communities allowed NDOT to move more rapidly in deploying the landscape and aesthetic master plan, incorporating highway elements that uniquely express Nevada's landscape and communities (Sipes 2007).

Public Partnerships

Like the U.S. Department of Transportation, the AHTD has a focus on public information. The public information system is set up to deliver information on construction, traffic delays, and potential projects, while the Environmental Division is charged with acquiring information from the public through surveys and public information sessions. Essentially, the public relations function is a divided highway, with information going out to the public in one lane and coming in by a separate lane, with a huge amount of time dividing the two.

AHTD employs many types of media, including a web site, to disseminate its messages. While public information is important it is only a small part of the public relations function. Other strategic components of public relations include strategic planning, media relations, crisis management, integrated communication, and relationship building with internal and external audiences. The changing relationship between government agencies and the public makes a move toward a fuller internal public relations structure in AHTD increasingly important. AHTD recognizes the importance of public relations in gaining public support for a major project. The ambitious Interstate Rehabilitation Program (IRP) had a goal of renovating 60 percent of the state's interstate highways in only 5 years, which meant more than 125 miles of road would be under construction every year. Although AHTD already had a good system for keeping the public informed about the depth, time frame, repair methods, safety issues, Director Dan Flowers knew it would take more than that to maintain public support as motorists experience an unprecedented number of work zones (2007).

To address this complex problem, AHTD contracted with public relations agency Thoma Thoma Creative, which developed a multilevel campaign called "Pave the Way." Thoma's initial research identified two major audiences: the statewide Arkansans who could be reached in their homes before they traveled and an audience of out-of-state and trucking industry motorists who had to be reached on the road. Their creative solution, described by Flowers in *Arkansas Combines Best Practices for an Innovative Interstate Rehabilitation Program*, was awarded the AASHTO "President's Award for Highway Safety" and won the "Bronze Quill Award of Excellence," presented by the International Association of Business Communicators for the best statewide public affairs campaign (2007).

In a sidebar to Flowers' article, Martin Thoma lists the essential components that made the campaign successful. The key element: getting partners involved. Thoma explains,

> *Nobody has all the answers, and no single department or group can do everything. We've actively sought out groups and individuals to partner with us in getting our message out. One very effective tool has been an advisory board representing state law enforcement, public officials, media, travel and tourism, transportation, construction, and business. This group has not only been instrumental in shaping communication efforts, it has actively pitched in and told the story, inserting articles in newsletters, mailing brochures to their members or constituents, and sharing mailing lists.*

His opinion is echoed in *Flexibility in Highway Design*, the US DOT Guide to Highway Planning and Development (1997). After enumerating the five stages of highway development, the Guide identifies the first one – planning – as "the key time to get the public involved." It stresses that designers and communities, working together, can have the greatest positive impact on the project.

The success of Pave the Way, which is being hailed as a national model for major highway projects, is an indication of the changes AHTD and its counterparts across the US are seeing in public attitudes and actions. No longer content to come to an information session or read about proposed activities it in the newspaper, many residents are seeking out ways to be more interactive. This can be an opportunity for AHTD to create a structure to facilitate public participation that will give the agency access to valuable insights and key constituencies.

Common Ground

The West Memphis project illustrates many of the issues that arise when the goals and responsibilities of different agencies and organizations coalesce around the same location. In addition to identifying potential issues and key constituencies, an analysis of the public relations dimensions of this project can provide a model for building mutually beneficial public partnerships. Although some aspects of the problem will be specific to the location, several components are common to many locations in Arkansas.

- **Economic Development.** Like virtually every community in Arkansas, West Memphis is engaged in a variety of economic development activities that range from recruiting manufacturers to pursuing a consortium for workforce development to developing historical tourism.
- **Arkansas Community of Excellence (ACE).** Also like more than 50 Arkansas cities, West Memphis is participating in the Arkansas Economic Development Commission's (AEDC) ACE certification program. Communities select areas of emphasis ranging from Business Retention and Expansion to Tourism to Community Beautification to Transportation. Many ACE Process Components touch on AHTD areas of responsibility, creating an opportunity for public partnerships.

- **Lack of Information.** Community leaders are unable to access the information they need to make key decisions. Whether they are writing grants or trying to define projects, they are working to improve the quality of life in their area, but they do not know where to find the data they need.

- **Agency Ambiguity.** The overlapping responsibilities and reporting requirements of Arkansas government agencies can make it difficult for residents to know where to begin. Not knowing where to begin, community leaders start with someone they know – an extension agent or district engineer or economic developer. Unfortunately, although their agencies interact at some level, these individuals may not know the appropriate agency or individual to address the issue presented by the community.
- **Lack of Clarity.** Community leaders may not know exactly what they want or what is possible. This development phase is an ideal opportunity for implementing partnerships between agencies and the public if the appropriate connections can be made.

All of these issues were represented in the initial West Memphis project. Participation by the University of Arkansas Economic Development Institute (UAEDI) and, subsequently, the Mack Blackwell Rural Transportation Center, was initiated by a request from the Crittenden Arts Council. In pursuing ACE certification, West Memphis community leaders turned to the Chamber of Commerce and Arts Council for help with the Community beautification and Business retention components. After soliciting community input, they identified the I-40 underpass at Missouri Street as a project and expanded the advisory committee to include landscape architects, engineers, and artists. Arriving at an acceptable design, they moved to the implementation phase and ran into Agency Ambiguity.
Although it had received funding from local, state, and federal sources, the community could not get permission to implement their plan. After consulting with individuals at various agencies, the frustrated group contacted UAEDI. The resulting Students Engaged in Economic Development (SEED) project comprised students from landscape architecture, art, and civil engineering. The students took components of the West Memphis proposal, established the operative regulations, and drew up a set of designs that met the needs of the community and complied with AHTD regulations.

During the project, several additional potential problems were identified relating to the volume of vehicle and train traffic through the intersection. The Mack Blackwell Rural Transportation Center funded this feasibility study to evaluate potential alternatives for addressing these issues. The study also highlighted the critical role of public/agency partnerships in facilitating project success. Application of fundamental public relations principles produced recommendations to facilitate the building of public partnerships,

Recommendations

While AHTD is certainly not the cause of many of the problems various groups encounter, it could provide the solution to many of them. AHTD would become a strategic partner for groups working in economic development and community development, ensuring that it would be involved at the earliest stages of projects and have access to key constituencies. By addressing the changing dynamics of relationships between the public and government agencies, AHTD will become part of the solution rather than part of the problem.

AHTD Web Site. Use the AHTD web site more effectively to convey information. The present site provides a wealth of information for contractors, but it is not very useful for lay visitors. A specific area providing resources for the general public could make it more useful and reduce the amount of time AHTD workers spend responding to simple requests.

SEED Projects. Encourage public partners to use SEED projects as part of the planning phase. These projects, which use multidisciplinary student teams, are not intended to replace the work of engineering companies. However, students can help community representatives refine their ideas, recognize the limitations of the project and make important decisions that save time and money.

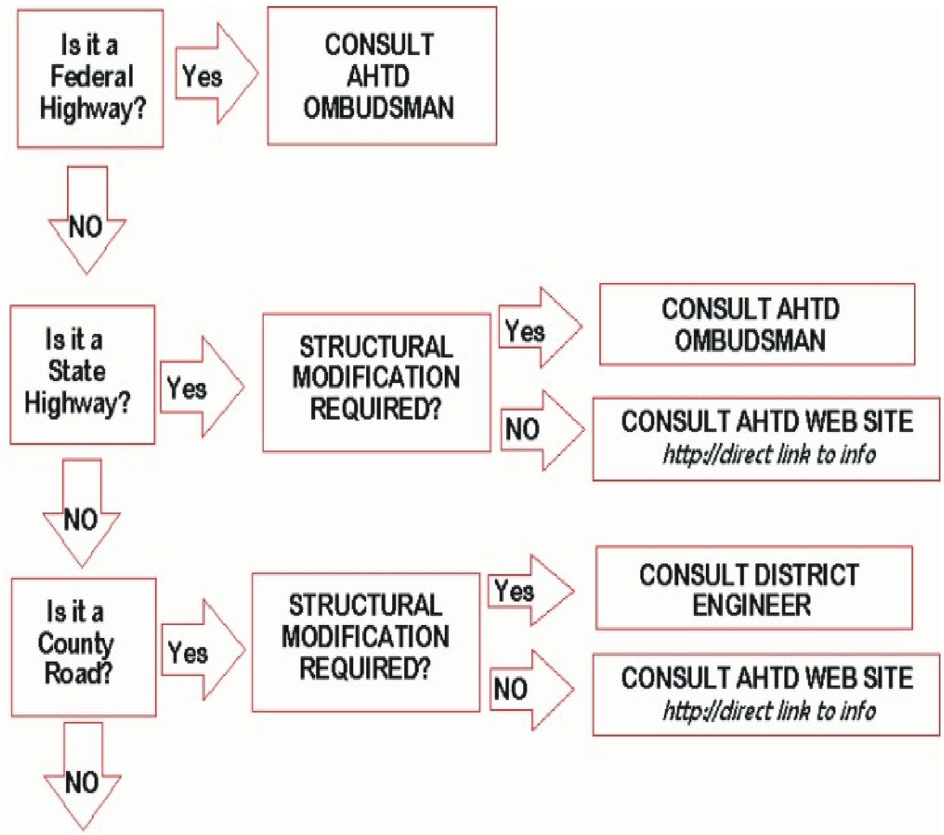
Public Relations. Expand the public relations effort to include traditional public relations roles and report to the AHTD director. The PR unit would be responsible for such of activities as:

- Information dissemination
- Public input
- Monitoring relationships with other agencies
- Maintaining External relationships with key constituencies
- Media relations
- Preparing department professionals for public interaction and develop strategies to optimize the use of professional employees to represent AHTD in public meetings by providing training for AHTD employees who want it, so they represent the agency most effectively.
- Coordinating public ombudsmen. These employees would to act as the contact point with AHTD for citizen input. They would respond to public requests and maintain awareness of changes and emerging dynamics in state (eg., regional coalitions, etc.)
- Conduct/commission regular public opinion surveys (UA Institutional Research) to see what people think about AHTD, roads, etc.
- Develop PR strategies to enhance the image of AHTD with general public
- Developing web site tools to facilitate interaction with the public. These would include:

- A *Handbook* for Municipal Governments, Libraries, Chambers of Commerce that,
  - Expands on (or references) the Play-by-Play Guide discussed below
  - Talks about the organizational philosophy of AHTD, structural overview
  - Includes “interesting” highway facts and figures
  - Highlights about Arkansas Innovations (eg., Kelvin Wang’s automated data acquisition system, Hopper Tunnel, roundabouts) is available online for download

- A *Play-by-Play Process Guide*. Guide the public through specific processes. Select several typical consumer requests and present the necessary steps both as a narrative and a flow diagram. Consumers have no idea how to go about interacting with AHTD, they don't know what is possible, what to expect, why it is that way, and this creates a level of stress and distrust at the beginning. By eliminating that, it is more likely that a successful public partnership will develop.

For Example: *A citizen group wants to make a modification to an existing Interstate highway.*
EXAMPLE PICTORAL FLOW DIAGRAM



PROCESS NARRATIVE
1) Who controls (makes the final decisions – fed, state, AHTD, etc.)
2) What rules/regulations apply.
3) Who to contact with questions.
4) What happens next? (Ombudsman meets with citizens group, ascertains actual issue. O meets with district engineer or other appropriate AHTD personnel. AHTD requests formal application [fill out forms XX, YY, ZZ and send in triplicate to ?????] The application will be reviewed by a committee and a response generated within 6 weeks.
5) What happens if it is denied? Appeal process
6) What happens if it is returned for further information?
7) What happens if it is approved? (Role of funding, public input, consultants, city engineers, etc.)

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Project Conclusion and Recommendations

Over twenty states now have aggressive policies guiding the development of roundabouts and over a thousand have been built since 1990. http://www.livingstonroads.org/Roundabout%20Guide.htm These policies include building strong public partnerships. While roundabouts have been recommended for interstate intersections by a number of states such as Kansas and Michigan Departments of Transportation, they are by no mean a perfect solution for all intersections, especially those involving busy railroads and those with proposed heavy traffic flows similar to those found at the I40-I55 intersection with State Highway 77 in West Memphis. The civil engineering student study did suggest that a three lane roundabout might be explored to carry the volume of traffic expected in the future. States such as Michigan have a history of one, two, and now, three lane roundabout uses, but Arkansas needs to establish policy that begins to consider more modest one and two lane roundabouts as part of a broad public education effort.

The presentation of the student engineering study was made at an open meeting during the spring semester of 2007 involving the City Engineer, the Crittenden Arts Council, the West Memphis Chamber of Commerce, AHTD and students from the University of Arkansas Landscape Architecture Department. Over the next month the landscape architecture students then prepared potential planting, lighting, and pedestrian circulation solutions to the plan prepared by the Parson Engineering Corporation of Memphis. Student plans responded to the varying site moisture conditions, focused on the use of low maintenance vegetation and provided for pedestrian circulation. An example plan follows.

Figure 7. A bold conceptual plan that provides a number of site features such as public art locations and bold planting to be seen from the Interstate and the Great River Road (Missouri Street or Highway 77). After cleaning and repainting the bridge, night marker lighting along upper bridge rails and up-lighting of bridge piers would create a strong sense of entry to the site and the City of West Memphis.

Figure 8. Potential pedestrian plan to link parks and The Great River Road with the Mississippi River

As a result of this study and prior student work, the City of West Memphis has applied for a Scenic Byway grant to improve the quality of life and safety of the intersection though positive engineering and landscape architectural design. In addition to recommendations made in the preliminary report found in Appendix A, further recommendations from the current study follow.

- The Arkansas Highway and Transportation Department should begin a study to identify potential sites for roundabout use especially at Interstate intersections with high crash numbers. Several roundabouts need to be built and observed by AHTD as part of a public education campaign on roundabout use and advantages. A portion of the AHTD web site should be developed to include roundabout use as public education outreach.

- The study identified that the Interstate corridor between the Mississippi River Bridge at Memphis and the Great River Road Intersection with I 40/I55 is a "gateway" into Arkansas that is visually unsatisfactory. Visitors are greeted by bridges with peeling paint and discoloration that would benefit from cleaning and repainting. Several unappealing views between the Mississippi River Bridge and the study site would benefit greatly from limited strategic buffer plantings that would bolster a "gateway" effect.

- The Great River Road (Highway 77) from Marion to West Memphis needs to be brought up to scenic byway standards and celebrated as a tourist attraction. The desire by West Memphis to have the I-40/I-55 and Highway 77 bridge painted and lighted both above and below as an entry feature into Arkansas and into the town would benefit tourists and citizens alike.

- West Memphis is one of only three towns in Arkansas that has access to the Mississippi River. All future plans around the study intersection and the surrounding area need to consider pedestrian and bicycle systems linked to a system of trails and greenways that connect the site with West Memphis' parks and access to the Mississippi River. (See Figure 8)

- A public partnership model that embraces public art, landscape architectural and engineering concerns and includes all stakeholders at timely intervals can create a more comprehensive publicly accessible planning approach that would have help market the area to transportation oriented industry.

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(cited in Project Organization and Process, Conclusion, and examples in Appendix B)

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Appendix A

2004 Report for City of West Memphis

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Department of Landscape Architecture

Administrators and Friends of the City of West Memphis, December 7, 2004

During the Fall of 2004 the Department of Landscape Architecture was asked to provide alternative enhancement plans for the overpass where I-55 and I-40 cross Highway 77 in West Memphis Arkansas. Over 60,000 vehicles a day with heavy truck traffic traverse this section of the minimal 4-lane Interstate with older bridges in need of cleaning and painting.

The project was perceived to have undergraduate research potential coordinated by faculty in a multi-disciplinary environment involving students from Civil Engineering and the Art School working in concert with Landscape Architecture Students in Design III to promote safety and aesthetic issues respectively. A senior civil engineering student provided a history and current issues leading to current AHTD safety standards regarding the safe use of plants around freeways and access road rights of way. This report will be made available to the City of West Memphis. (Generally, trees over 4" should be placed at least 30 feet back from edge of pavement)

Landscape Architecture Students and involved faculty began their investigation through case studies and examples from other states as part of the research process to help identify potential solutions to analysis findings. The case studies indicate that many urban and urbanizing areas of America are rapidly shifting from the past pattern of strictly utilitarian interstates to freeways and access/frontage roads that enhance rather than detract from the urban fabric. (See the visual analysis board)

> "Strategies and techniques which attempt to make the freeway as least disruptive to the existing urban fabric as possible or otherwise make for a better driving experience can be classified into four general categories: **aesthetic enhancements, impact mitigation, integration of uses, and freeway removal**. It should be noted that most freeway enhancement projects do not fall under the exclusive domain of a single technique; a freeway project that employs carefully-landscaped berms and artfully-designed sound walls is an example of both aesthetic enhancement and impact mitigation, because the freeway is made to look nicer at the same time the negative externalities of the freeway are being lessened.

Aesthetic Enhancements

Aesthetic enhancements are projects which seek to "soften the edges" of the freeway or otherwise improve its visual quality, making it more pleasant for motorist and community alike. These include billboard removal, landscaping and contouring, the use of color or artistic designs enhancements, the sculptural treatment of freeway bridges and structures, and the placement of public art. Improvements of this character oftentimes attempt to beautify the freeway landscape or make the freeway less anonymous or monotonous by giving it a distinctive identity.

Simple techniques such as the use of color can clash with established highway department regulations. In the mid-1980s, a design studio at the University of Houston studying ways to reinforce the character and identity of Houston's Chinatown neighborhood suggested that the columns supporting the elevated Eastex freeway between downtown and Chinatown be painted red as a way of denoting an "entrance" into the neighborhood. Vehicles passing underneath the freeway, for example, might see the red columns and a "Welcome to Chinatown" sign and understand that they were passing into a unique but heretofore vaguely-defined Houston neighborhood. However, Mr. Colbert and his studio navigated through a ponderous TXDoT bureaucracy only to find that, in the end, such a simple and seemingly innocuous gesture was not permitted under TXDoT regulations (Colbert 1999). [*update: the treatment suggested by Mr. Colbert and his studio in the mid-1980s finally occurred in early 2004. 90 columns of US 59 between Polk and Capitol have been painted right red to highlight and honor Chinatown. The creation of an East Downtown Management District and its associated Tax Increment Reinvestment District in 1999 finally provided the political and financial muscle necessary to make this aesthetic enhancement a reality.*] Ironically, oftentimes the only sort of aesthetic treatment given to freeway projects in Houston at all is a stripe of color painted along the sides of freeway bridges and overpasses. (Tsai 1999)

Impact Mitigation

While making aesthetic enhancements to highways which combat their utilitarian monotony creates a more positive experience for motorists and the city alike, simply making overpasses look nicer or planting trees and shrubs along embankments are oftentimes superficial solutions and do little to address the real issues behind the urban freeway, such as the way it divides neighborhoods, leaves a scar through a city, and makes for a lower quality of life for those living near it. Impact mitigation projects are geared towards screening the freeway and its attendant noise, vibration and pollution from surrounding neighborhoods, and include techniques such as sound barriers or building freeways below grade.

Freeway Integration

Projects, which seek to integrate the freeway right of way with other uses, fall into a third category. Since the freeway is a public right of way, this technique usually means the conversion of land either above or underneath a freeway into a public space of its own through the use of “highway lids” and “cut and cover tunnels” described above or through the merger of highways and architecture. Freeway Park which straddles Interstate 5 in downtown Seattle is an excellent example; it allows the freeway to “give something back” to the city it bisects and better integrates the freeway into its urban surroundings by providing for multiple uses of a right of way that would otherwise be exclusively the domain of automobiles. Margaret T. Hance Park in Phoenix, which straddles I-10 as it runs through downtown, is another example.

Freeway Removal

A fourth application aimed at limiting the freeway’s impact on the urban environment is to simply eliminate the freeway altogether. The Embarcadero Freeway in San Francisco is perhaps the best example of this technique. Built in the late 50s, the Embarcadero was a double-deckered freeway that divided downtown San Francisco. The 1989 Loma Prieta earthquake damaged the structure and provided the city incentive “to demolish the double decker, whose superstructure shunted pedestrians through a dark, sooty gauntlet between downtown and the San Francisco Bay.” Both Boston and New York are also submerging freeways and creating public green space for parks and promenades. **www.mindspring.com/ ~tbgray/prch2.htm**

The Visual Site Analysis – West Memphis

A visual site analysis was undertaken by students to understand the context of the bridge as part of the larger local transportation system and it’s potential to act as an arrival gateway into West Memphis. The Landscape Architecture and art students also explored the potential sequence of visual events for people entering the City of West Memphis from both the east and the west. Three zones of concern were revealed by the analysis:

1. The exit zone required to identify the correct exit which enables the driver to leave the Interstate at the correct place in a safe and timely manner

2. Protection and/or enhancement of the visual experience of arrival along the exit ramp and frontage road areas leading from I-40 east and west and from I-50 south to the site of the West Memphis Mall Area while addressing safety and landscape enhancement possibilities including welcome signage and lighting

3. Generation of ideas for enhancement of the older, poorly maintained bridge that presently dominates the major entry into West Memphis from the Interstates in keeping with the request from the Crittenden Arts Council that this area would be the major focus of the study

The analysis of the overall site identified several design issues, including:

- Need for a stronger definition of space and manipulation of gateway concepts
- Need for “sense of place” and identifiable community landmark

- Increased motorist visibility of multiple entry signs and features
- Mitigation of visually chaotic character: Sign clutter on arrival into West Memphis from the east
- Need for unification or integration of buildings and existing elements to the landscape that considers street tree plantings
- Ameliorating Undefined edges especially around the bridge underpass
- Maintaining the bridge that acts as a gateway into the West Memphis Mall area

More specifically the site analysis generated several key responses:

1. Better highway signage may be required on the westbound Interstate lanes for people desiring to exit safely into the West Memphis Mall area. Projected traffic volumes may dictate the need for additional lanes in the future.
2. The exit ramps and access road for westbound traffic exiting at West Memphis Highway 77 have potential for welcome signs and lighting incorporated into a designed landscape that considers the bridge embankments and effective buffering from future development.
3. Access roads leading from the I-40, I-55 east exits into the Mall Area are a potential corridor for further tree planting and more visible welcome sign(s) that avoids conflicts with the intersection with Highway 77
4. The bridge underpass has potential for a cleaner and more imaginative treatment.
5. The bridge as a landmark object requires a strategy for treatment as an entry feature into West Memphis that will enhance rather than detract from the traveler's experience of visiting West Memphis

Strategies for enhancing the immediate bridge zone include:

1. **Landscape buffering or screening** of the bridge to reduce its visual impact
2. **Visual Diversion** through provision of a large installation art object that takes attention off the old style and poorly maintained bridge
3. **Visual Enhancement** of the bridge including repainting so it becomes a visual asset rather than a visual liability

A combination of these strategies was considered by the students who each created two alternative schemes on presentation sheets suitable for hanging and public review. Several schemes went beyond project requirements and envisioned the redesign of the Highway 77 intersections on both sides of the bridge and replacement with round-abouts that are currently in use by a number of states due to their high safety record and aesthetic potential. Roundabout intersections are becoming safe focal points in the community replacing old intersections and may be designed even when railroads are present. Page 7 of Chapter 8 of the following Federal government website illustrates and discusses railroads at roundabout. http://www.tfhrc.gov/safety/00068.htm

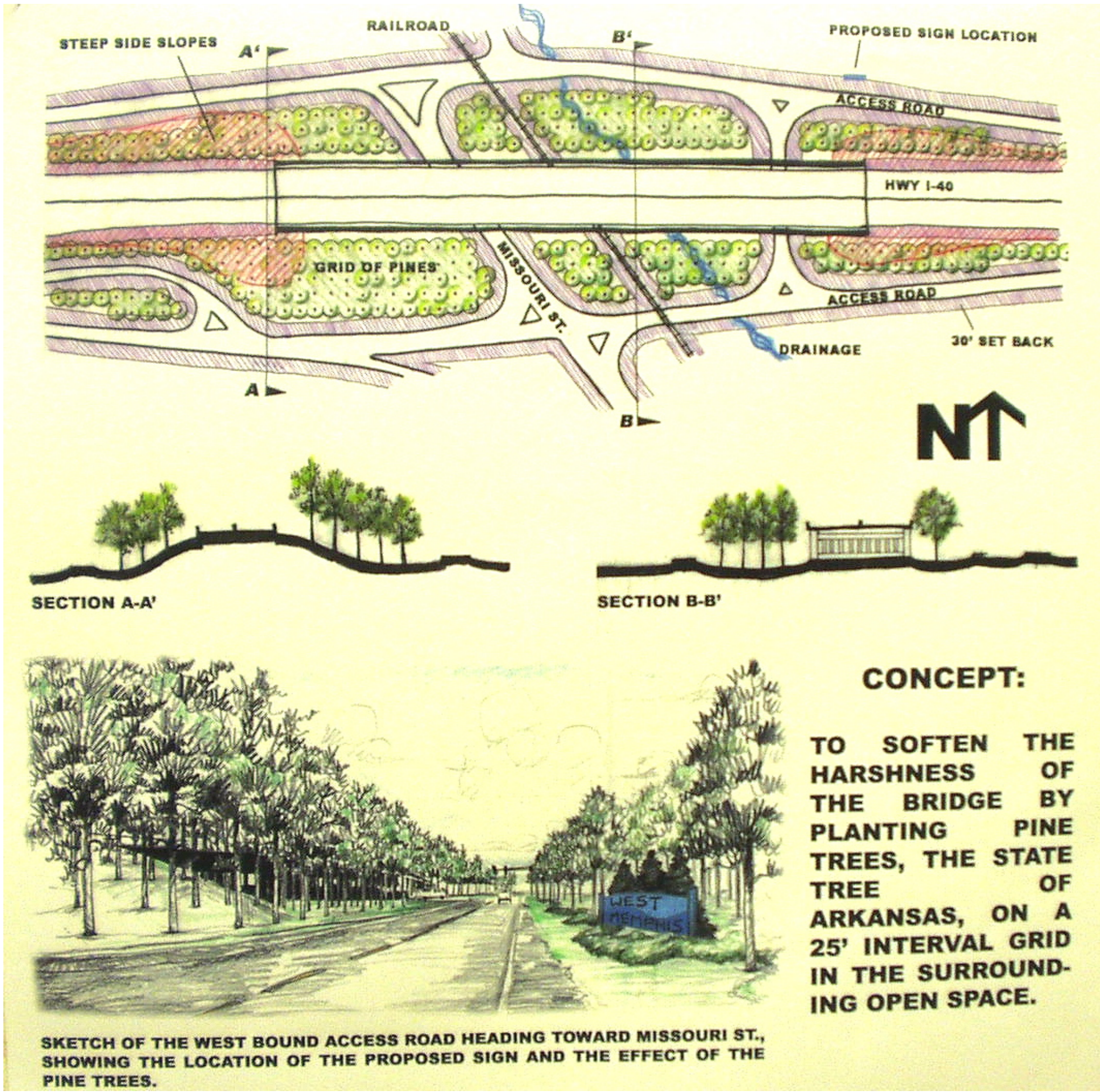


Figure 1. Use of buffering to hide or soften aging bridge in need of cleaning and painting. Plan by Shannon Wallace

Figure 2. Use of element to divert attention away from the bridge. The vertical sculptural element uses a transportation history theme Shawn Shrum

Figure 3. Entry sculpture into Old Town Albuquerque, on Interstate 40 in New Mexico

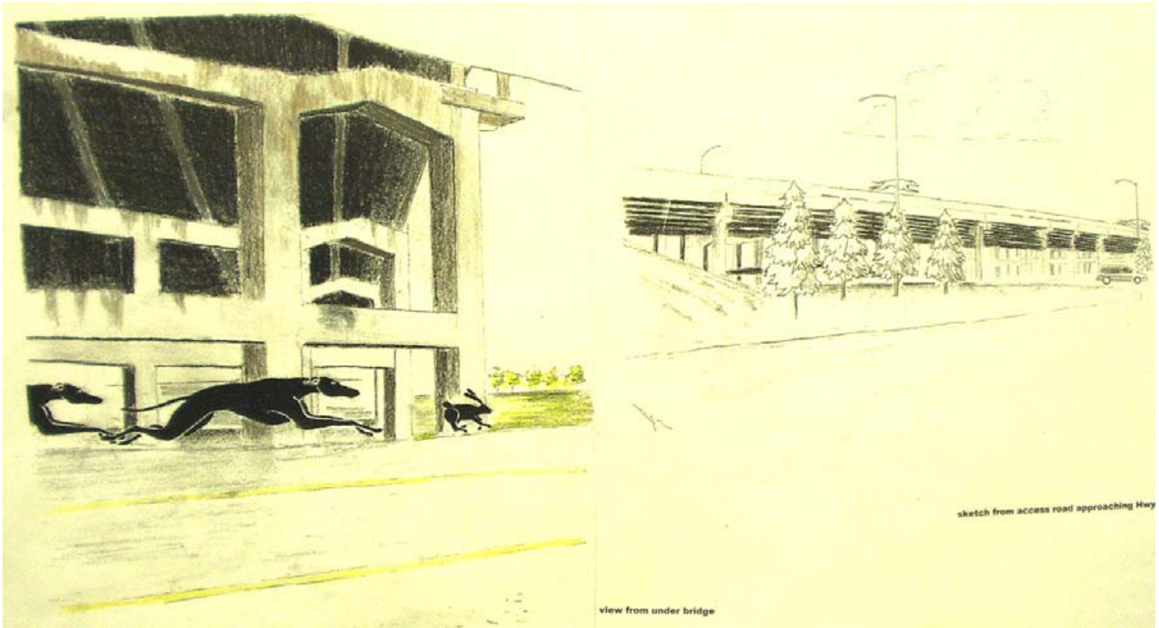


Figure 4. Use of sculptural greyhound cut-outs mounted above and below bridge as a visual diversion on Highway 77 below I-40/I55 in West Memphis. Billy Kribbs

Figure 5. Example of metal cut-out flag attached to bridge in Tucson, Arizona

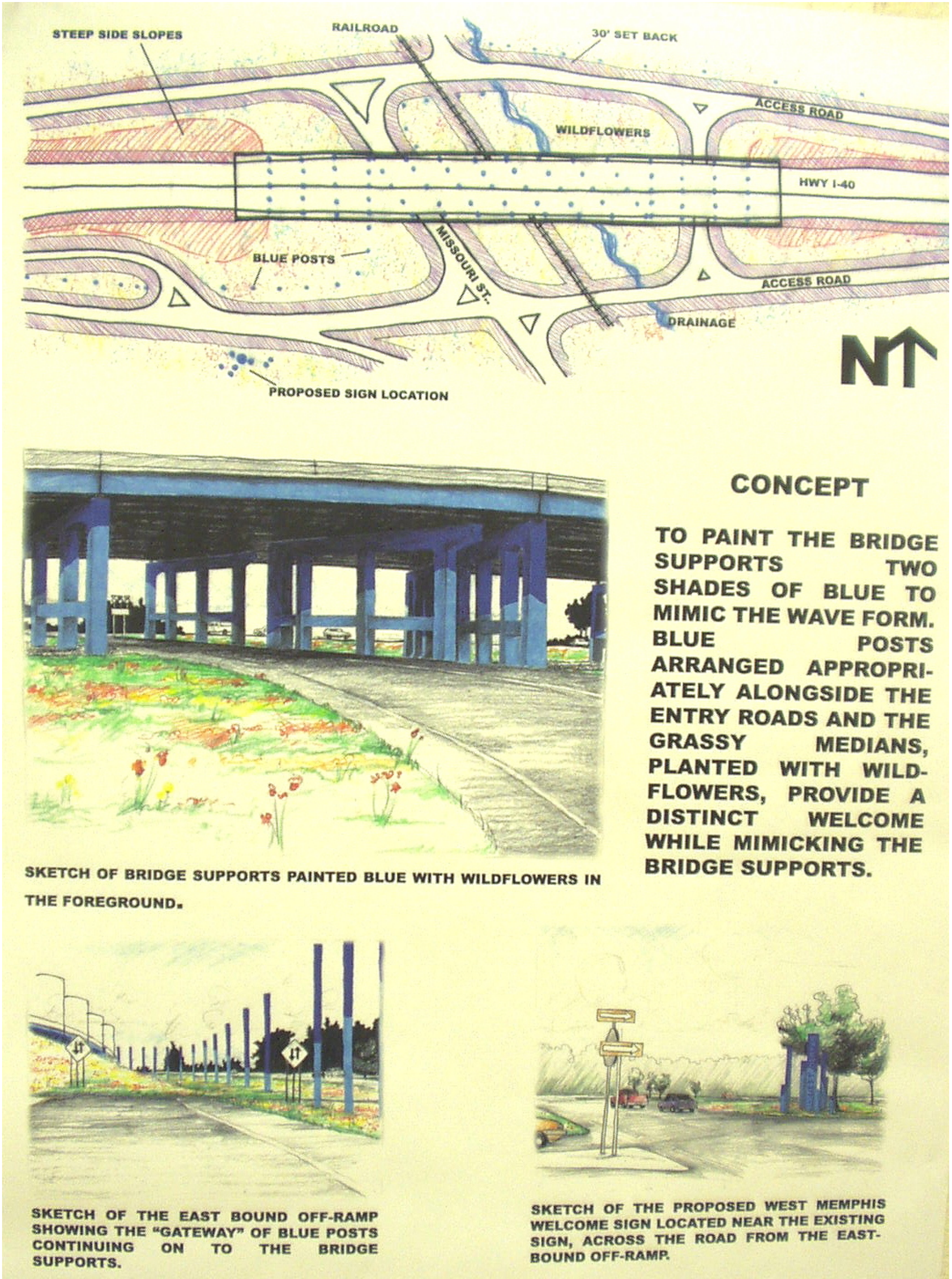
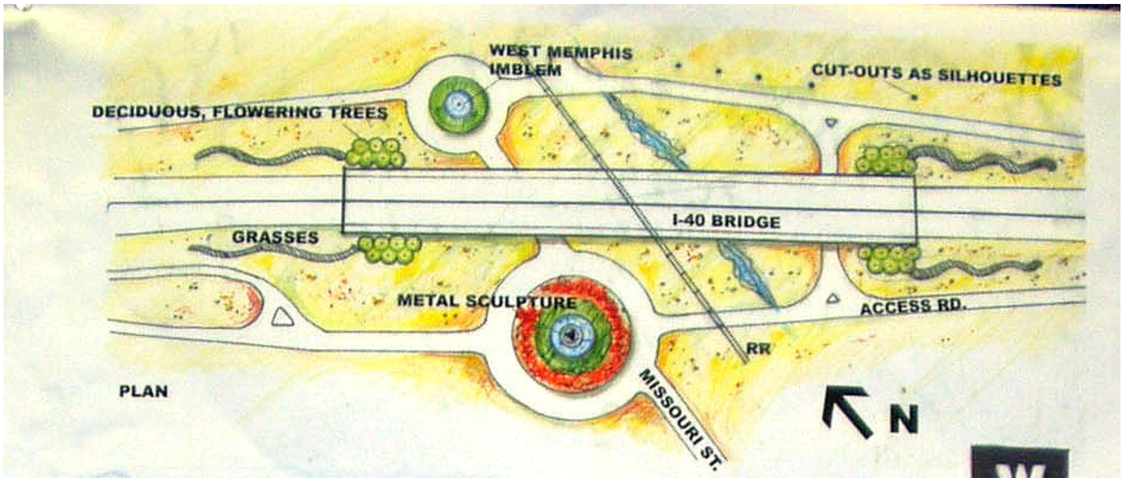


Figure 6. Celebrating the bridge and surrounding landscape with blue colors reflecting a wave form used on the West Memphis logo and appropriate for an entry into West Memphis, AR., on The Great River Road. Shannon Wallace

Figure 7. Newly painted bridge on I-40/I-25 interchange in Albuquerque, New Mexico

Figure 8, Newly painted bridge on I-25 south of Santa Fe, New Mexico



VIEW OF ROUND-ABOUT WITH MAIN FOCAL POINT

METAL SCULPTURE

THE THREE SIDED SCULPTURE IS LIT FROM INSIDE ALLOWING LIGHT TO MAKE THE SILHOUETTES VISIBLE AT NIGHT. THE SCULPTURE USES DIFFERENT FORMS OF TRANSPORTATION, TO SYMBOLIZE WEST MEMPHIS' LONG HISTORY OF TRANSPORTATION.

CONCEPT

THE CONCEPT FOR THIS DESIGN USES A ROUNDABOUT WITH THE CENTER AS A FOCAL POINT. THE SCULPTURE IS THREE SIDED, AND PLACED UPON A SERIES OF TRICKLING FOUNTAINS. THE BRIDGE IS TO BE PAINTED A DARK UMBER, SO THAT IT NARURALLY RECEDES INTO THE LANDSCAPE. THE CUTOUTS FROM THE SCULPTURE ARE PLACED ON THE NORTHEAST SIDE OF THE BRIDGE IN A PROCESSION TO THE FOCAL POINT OF THE WEST MEMPHIS IMBLEM.

CUT-OUTS LEADING TO FOCAL POINT AT ROUND-ABOUT

REPAINTED BRIDGE WITH NATIVE WILDFLOWERS

Figure 9. Potential use of double roundabout at Intersection to create gateway features at entry to West Memphis. Future study needs to determine the viability of a roundabout at this location. 2004 Shawn Shrum

Figure 10. Comparison of existing condition of Highway 77 heading north and proposed roundabout masking the unsightly bridge. Notice proposed pedestrian walk ways.

Figure 11. New York Route 67 uses a series of roundabouts with the bridge over Interstate 87.

Conclusion

"*When freeways have failed, it has been because their designers have ignored their form-giving potentials and their inherent qualities as works of art in the city. They have been thought of only as traffic carriers but, in fact, they are a new form of urban sculpture for motion. To fulfill this aim, freeways must be designed by people with sensitivity to structure but also to the environment; to the effect of freeways on the form of the city; and to the choreography of motion.* (Halprin, Lawrence, 1966. *Freeways*. Reinhold Publishing Corporation, New York. Page 5)

The need for planning at any level begins with the region and must be thorough and comprehensive so that transportation, aesthetic and economic issues are fully integrated into all planning efforts. Municipalities are wise to consider the issues of local transportation including creating better pedestrian and bicycle environments in the context of regional and local changes proposed by highway departments and other concerned municipalities. West Memphis has - as the Gateway community first seen by tourists crossing the bridge from Memphis - to excel at creating an image that will attract visitors through an appropriate comprehensive planning process.

> "Regional plans can help establish a vision for how communities want to develop, but implementing this vision requires specific local plans and actions. Agencies throughout the country, and their private and nonprofit partners, have led Transportation and Community and System Preservation Projects (TCSP) that focus on improving transportation, promoting economic development, and enhancing quality of life in individual neighborhoods and communities.
>
> To support local area planning studies, TCSP project sponsors have combined TCSP funds with other Federal aid transportation funds, local (MPO, city, or county) planning funds, Department of Housing and Urban Development (HUD) grants for housing and community development, EPA funds, State DOT funds for transportation planning, and even contributions from local businesses, institutions, and utilities.
>
> The cost of conducting a planning study is usually small compared to the cost of implementing its recommendations. Federal funding is potentially available for transportation projects meeting TCSP goals, through sources such as the Surface Transportation Program (STP), Transportation Enhancements (TE), and the Congestion Mitigation and Air Quality (CMAQ) program. The challenge is to create projects that perform well on the criteria established by State DOTs and MPOs for distributing these funds.
>
> For projects with a community development focus, private investment in development projects is a key measure of success and complements public investment in infrastructure. Often, private investment in redevelopment areas requires "gap financing" techniques to make a project profitable for the developer. TCSP grantees have used Federal sources of gap financing such as HUD grants and loans for community development and housing projects, and EPA Brownfields cleanup funds, as well as State and local sources, including tax abatements and loan

guarantees." See **www.fhwa.dot.gov/ tcsp/case10.html** for the remainder of this article and case studies.

Efforts to improve the aesthetic quality of the highway are nothing new. In 1907, the New York Legislature created the Bronx River Commission and charged it with protecting the Bronx River from encroaching development and attendant pollution. However, it was not until The Highway Beautification Act of 1965 that federal funds were set aside to be used specifically for programs that limited outdoor advertising, removed or screened "offensive" uses such as junkyards along highways, and supported scenic enhancements (FHWA 1976: 369).

The Transportation Equity Act for the 21st Century (TEA-21), passed by Congress in 1998, included an authorization of $120 million over five years to fund the Transportation and Community and System Preservation Pilot Program (TCSP). Small in comparison to the total of $218 billion in transportation spending authorized under TEA-21, the TCSP program nonetheless is having an impact far out of proportion to its size. Administered by the Federal Highway Administration (FHWA), TCSP has funded projects in all 50 States and the District of Columbia to link transportation, community, and system preservation practices. This program is leveraging other Federal resources, State, regional, and local funds, and private sector contributions, to create lasting changes in planning and implementation practices.

A newer Congressional act known as TEA-21st Century was established to build on the initiatives established by the earlier ISTEA. This act was created with the purpose of meeting the challenges of improving safety, protecting and enhancing communities and the natural environment by establishing new programs and reauthorizing existing programs that would boost America's economic growth and achieve the goals of TEA-21. Funding opportunities are administered by state highway departments and include the following areas.

• Provide safety and educational activities for pedestrians and bicyclists.
• Acquisition of scenic easements and scenic or historic sites, scenic or historic **highway** programs (including the provision of tourist and welcome center facilities).
• Landscaping and other scenic beautification
Historic preservation, rehabilitation and operation of historic transportation buildings, structures, or facilities including historic railroad facilities and canals.
• Preservation of abandoned railway corridors including the conversion and uses them for pedestrian or bicycle trails.
• Control and removal of outdoor advertising, archaeological planning, and research.
• Environmental mitigation to address water pollution due to **highway** runoff or reduce vehicle caused wildlife mortality while maintaining habitat connectivity.
• Establish of transportation museums.

Given West Memphis' location and history, the establishment of a pedestrian oriented transportation museum that could also serve as a tourist information center would appear to be worth considering in concert with the student designed landscape enhancements.

Several websites offer further information on highway landscape enhancement.

http://www.dot.state.fl.us/emo/beauty/landscap.pdf Florida Highway Landscape Guide

http://www.doh.dot.state.nc.us/operations/dp_chief_eng/roadside/design/graphics/PlantingGuidelines.pdf North Carolina Highway Planting Guide with plant lists

http://www.improvei70.org/ Current Interstate intersection improvements in Missouri including roundabouts

https://www.transportation.org/publications/bookstore.nsf/Home?OpenForm to order a copy of AASHTO Roadside Design Guide

http://www.tfl.gov.uk/streets/downloads/pdf/streetscape-guidance/technical-guidance-street-furniture.pdf Street Furnishings

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The Department of Landscape Architecture would like to express its thanks to all the participants of the West Memphis Highway 77 Overpass Project.

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APPENDIX B

ROUNDABOUT MODELS AND NOTES

Avon Rd Roundabouts

Directions if you choose to drive: enter I-70 Westbound at the Vail West Interchange (Exit 173). Follow freeway to Exit 167, Avon. Please note that between Exits 173 and 167, the freeway has sharp curves and a posted speed limit of 60 miles per hour . . . so, please be safe! Exit to the right and at the botton of the exit ramp you will enter the first of five roundabouts on the Avon Road tour.

Roundabout No. 1

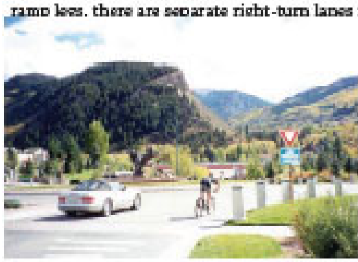
WB I-70 Ramps

This multi-lane roundabout is a tear-drop design with a 150-foot diameter and capacity of 4,200 vehicles per hour. There are four-legs approaching the intersection. The south leg is the Avon Road undercrossing of Interstate 70. The north leg is Nottingham Drive that connects residential areas north of the freeway to the Town of Avon. This rounadbout has been in operation since 1997.

Roundabout No. 2

EB I-70 Ramps

This multi-lane roundabout is a tear-drop design with a 150-foot diameter and capacity of 5,800 vehicles per hour. There are four-legs approaching the intersection. The north leg is the Avon Road undercrossing of Interstate 70. The south leg is alson Avon Road and serves as the gateway to the Town of Avon. On the ramp legs. there are separate right-turn lanes for traffic exiting or entering Interstate 70. This rounadbout has been in operation since 1997.



Roundabout No. 3

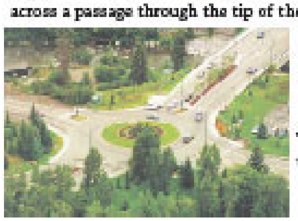
Beaver Creek Rd

This multi-lane roundabout is an oval design with 75-foot-radius tips and 200-foot-radius sides, has a capacity of 6,000 vehicles per hour. The rounadabout replaced a signalized intersection in 1997. Of the five roundabouts along Avon Road, the Beaver Creek Road intersection is the largest.

Roundabout No. 4

Benchmark Rd

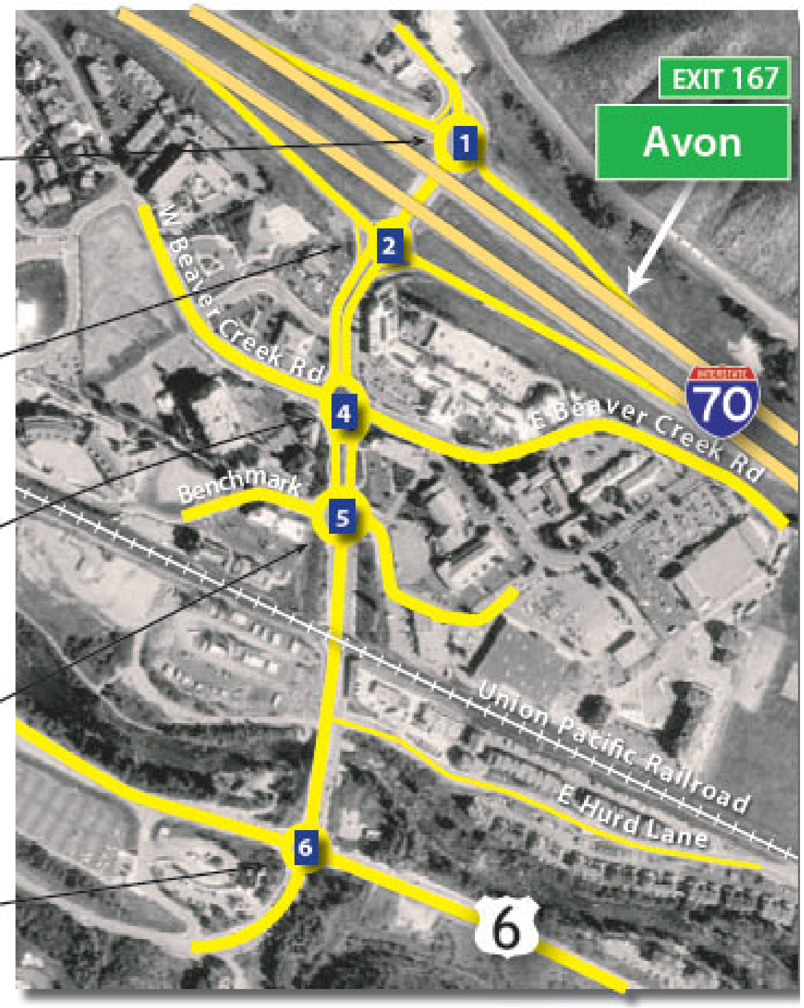
Built on a sharp crest vertical curve, a 150-foot-diameter raindrop-style roundabout at Benchmark Road prevents circulation around its low side. If left open to full circulation, a five-percent adverse cross slope on the low side would be hazardous to trucks. Drivers of fire and police vehicles will remotely actuate a lift-gate across a passage through the tip of the central island. With two-lane entries, the roundabout has a capacity of 4,300 vehicles per hour.



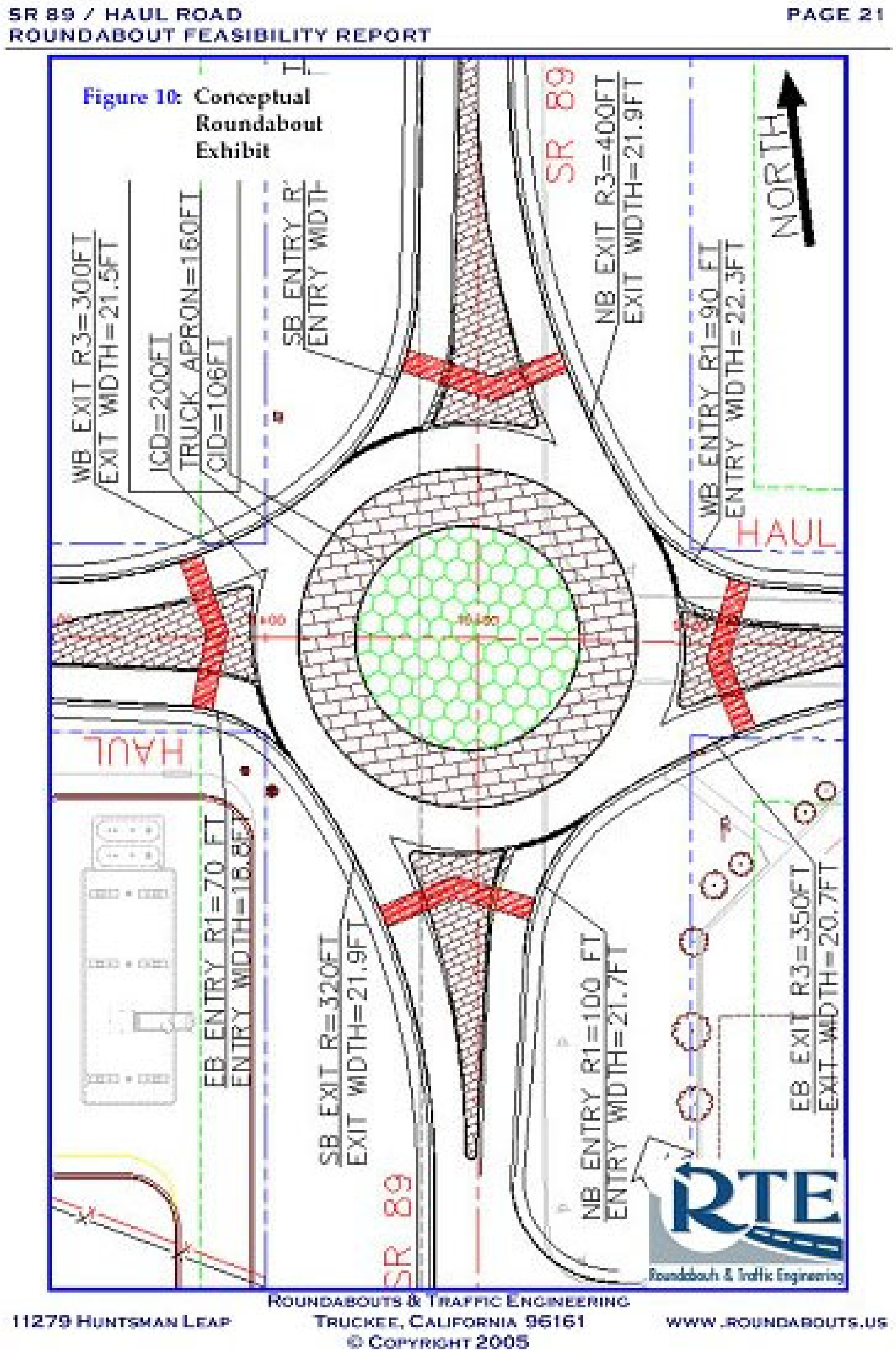
Roundabout No. 5

SH-6

This multi-lane roundabout serves four -legs including the entrance to the Beaver Creek Ski Resourt. It has a 150-foot diameter and a capacity of 4,900 vehicles per hour. It opened to traffic in 1997.



http://www.teachamerica.com/roundabouts/RA052C_Avon.pdf



http://www.roundabouts.us/images/project_info/Arizona_SR89@Haul.jpg

Roundabout Geometry Notes:

Roundabouts are circular intersections with specific design and traffic control features. These features include yield control of all entering traffic, channelized approaches, (i.e., raised splitter islands) and appropriate geometric curvature to ensure that travel speeds on the circulatory roadway are typically less than 50 km/h (30 mph). Thus, roundabouts are a subset of a wide range of circular intersection forms.

Circulatory roadway - The *circulatory roadway width* defines the roadway
Approach width - The *approach width* is the width of the roadway used by approaching traffic upstream of any changes in width associated with the roundabout..
Departure width - The *departure width* is the width of the roadway used by departing traffic downstream of any chances in width associated with the roundabout. The departure width is typically less than or equal to half of the total width of the roadway.
Entry width - The *entry width* defines the width of the entry where it meets the inscribed circle. It is measured perpendicularly from the right edge of the entry to the intersection point of the left edge line and the inscribed circle.
Exit width - The *exit width* defines the width of the exit where it meets the inscribed circle. It is measured perpendicularly from the right edge of the exit to the intersection point of the left edge line and the inscribed circle.
Entry radius The *entry radius* is the minimum radius of curvature of the outside curb at the entry.
Exit Radius The *exit radius* is the minimum radius of curvature of the outside curb at the exit.
When designed correctly, modern roundabouts can accommodate large commercial trucks that use the interstate transportation system and fire trucks. Within the central island, it is common to find a widened concrete pad for rear wheel tracking.

Major Differences between Traffic Circles/Rotaries and Modern Roundabouts

Characteristic	Traffic Circle/Rotary	Modern Roundabout
Diameter or ICD	600+ feet	130 – 250 feet
Entry Control	Circulating vehicles yield to entering vehicles/High speed merge	Entering vehicles yield to circulating vehicles
Speeds	High (30-55 MPH)	Low (15-25 MPH)
Lane Utilization	Weaving	Stay in your lane
Traffic Capacity	Can lock up during high capacity hours (A.M./P.M. peak hours)	Determined by geometric layout and gaps – Can have very high capacity rates if designed correctly
Crash Rates	Typically high at medium to higher rates of speed	Very low – mostly low impact collisions such as sideswipes
Public Opinion	Negative	Typically favorable after implementation

Table Courtesy of DLZ Michigan, Inc.

An elevated continuous bridge roundabout and four-lane overpass with structures below built in London, England.

Operational Performance of Roundabout Notes:

Roundabout intersection analysis models generally fall into two categories.

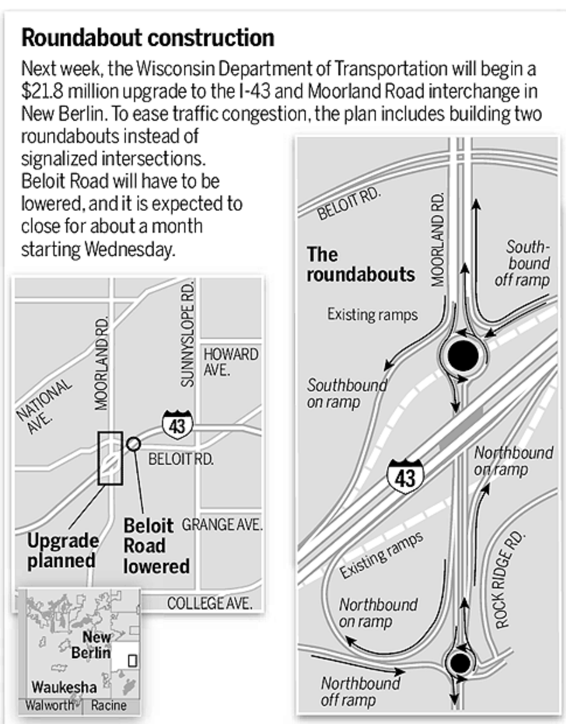
Empirical models rely on field data to develop relationships between **geometric features** and **performance measures** such as **capacity and delay**; these are commonly regression models. Empirical models are often used in cases where an understanding of driver behavior characteristics is incomplete.

Analytical models rely on field measures of **driver behavior** and an analytic formulation of the relationship between those field measures and performance measures such as **capacity and delay**.

Gap acceptance models are generally the preferable type of **analytical model** at unsignalized intersections since they capture **driver behavior characteristics** directly and can be made site-specific by custom-tuning the values that are used for those parameters.

Based on recent analysis of U.S. field data, an analytical **gap acceptance model** is recommended for **single-lane roundabouts**, and a **simple, empirical, lane-based, regression model** is recommended for **multilane roundabouts**.

TRB Higway Capacity Manual 2000
Source:http://people.sunyit.edu/~lhmi/ahb40/meetings/2005-07/Draft%20Ch%2017-C%20Procedure%202005-07-02.pdf



Roundabout construction

Next week, the Wisconsin Department of Transportation will begin a $21.8 million upgrade to the I-43 and Moorland Road interchange in New Berlin. To ease traffic congestion, the plan includes building two roundabouts instead of signalized intersections. Beloit Road will have to be lowered, and it is expected to close for about a month starting Wednesday.

Journal Sentinel

ROUNDABOUTS OR SIGNALS? COSTS?

"Modern roundabouts at freeway-to street interchanges provide capacity where it is needed, at the ramp and frontage road intersections, while minimizing the number of lanes passing over or under the most expensive part of the interchange, the bridge. By contrast, signalized interchanges require wide bridges for storage and turning lanes. For this reason modern roundabout interchanges are usually much less expensive than signalized interchanges. It costs roughly $2 to $6 million dollars to retrofit an existing interchange with roundabouts. This compares with roughly $10 to $15 million dollars to install signals and widen the bridge. In addition to their cost advantage, modern roundabouts usually cause less delay and fewer crashes than signalized cross intersections."

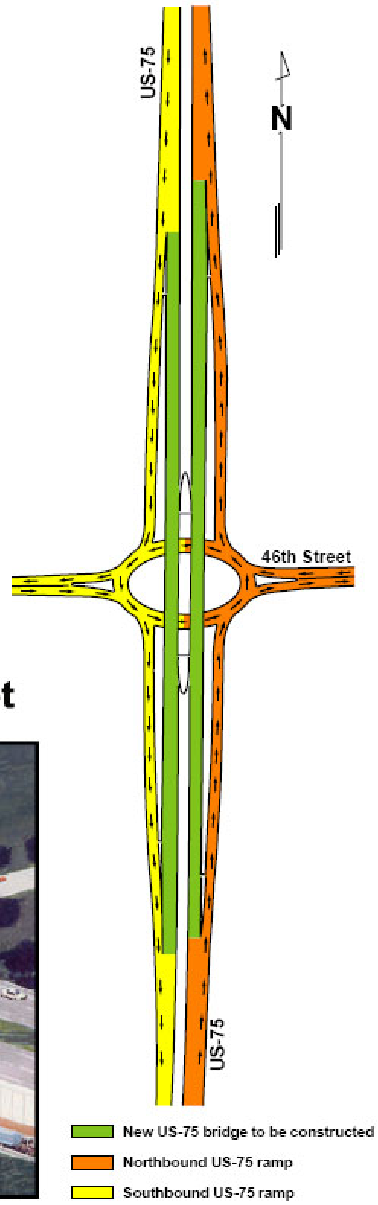
http://findarticles.com/p/articles/mi_qa3734/is_199712/ai_n8767822/pg_2

Left -Milwaukee Journal Sentinel April 26, 2007

1. For about three months, N.W. 46th Street will have no access to US-75 until the roundabout and ramps are built. Through traffic on US-75 will be reduced to one lane.

2. Once the ramps and roundabout are built, **the drawing at right** shows how US-75 traffic will be routed onto the ramps while the new US-75 bridge is built. 46th Street traffic will also have access to and from US-75 as well as across the intersection by using the roundabout.

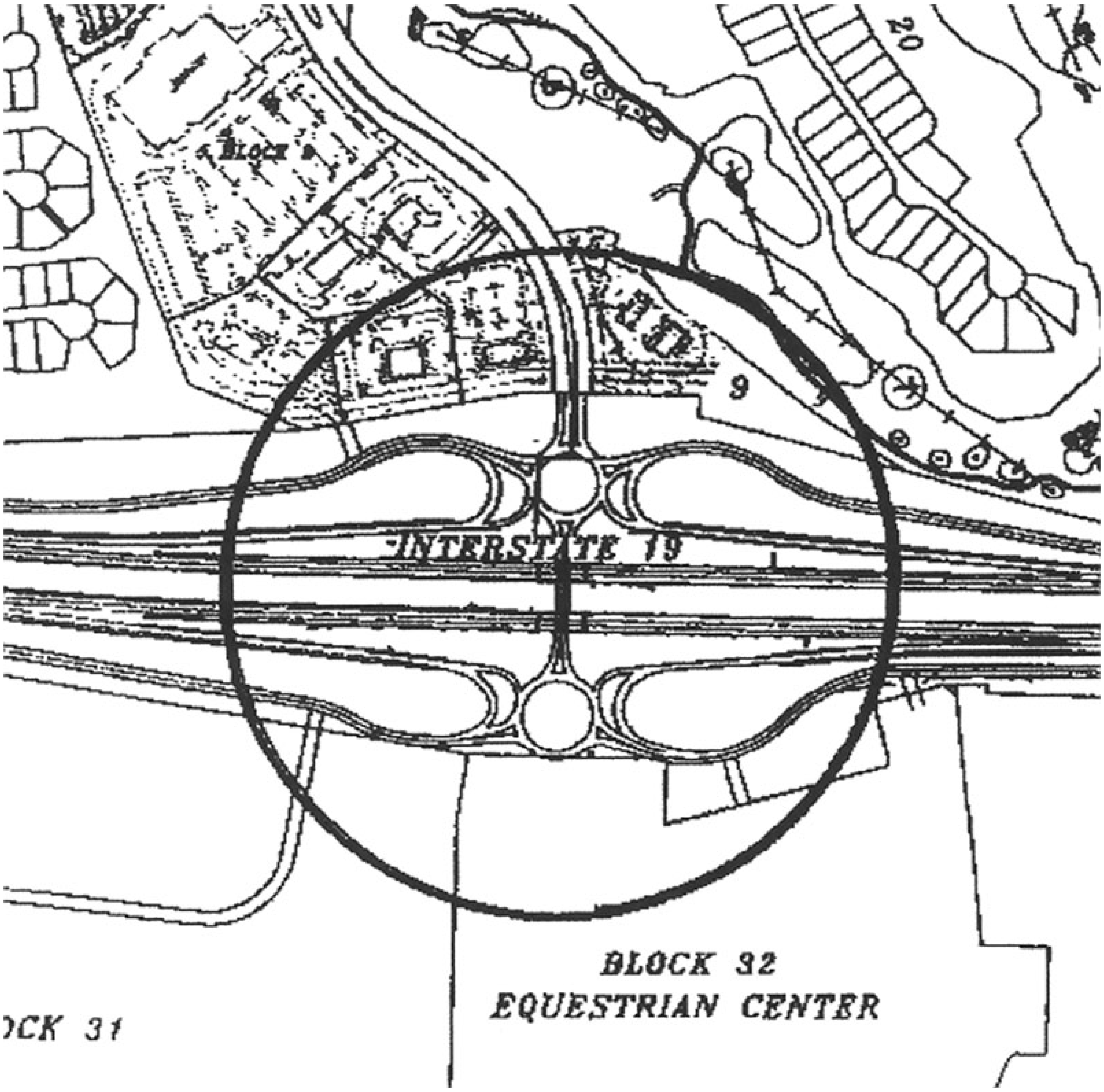
3. When construction is complete, **the drawing below** shows how through US-75 traffic will use the bridge over N.W. 46th Street and not stop. US-75 traffic to and from 46th Street will use the roundabout below the bridge.



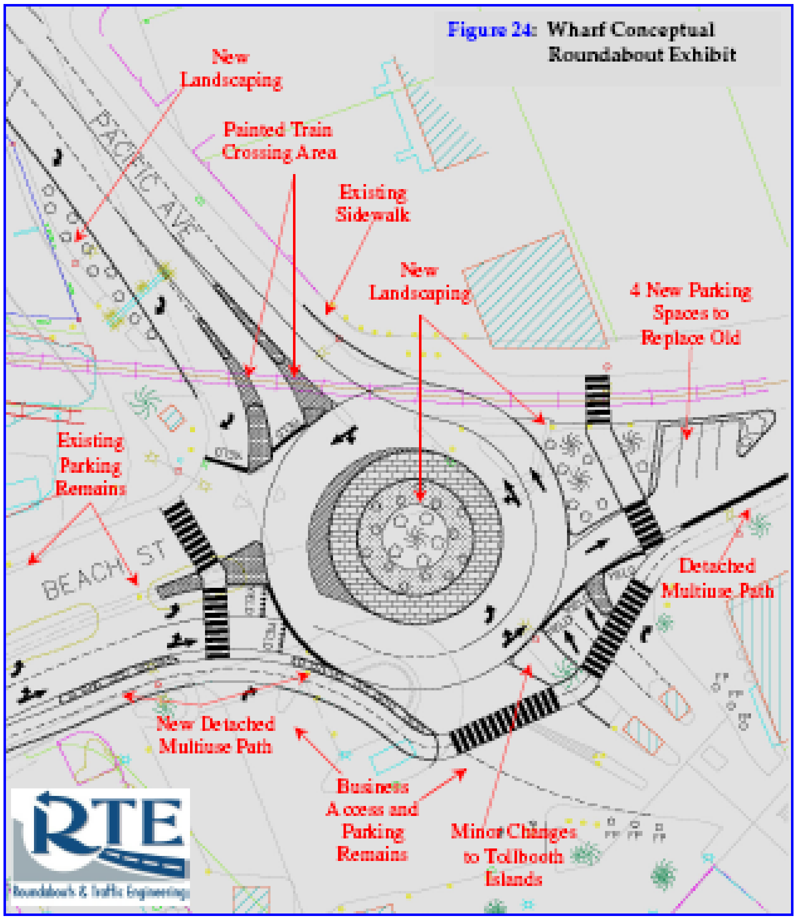
Topeka, Kansas, US-75 and 46th Street

KDOT Bureau of Transportation Information February 2002

A single circle/oval roundabout under a Kansas Interstate 75
http://www.ksdot.org/archive/PDF_files/us75NW46th.pdf



Roundabouts with extra bypass lanes planned for Tucson Arizona
Ourston Roundabout Engineering http://www.ourston.com/08_Projects_Location.htm



FEASIBILITY
REPORT
BEACH AREA ROUNDABOUT
TRAFFIC SIGNAL PROJECT
(PACIFIC AVENUE / BEACH STREET &
PACIFIC AVENUE / CENTER STREET)
Prepared For:
City of Santa Cruz, California
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&
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An integrated roundabout system proposal for Sedona, and Village of Oak Creek, Arizona.

A Dye Design, 1158 E. Missouri Street
Phoenix, Arizona

Angela Dye, Landscape Architect for project.

http://www.scenic179.com/projectoverview/projectmap.cfm

Roundabouts as entry features for communities. Top – Avon Colorado, Bottom – Clearwater, Florida   Photos: Bruce Robinson

http://safety.fhwa.dot.gov/intersections/roundaboutsummit/rndabtatt5.htm