

Gateway to suburbia

Michael Baker Jr. Inc. recounts its experience designing the multiple award-winning Liberty Tunnel Interchange, and how software contributed to its success

by Kelly Foley and Noel Dolotallas

If you had to reel in a trophy swordfish, would you do so armed only with 100-lb test line and sheer bravado? If you had to drive 280 yards to the green, would you throw the ball?

Being mortal, we rely on technology and technique to “land the big one” or “drive the green.”

With large-scale transportation projects laden with so many challenges, engineers champion the use of software in order to meet tight deadlines, stay above the bottom line and reel in that big project. The Liberty Tunnel Interchange project, or “Big Flip,” is an example of how state-of-the-art software can assist in the management of time, budgets and resources.

Tunnel vision

As urban development continues at an alarming rate in major U.S. cities, the need for exceptional engineering solutions becomes readily apparent. Pittsburgh is no exception. Bordered by three major rivers and steep topography, the city has limited options for transportation routes. Because of this, the major traffic corridors leading into the city can become



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severely congested, especially during commuter rush hours.

An area of particular concern is the Fort Pitt Bridge and Tunnel, the pivotal course of travel from the western suburbs to downtown. It is currently used by over 140,000 commuters daily, yet is scheduled to close for rehabilitation in 2002. This would mean rerouting thousands of commuters to the Liberty Tunnels, which, prior to rehabilitation, carried more than 80,000 vehicles per day.

The Liberty Tunnel Interchange is located at the intersection of West Liberty Avenue and Saw Mill Run Boulevard (Route 51) on Pittsburgh’s south side. Commuters flock to this intersection to use the Liberty Tunnels, which carry traffic under Mount Washington and lead directly to the upper central business district.

It was evident that a major redevelopment of the intersection was necessary to meet the impending influx of traffic. Michael Baker Jr. Inc., a subsidiary of Michael Baker Corp., had the considerable task of designing the Liberty Tunnel Interchange. The client, Pennsylvania Department of Transportation (PennDOT) District 11-0, located in Pittsburgh, deemed the project was necessary to provide short-term and long-term mobility solutions to commuters. Baker provided preliminary engineering services, right-of-way plan preparation, final design and construction phase services.

The \$40 million infrastructure development involved the conversion of an at-grade intersection serving heavy commuter traffic into a modified single point urban interchange which grade separated West Liberty Avenue and Route 51. The design involved several components, including seven intersecting streets, 3,500 ft of connector roads, two bridges, two box culverts, five retaining walls, drainage, lighting, signing and five signalized intersections.

The project was FAST tracked (Facilitate Accelerated design through Specialized Techniques) with a very aggressive schedule and involved a consortium of technical disciplines, stakeholders, client groups and regulatory agencies. The final design was overseen by both a Steering Committee and Technical Committee comprised of the Federal Highway Administration, Penn DOT, Southwestern Pennsylvania Regional Planning Commission, Allegheny County, City of Pittsburgh and the Port Authority of Allegheny County. To assist in the project, Baker contracted several subconsultants.

Due to a demanding design schedule of 10 months, it was clear that Baker would need to utilize software that was powerful enough to provide quick and accurate solutions to the design challenges, yet simple enough to make effective presentations to the public and to the client.

The road map

Knowing where you are going, and what you expect it to look like when you get there, is a basic part of project management. The Liberty Tunnel Interchange project had a clear vision at the onset: to provide a single point urban interchange that would improve mobility, reduce travel time and cost, and improve safety in the vicinity of the intersection. This all needed to be accomplished within the project parameters: on time, within budget and to the expectations of a large stakeholder group.

In order to meet this challenge, a number of objectives

were clearly identified; the management and design of the project could then be coordinated to best meet these goals. Software is an important, yet often overlooked, component of the project delivery process. Baker, however, used AutoTURN, a product developed by Transoft Solutions Inc., throughout the planning, design and construction phases of the project. Moreover, it assisted in meeting Baker's project objectives:

- Ensuring safety;
- Minimizing costs;
- Maintaining schedule;
- Keeping stakeholders involved;
- Maintaining traffic throughout all phases of construction; and
- Providing optimum quality.

Safety: First and foremost

Baker's design team was able to develop quick and reliable alternatives that optimized safety. By using AutoTURN, the designers were able to analyze alternatives against a wide set of variables. The selected design led to the need for tightly controlled alignments. This meant that a key challenge was to provide for safe turning movements for all vehicles including semi-trailers. Moreover, this had to be accomplished not only in the ultimate traffic patterns, but at all times during construction including the design of temporary roadways.

"For example," explained Baker Design Engineer Jason Davis, "the original design called for two right-turn lanes from northbound Route 51 into the tunnels. However, it was observed that semi-trailers might have difficulty negotiating the turn. A quick solution was required to provide for pedestrian and vehicular safety. AutoTURN was utilized to determine that trucks could not negotiate the turn from the inside lane. As a solution, the traffic engineer developed advanced signing to preclude trucks in the right lane."

Cutting costs, not corners

After safety, capital cost control is one of the most critical areas for the successful management of large multi-discipline projects. The use of design software can help to identify cost curbing options, optimize engineering effort and expedite the project schedule.

For the Liberty Tunnel Interchange, one way of mitigating costs was to reduce the amount of space required in roadway design.

"Baker's design team used AutoTURN to understand how much space the vehicles needed to safely negotiate each turning movement," said Davis. "In this way, they were able to minimize right-of-way impacts and implement cost reduction measures."

One example of this was the right-turn movement for southbound traffic exiting the tunnel. The existing terrain was especially steep in this area and was restricted by Saw Mill Run. Every square foot of land that could remain undisturbed would translate into cost savings of hundreds of dollars in retaining wall costs. By plotting the turning

movements of semi-trailers against the proposed design, engineers at Baker were able to optimize the wall heights and thereby reduce construction costs. Furthermore, minimizing the amount of land required also had a positive environmental impact.

Staying in the fast lane

The Liberty Tunnel Interchange project was fast tracked, incorporating a demanding final design schedule. This non-negotiable deadline was established to meet the upcoming traffic demands resulting from the closure of the Fort Pitt Bridge and Tunnel.

In many ways, effective scheduling is an exercise in



FONSI (Finding of No Significant Impact) for the project was secured in a third of the norm (nine months), resulting in savings of approximately \$1 million. The final design was completed in 10 months and construction was completed in 30 months.

design efficiency and communications. Designs need to be generated quickly, reviewed and accepted in order to expedite each phase of the project. Software can play a critical role in this process.

"AutoTURN assisted the design team in meeting their deadlines. As an easy-to-use program, it allowed alternative designs to be generated quickly. Feedback could then be attained from other team members before final design," noted Davis.

Keeping the faith

As a very high profile project, the Liberty Tunnel Interchange involved many stakeholders, requiring a very effective communications program. The client alone consisted of a consortium of six government agencies. At the onset, it was important that the design software also be used as a communications tool. By utilizing AutoTURN, Baker was able to generate graphic displays that were detailed, yet simple enough to be effective. Design personnel, the client groups and the public could view the displays and easily comprehend the design issues at hand.

Going with the flow

As a major transportation corridor, and with a construction schedule of 30 months, a key project issue was the maintenance of traffic.

“Maintaining a safe construction work area while minimizing delays to the traveling public was essential,” noted Greg Cerminara, traffic engineer with Baker. “The project team made mobility a priority throughout construction, utilizing temporary roadways, temporary signals and opening the new roadways early on. The traffic control plans were designed to accommodate traffic pattern changes in individual simplistic steps, to be motorist-friendly.”

GuidSIGN 4.0, also developed by Transoft, was used to develop temporary signs pointing to detour routes during construction. It offered the ability to design fabricated temporary signs for the Liberty Interchange Project Traffic Control Plan. The program allowed the project team to design and present several conceptual signs during the preliminary plan submissions to PennDOT.

The physical surroundings added to the design complexity. The northern border of the project was Mount Washington, a steep hillside between the project area and downtown. Saw Mill Run, a tributary to the Ohio River, parallels Route 51 and challenged the engineering solutions. The narrow corridor along Route 51 would have to serve traffic flow during construction, as well as construction of the proposed facility. AutoTURN was a key tool for this component of the project. It allowed Baker designers to work within tight parameters and evaluate the minimum paths required for all vehicle types. In this way, they could quickly and inexpensively design temporary roadways that provided safe triaxle movements.

Light at the end of the tunnel

Attaining optimum quality is at the heart of all projects,

particularly transportation projects that literally effect millions of people. As outlined previously, the Liberty Tunnel Interchange had a number of quality goals. In meeting these overall objectives, specific quality issues were addressed throughout the project.

As an example, Baker designers sought to maximize pedestrian flow at crosswalks. By using AutoTURN, they were able to analyze the proposed design at several crosswalk locations, and the curb radii were minimized to reduce the distance pedestrians had to travel between curbs. These modifications led to more efficient intersections for both pedestrians and vehicles.

The Interchange project was a great success on several fronts. FONSI (Finding of No Significant Impact) was secured in a third of the norm (nine months), resulting in savings of approximately \$1 million in construction costs. In addition, final design was completed in 10 months, and construction was completed in 30 months.

Officially opened to the public on November 19, 1999, the Liberty Tunnel Interchange now stands as an engineering accomplishment. Michael Baker Jr. has received two prestigious awards for its design work: the 2000 Diamond Honor Award for Transportation for Engineering Excellence from the Consulting Engineers Council of Pennsylvania and the Pittsburgh Civil Engineering Achievement Award from The American Society of Civil Engineers. ^{RB}

Information for this article provided by Electric Crayon, Burnaby, British Columbia, Canada, and Transoft Solutions Inc., Richmond, British Columbia, Canada.