



System Performance Innovation Fact Sheet

Freeway and Highway Access Management Solutions

Description of the Challenge or Opportunity

Freeway and Highway Access Management Solutions

Understanding the motivation.

Every year, hundreds of millions of California tax payer and developer dollars are invested to add, expand and improve intersections and interchanges in order to:

- Remediate system performance (safety & mobility) problems.
- Provide access and connectivity that directly supports economic development.

However, project sponsors and engineering practitioners rarely, and often do not consider newer access solutions that are often better, cheaper, safer, cleaner, and easier to implement than conventional intersection & interchange types and configurations. In order to meet ever increasing peak hour traffic volumes, transportation agencies continue to expand the size of signalized intersections by adding through and multiple left and right turn channelization lanes. This approach may no longer be the best, optimum or most cost-effective solution for highly prevalent traffic problems, needs and proposals, such as:

- New intersections (new access to the SHS related to local development proposals)
- New interchanges and expensive reconstruction proposals in response to capacity and operational deficiencies; and/or, to accommodate the expected increase in demand due to local development projects
- Safety “hot spots” and operational bottlenecks at existing intersections and interchanges

The opportunity.

The innovative access strategies and solutions identified below have been proven - primarily in other countries, U.S. cities and state DOT's - to produce fewer collisions, significantly fewer severe collisions, and less delay during peak and off-peak conditions with smaller construction and R/W footprints, which translates into lower capital costs than for conventional solutions. In spite of these proven advantages over conventional solutions, the modern roundabout, Diverging Diamond Interchange, and various forms of Continuous Flow Intersections are either not utilized, infrequently considered, or severely under-utilized as alternatives to conventional solutions.



System Performance Innovation FACT Sheet *Freeway and Highway Access Management Solutions*

Information Regarding the Innovation

Defining the need.

Access points on local and SHS facilities (freeways, expressways and conventional highways) are the source of approximately half of all severe collisions, and a primary source of congestion & delay (during both peak and the much longer non-peak periods of each day). The family of innovative solutions that eliminate, convert or relocate problematic conflicts (left turn movements) can directly and significantly contribute to performance goals for traveler safety & mobility (travel time & reliability). In fact, roundabouts & Diverging Diamond interchanges typically improve both safety & mobility to a higher degree than conventional solutions.

In addition, because each of these strategies can be implemented with smaller footprints (that is: fewer lanes, and therefore less R/W and impacts to communities and natural resources), and therefore less cost for a broad range of needs and operating conditions, these innovative solution concepts directly contribute to the following departmental and state strategic goals / objectives:

- Stewardship (better outcomes from smaller investments for capital, R/W and life-cycle costs)
- Active Transportation / Complete Streets (via smaller intersections with lower operating speeds)
- Sustainability (Air & Water Quality, reduced Maintenance & Operational workload)

These innovative access concepts improve safety and mobility (System Performance) by removing or relocating left turns from the targeted intersection and/or intersections at interchanges. In the case of the roundabout, operating speed and speed differential among all users is significantly reduced, which produces substantial safety benefits and greater capacity than signalized intersections. As previously mentioned, the elimination or relocation of left turns (e.g. dual or triple left turn lanes) reduces the size of the intersection and thereby reduces the conflict area and the crossing distance, or exposure of pedestrians and bicyclists who walk or pedal across these intersections.

In spite of successful installations by “early adopters” (primarily local agencies) and the construction of over 3000 across the U.S., roundabouts are still incorrectly viewed as *inappropriate* for high-speed and higher volume intersections; and, they are usually controversial when proposed in a city or community that does not have a modern roundabout. These impediments led the Department (with support of a statewide coalition



System Performance Innovation FACT Sheet

Freeway and Highway Access Management Solutions

of strategic safety partners) to develop the aforementioned business process change (ICE), training and marketing among Caltrans Districts and some partner agencies. There are now 20 roundabouts on the SHS (all installed between 1993 and 2014), but this pales in comparison to the number of traffic signals and widening projects that have been funded at SHS intersections during the same period (approximately 2,000). Prior to the aforementioned business / engineering process change (the Intersection Control Evaluation Directive, August 2013), most roundabout proposals were met with strong opposition by the public, local officials and often engineering practitioners. Even today, the first roundabout in a community or city is met with resistance that requires a substantial effort to overcome.

There are no Diverging Diamond Interchanges in California, and few (if any) of the Continuous Flow Intersection concept that has evolved from practice abroad and basic versions in the U.S. There are 20 Diverging Diamonds in operation in several states, and a handful of state agencies have implemented Continuous Flow Intersections. Some agencies have already adopted these innovative strategies as standard or best practices; a few states have established a “Roundabout First” policy in which traffic signals are only considered when the roundabout is impractical due to right of way or obvious environmental impacts (e.g. to wetlands).

Basic outreach and education by Caltrans and the FHWA has produced a growing interest in these innovative strategies, especially when they are introduced for a project location that is constrained and/or under-funded. Even when there are no constraints or a budget problem, project sponsors are becoming interested in roundabouts and Diverging Diamonds because of the numerous advantages over conventional solutions (especially their “smaller footprint” and related benefits).

Among the best applications for roundabouts are: interchanges, high-speed rural highways, and as part of Road Diets (in which the number of through lanes and intersection channelization lanes are reduced to half or less than half of the existing width). This allows for the installation of ped and bike infrastructure, as well as planted islands and parking. In addition, roundabouts installed in corridors (either around interchanges or through business districts) have become a popular / successful access management strategy.

Estimating the cost.

As with any new solution, there is a “learning curve” and “start up” cost associated with the first deployment, but this can be lessened through “just-in-time” training (education) and other technical assistance that can be arranged through HQ and the FHWA. However, any



System Performance Innovation FACT Sheet *Freeway and Highway Access Management Solutions)*

innovative access solution can be proposed, studied, selected and funded pursuant to established transportation planning and project development processes. The total cost (for construction, right of way, and the mitigation of impacts) may be greater, but is more often less than the cost of conventional solutions. In many cases, the Benefit/Cost ratio is higher or much higher because these innovations can serve a longer “service life,” produce better performance outcomes, and have lower life-cycle costs. Maintenance & Operating costs (including energy consumption) are typically lower because traffic signals have more electrical system infrastructure and require frequent adjustment by engineering personnel.

Quantifying the benefits.

Performance evaluation and research studies have repeatedly found that roundabouts experience 80% fewer severe collisions than conventional crossing type intersections with signal and stop control. In addition, roundabouts typically incur substantially less control delay during peak and non-peak periods compared to intersections and interchange ramp terminals with Signal Control, Two-way Stop Control & Multi-way Stop Control. The preliminary results from research on Diverging diamond interchanges confirms that they reduce left-turn related collisions by an average of 20% while delivering more vehicle throughput (i.e. higher capacity) than conventional interchange configurations that require much larger construction footprints, and therefore higher capital and right of way costs. As a result, the Benefit / Cost ratio for the installation of roundabouts and DDI's is usually much higher than for conventional access solutions.

Understanding the risks.

Minimal or no risks as these solutions have been proven by other countries, cities, state DOT's. Public acceptance is usually the greatest challenge to the initial deployment of unconventional intersection and interchange strategies. Public and customer acceptance normally hinges on the success of the first deployment in a community. Therefore, outreach and education is critical to ensure that public opposition does not prevent transportation agencies from pursuing innovative solutions where they are expected to outperform conventional solutions.

The greatest risk to the successful deployment of roundabouts is driver performance during the initial weeks or months of “opening” to traffic. The investment in local public information and education efforts and special monitoring by traffic engineering and law



System Performance Innovation FACT Sheet *Freeway and Highway Access Management Solutions*

enforcement personnel are critical to minimize the adjustment period that follows significant changes in highway infrastructure.

Other considerations.

Lessons Learned & Barriers to Greater / Systematic Deployment

In spite of successful installations by “early adopters” (primarily local agencies) and the construction of over 3000 across the U.S., roundabouts are still incorrectly viewed as inappropriate for high-speed and higher volume intersections; and, they are usually controversial when proposed in a city or community that does not have a modern roundabout. Deployment has been severely hampered by poorly or misinformed practitioners, transportation officials, elected officials and the general public (our customers). Roundabout proposals have NOT been studied, and have been dropped due to unfounded resistance and skepticism.

Recommendations to Increase and/or Systematically Deploy Innovative Access Solutions

The Department has already established an evaluation & selection process for access-related proposals that requires consideration of innovative solutions that are often better, cheaper, cleaner, more sustainable and easier to implement. However, this business process change requires ongoing technical and management-level support (see recommendations below) to overcome the natural resistance to change and engineering solutions that are unfamiliar to designers, sponsoring agencies, our partners, stakeholders and customers.

1. Technical assistance in the form of training, peer reviews, peer exchanges, and educational workshops by and with credible practitioners and specialists has been proven to overcome the above barriers to the consideration and implementation of innovative access solutions that appear to be “too radical” or “inappropriate for California volumes and driving conditions.” NOTE: Caltrans Divisions of Traffic Operations & Design and the FHWA (Division Offices and Resource Center specialists) are collaborating to formalize and resource a Joint Agency Technical Assistance Program that can support project teams and sponsors who are evaluating or pursuing the first installation of a roundabout, multi-lane roundabout, Diverging Diamond Interchange, or other Continuous Flow Intersection concepts. Without credible / meaningful technical assistance to overcome the lack of experience with innovative solutions, project teams and sponsors often take the “path of least resistance” – that is: conventional solutions that do not provide the



System Performance Innovation FACT Sheet

Freeway and Highway Access Management Solutions

optimum Return on Investment through greater system performance benefits, the extended service life, reduced life-cycle costs, and contributions to multiple strategic objectives.

2. In addition to Technical Assistance, additional project planning and delivery resources are needed to equip project teams to:
 - a. learn as they plan, design and analyze innovative solution concepts *for the first time*
 - b. Perform the outreach necessary to build a consensus or support from local officials, stakeholders, and the community in which an innovative engineering solution is proposed
 - c. Perform critical public outreach (information and education) just prior to the “opening” of innovative infrastructure solutions.
 - d. Traffic Engineering and law enforcement personnel need to monitor and evaluate driver performance and acceptance of the innovative infrastructure during the initial adjustment period. There is usually a need for minor but critical adjustments (signing, striping and minor geometric changes) to optimize driver understanding and performance. This work should be expected and therefore planned.
3. Caltrans management can establish a culture that is willing to take risks and invest more resources (up front) in order to produce a better product and system performance outcomes. Management must expect that more resources and time will be required initially, and that innovative solutions also require resources for monitoring, evaluation and adjustment (possibly more than once) to “get it right.” And sometimes, innovative solutions will not succeed, so project teams must not have to fear punishment.

How to Measure Success.

In order to measure progress toward the acceptance of innovative (proven, but under-utilized strategies / solutions concepts), the Department must track the percentage of decisions to install roundabouts, DDI's, etc. compared to conventional access strategies or practices. The percentage should increase as initial deployments prove to be successful, which will quickly dissipate the concerns and resistance of the general and traveling public (thereby making it easier to implement the innovation).



System Performance Innovation FACT Sheet *Freeway and Highway Access Management Solutions)*

Of course, Before-After Performance Evaluations are necessary to understand and/or confirm that the estimated safety, capacity and operational benefits are being produced. If not, then the Department and sponsoring agencies need to investigate and pursue adjustments and re-evaluation before declaring failure.

About the Originating Author/Team

Jerry Champa (Division of Traffic Operations) has represented Caltrans in national research projects (since 2001) that confirmed the effectiveness of roundabouts. Jerry has led or supported business process & program improvement efforts focused on access-related performance problems and solutions in the role of:

- The Department's Traffic Safety & Operations Liaison
- Technical Assistance Program Manager for Innovative Access Solutions
- Chief of the Division of Design Office responsible for the Highway Design Manual.
- Member of the AASHTO Geometric Design Task Force and TRB Committee on Geometric Design
- Strategic Highway Safety Program Co-Lead