UAID: Unconventional Arterial Intersection Design
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Overview of Unconventional Arterial Intersection Design
Unconventional Arterial Intersection Design refers to a class of innovative intersection designs that attempt to increase the intersection capacity by reducing the impact of turning movements at the major intersection through various geometric design and management strategies.
General Control Strategies

- Rerouting of turning movement paths
- Emphasis on predominant movements
- Reduction in signal phases
- Reduction in conflicting points
- Separation of intersection planes
System Structure
A Multi-Stage Design Process

Start → Planning Evaluation → Signal Design → Operation Analysis

**Input:**
- Demand pattern
- Preliminary geometry design

**Output:**
- Estimated delay
- Queue spill back locations
- Q/L ratios of each critical segment

**Input:**
- Demand pattern
- Detail geometry of intersections

**Output:**
- Optimal offset
- Optimal green split and cycle length

**Input:**
- Demand pattern
  - Detail geometry of intersections
  - Signal settings

**Output:**
- Accurate delay
- Time-dependent queue configuration
- Overall level of service
A Multi-Stage Design Process

- At the planning stage, this system offers a set of empirical equations for engineers to compute the overall interchange delay and to identify potential queue spillback locations in a DDI design.

- The second stage is to help traffic professionals develop the optimal signal timing plan, so as to synchronize traffic flows at those intersections and to prevent any potential queue blockage.

- Based on the recommended geometric features and signal plans, the system subsequently offers a function to employ VISSIM-based simulation model for users to assess the resulting queues and delays.
Continuous Flow Intersection (CFI)
Continuous Flow Intersection

The main feature of CFI is to eliminate the conflict between left-turn and opposing through traffic by relocating the left-turn bay to several hundred feet upstream of the primary intersection so that the through and left-turn flows can move concurrently.
Planning Evaluation

1. Identify all the geometric factors contributing to delay and queue
2. Build simulation models using VISSIM
3. Calibrate VISSIM model parameters with field data
4. Random sampling of different demand scenarios
5. Build simulation datasets
6. Perform regression analysis for each type of queue
For the convenient of discussion, we define a set of QL ratios to indicate the queue occupancy rate at each link:

$$QL \text{ ratio} = \frac{\text{Maximum Queue Length}}{\text{Bay Length}}$$

- If QL ratio of a bay is less than one, it indicates that the design provides a sufficient storage capacity to accommodate all volumes approaching the target bay.
- If QL ratio of a bay is greater than one, then it implies that queue spillback may incur due to insufficient bay capacity and the service quality of the entire system may be deteriorated.
The figure illustrates the relationship between the average delay and queuing size within CFI, which reveals that the QL ratio has significant impacts on the CFI delay.
CFI Delay Analysis

**Delay**

\[
0.047 \frac{X_1}{1 - X_1} + 0.028 \frac{X_2}{1 - X_2} + 0.025 \frac{X_3}{1 - X_3} + 0.033 \frac{X_4}{1 - X_4} + 0.062 \frac{X_5}{1 - X_5}
\]

\[+ 0.167 \beta_1 + 0.182 \beta_2 + 0.192 \beta_3 + 0.195 \beta_4 + 0.23 \theta_1 + 0.196 \theta_2 + 0.207 \theta_3 + 0.219 \theta_4 + 0.072 \gamma_1 + 0.091 \gamma_2 + 0.101 \gamma_3 + 0.049 \gamma_4 + 0.213 \omega_1 + 0.229 \omega_2 + 0.187 \omega_3 + 0.281 \omega_4\]

QL ratio of sixteen queues

\[R^2 = 0.9142, \quad \text{Sample size N: 800}\]
CFI Delay Analysis

- Ranking for the intersection degree of saturation impacts
  - Level 1: Primary intersection degree of saturation (0.062)
  - Level 2: Crossover intersection degree of saturation (0.047; 0.028; 0.025; 0.033)

- Ranking for Queue Impacts (Parameters analysis)
  - Level 1: Type-4 Queues (0.213; 0.229; 0.187; 0.281)
  - Level 2: Type-3 Queues (0.23; 0.196; 0.207; 0.219)
  - Level 3: Type-1 Queues (0.167; 0.182; 0.192; 0.195)
  - Level 4: Type-2 Queues (0.072; 0.091; 0.101; 0.049)
Queue Length Estimation

Type-1 Queue: Through queues at the primary intersection
Type-2 Queue: Left-turn queues at the crossover intersections
Type-3 Queue: Left-turn queues at the primary intersection
Type-4 Queue: Through queues at the crossover intersections
The ratio between demand and the remaining capacity of the primary intersection

Type-1 Queue:

\[
\text{Queue} = 0.92 \gamma \frac{D_t(1-G_t)s}{s-D_t} + 5.14 \left( \frac{D_t}{s-CV_m} \right)^2 + 1.72e^{\theta_{d}}
\]

\(\gamma\) is a weighted factor between deterministic queue and correction components

Deterministic queue determined by demand and estimated green ratio

Downstream queue-to-bay ratio

The ratio between demand and the remaining capacity of the primary intersection.

\(Q_d\) and \(D\)
The ratio between the demand and the remaining capacity of the crossover intersection is given by the following equation:

\[ \text{Queue} = 1.03 \gamma \frac{D_1(1-G_1)s}{s-D_1} + 6.28 \left( \frac{D_1}{s-CV_n} \right)^2 + 1.13e^{\theta_{pd}} \]

- **Type-2 Queue**
  - Deterministic queue determined by the demand and estimated green ratio
  - Downstream queue-to-bay ratio
  - The ratio between the demand and the remaining capacity of the crossover intersection

\( Q_d \)
\( D \)
Full CFI Queue Regression (3)

Type-3 Queue:

\[ \text{Queue} = 0.729 \gamma \left( 1 - \alpha \frac{D_1}{(s-D_1)} (1 - G_u) \right) D_1 + 0.61 e^{\theta \rho_d} \]

- **GC**: Estimated green time at the upstream intersection
- **W**: Estimated green time at the primary intersection
- **D**: Downstream queue-to-bay ratio
- **Q_d**: Estimated green time ratio at the primary intersection
- **Demand**
Full CFI Queue Regression (4)

Type-4 Queue:

\[ \text{Queue} = 0.78 \gamma \frac{(\beta D_t + D_l)(1-G_t) s}{s - (\beta D_t + D_l)} + 5.62 \left( \frac{\beta D_t + D_l}{s - CV_n} \right)^2 \]

- \( W \): Estimated green time at the crossover intersection
- \( D_t, D_l \): through and left-turn demands
- Estimated green time ratio at the crossover intersection
- The ratio between total demand and the remaining capacity at the crossover intersection

For the possible coordination of signals along the through movement, only part of through traffic may stop in the queue. Given by: \( \beta D_t \)
Delay Analysis of CFI-T

\[
\log(D) = 2.316 + 0.049 \frac{X_1}{1 - X_1} + 0.035 \frac{X_2}{1 - X_2} + 0.132\rho_1 + 0.151\rho_2 + 0.213\rho_3 + 0.200\rho_4 + 0.514\rho_5 + 0.196\rho_6 + 0.23\rho_7 + 0.251\rho_8
\]

\[R^2 = 0.897, \quad \text{Sample size } N: 800\]
Delay Analysis of Two-leg CFI

\[
\log(D) = 2.554 + 0.059 \frac{X_1}{1 - X_1} + 0.031 \frac{X_2}{1 - X_2} + 0.033 \frac{X_3}{1 - X_3}
\]

\[
+0.167\rho_1 + 0.177\rho_6
+0.213\rho_4 + 0.245\rho_9
+0.178\rho_3 + 0.201\rho_8 + 0.315\rho_{12} + 0.297\rho_{14}
+0.072\rho_2 + 0.082\rho_7
+0.182\rho_5 + 0.169\rho_{10}
+0.210\rho_{11} + 0.228\rho_{13}
\]
Signal Optimization for CFI

Five Signalized intersections involved in one full CFI network
Signal Optimization for CFI

Compared with conventional traffic networks, a CFI network has its own characteristics:

- (1) only left-turn and opposing through traffic volumes involved in the sub-intersections;
- (2) conflict between left-turn and opposing through traffic volumes has been eliminated at the primary intersection; and
- (3) those intersections are quite close to each other due to the high construction cost of larger footprint.
- (4) the special design of CFI provides a simplified two-phase signal control while also brings some new problems, such as the interaction of queues among neighboring intersections.
Signal timing plan

- **NORTH INTERSECTION**
- **WEST INTERSECTION**
- **MAIN INTERSECTION**
- **EAST INTERSECTION**
- **SOUTH INTERSECTION**
Signal Correlations

The left-turn vehicles have to pass three intersections; The trough vehicles have to pass two intersections.

A good plan to coordinate those signal timings can reduce the delay significantly.
Blockage and Spillback

Correlation between Downstream and Upstream movements

Correlation between parallel Left-turn and Through movements
Critical Issues

- Cycle Length optimization
- Green Ratio optimization
- Offset Optimization
- Integrate geometry constraints
Network Flow Formulation

If the spillback or blockage occur, the oversaturated vehicles would be stored in the traffic flow entry links.
Traffic Queue Modeling

The analysis time period has been divided into a set of discrete time intervals.

Basic Point Queue Formulation:

\[ q_m^{k+1} = q_m^k + A_m^k - D_m^k \]

- \( q_m^{k+1} \): # of Vehs in the queue at time step \( k+1 \)
- \( q_m^k \): # of Vehs in the queue at time step \( k \)
- \( A_m^k \): # of arrival vehs at time step \( k \)
- \( D_m^k \): # of discharged vehs at time step \( k \)

Saturation Flow Rate:

\[ D_m^k = \begin{cases} 0 & \text{During Red Time} \\ \min(s_m \Delta t, A_m^k + q_m^k) & \text{During Green Time} \end{cases} \]
Traffic Flow modeling

For those traffic flow entry link:

$$A_i^k = \lambda_i^L + \lambda_i^{TR}$$

Through-Right turn Volume

Total Arrival Vehs

Left-turn volume

$$D_i^k = D_{im}^k + D_{ij}^k$$

Departing Vehs

Departing Vehs from i to m

Without the occurrence of blockage, the # of arrival vehs would equal to the # of discharged vehs. No traffic queue would accumulated in the entry link.
In order to take blockage into account, we introduce a set of binary variables to indicate the occurrence of blockage.

\[ B_m^k = \begin{cases} 
1 & \text{if } Q_{m}^{k-1} \geq L_m \\
0 & \text{otherwise} 
\end{cases} \]

Available storage space on the link is given by:

\[ N_m^k = L_m - Q_m^k \]
When blockage is happening:

\[ D_{im}^k = (1 - B_m^k)(1 - B_j^k) \min(q_{il}^{k-1} + \lambda_L^k, n_m s \Delta t) \]

If Scenario 1 happen, \( B_m^k = 1 \), then the departure flow form i to m \( D_{im}^k = 0 \);
If Scenario 2 happen, \( B_j^k = 1 \), then the departure flow form i to m \( D_{im}^k = 0 \);
Otherwise, \( D_{im}^k = \min\{\text{total stored left-turn vehicles in i}; \text{capacity of m}\} \)
When blockage is happening:

If Scenario 1 happen (Partially blockage), $B_m^k = 1, B_j^k = 0$ then the departure flow from $i$ to $j$ is computed by:

$$D_{ij}^k = (1 - B_m^k)(1 - B_j^k) \min(q_{it}^{k-1} + \lambda_{TR}^k, n_j s \Delta t)$$

$$+ B_m^k (1 - B_j^k) \phi \min(q_{it}^{k-1} + \lambda_{TR}^k, (n_j - 1) s \Delta t)$$

If Scenario 2 happen (Completely blockage), $B_m^k = 0, B_j^k = 1$, then the departure flow from $i$ to $j$ $D_{ij}^k = 0$;

Otherwise, $B_m^k = 0, B_j^k = 0$, $D_{ij}^k = \min \{\text{total stored left-turn vehicles in } i; \text{ capacity of } j\}$
For the other links

The arrival and departure process are correlated to the upstream and downstream links

\[ A^k_m = D^{k-t}_{up} \]

\( t \): travel time from upstream stop line to the end of queue at link \( m \)

\[ D^k_m = (1 - B^{k}_{down}) \cdot \min(q^k_m + A^k_m, n_m s \Delta t) \]

To indicate if blockage occurs at downstream
Flow merging

Flows from different direction may merge into one lane.

\[ A_m^k = D_{im}^{k-\tau} + D_{jm}^{k-\mu} \]

- \( \tau \): Travel Time from link i to link m
- \( \mu \): Travel Time from link j to link m
Signal Optimization Model

Objective: Minimize the total delay of the entire intersection

\[
\min D = \sum_k \sum_m q^k_m \Delta t
\]

Control parameters, decision variables and constraints

\(C_{\text{Min}}, C_{\text{Max}}\) minimal and maximal cycle length;  
\(g_{\text{min}}\) minimal green time for each phase;  
\(C\) common cycle length of the entire CFI design;  
\(\theta_i\) offset of intersection \(i\);  
\(g_i\) effective green time for \(\Phi2\) at intersection \(i\);  
\(I_i\) sum of inter-green time at intersection \(i\).  

\[s.t.\]
\[C_{\text{Min}} < C < C_{\text{Max}}\]
\[g_{\text{Min}} < g_i < C, \quad \text{for } i=1,2,...,5\]
\[0 < \theta_i < C, \quad \text{for } i=1,2,...,4\]
How to solve it?

- Objective is non-linear function
- The “Optimal” solution is really appropriate for application?

Two-Stage solution algorithm
- 1: MAXBAND Optimization algorithm to provide an initial feasible solution
- II: Adjust this obtained solution to come out the final optimal solution
Stage 1

- Green Ratio Optimization

The green split at each intersection would be calculated based on input volumes and capacity of the intersection.

$$g_i = \frac{\max \{\lambda_{k,i} : k \in V_i\}}{\max \{\lambda_{k,i} : k \in V\} + \max \{\lambda_{k,i} : k \notin V\}}$$

for each intersection $i$. 
Stage 1

How to synchronize those movements and optimize the offsets?

- Some literatures adopt the greedy heuristic method

Those movements with higher demand level would take the priority to be synchronized.

It may yield a local optimize solution when demand differences between movements are small.
To optimize the offsets, a typical phase plan of CFI is:

\[
x_{m,i} = \begin{cases} 
1, & \text{if traffic flow } m \text{ obtain the ROW in } \Phi 2 \text{ at intersection } i; \\
0, & \text{o.w.}
\end{cases}
\]

\text{e.g.: Northbound Left-turn flow and West bound Through flow}

\[
x_{NL,1} = 0; \ x_{NL,0} = 0; \ x_{NL,2} = 1; \\
x_{WT,2} = 1; \ x_{WT,0} = 1;
\]
\[ NL: \quad \theta_i + g_i + w_{1}^{NL} + t_{1,0} = CL + g_0 + w_0^{NL} \]

\[ CL + g_0 + w_0^{NL} + t_{0,2} = \theta_2 + w_2^{NL} + 2CL \]

\[ w_i^{NL} + b^{NL} \leq g_i \text{ for } i=0,1,2 \]
WT: \[ t_{0,2} = \theta_2 + w_{2}^{WT} \]

\[ w_{2}^{WT} + b_{WT}^{NL} \leq (C - g_2) \]
Stage I

\[ \text{Max: } \sum_{i \in V} u_i b^i \]

\[ \text{s.t. } \sum_{i \in V} u_i = 1 \]

Constraints for each movements.

This is a linear programming optimization problem, could be solved efficiently by simplex method.

Output: Common Cycle Length, offsets
Hari (1995) proposed a simplified and efficient method for offset optimization.

Similarly, for each particular intersection, we shift the offset by 1 secs, and check the corresponding total delay:

\[ \Delta D = D^{+1} - D^0 \text{ (or } \Delta D = D^{-1} - D^0) \]

If \( \Delta D < 0 \), the offset would be shift continually at the same direction until the total delay begins to increase; otherwise the offset would be shift in the opposite direction.
In this step, green ratio would be re-optimized based on the given offsets and cycle length;

- Adopt the decomposition approach developed by Heydecker (1955), each intersection is treated individually. The green ratio could be easily re-optimized with the given offsets and cycle length.
Stage II

- Step 1: Start from one sub-intersection, shift the offset and update the new optimal one;
- Step 2: Repeat Step 1 until all the sub-intersections have been re-optimized;
- Step 3: Re-optimize the green times of each intersection; define the current signal plan as $\Phi(k)$;
- Step 4: Check if $|\Phi(k) - \Phi(k-1)| < \delta$; yes, stop; no, go back to step 1.
Diverging Diamond Interchange (DDI)
Diverging Diamond Interchange

The key logic of DDI is to provide efficient navigation for both left-turn and through movements between highway ramps, and to accommodate left-turning movements onto the arterial without using a left-turn bay.
The procedures of the planning stage include the following steps:

- **Step 1:** Identifying all factors contributing to the DDI total delay, including external factors such as demand, and internal factors such as intersection geometric features;
- **Step 2:** Generating a comprehensive set of data set with all identified factors for simulating analysis;
- **Step 3:** Deriving the quantitative relationships between intersection delays and contributing factors;
- **Step 4:** Estimating the impact of queues on the overall intersection performance and developing a set of statistical models for queues length prediction at each critical location within a DDI.
DDI Delay Analysis

\[ \text{Delay} = 2.549 + 0.154 \frac{X_1}{1 - X_1} + 0.149 \frac{X_2}{1 - X_2} + 0.206 \rho_1 + 0.212 \rho_4 + 0.213 \rho_2 + 0.197 \rho_5 + 0.253 \rho_3 + 0.251 \rho_6 + 0.201 \rho_7 + 0.217 \rho_8 \]

Congestion level of intersections

Queue-to-bay ratio of each location

\( X_1 \) and \( X_2 \)
Type-1 Queue:

\[
\text{Queue} = 0.64 \frac{D_t (1-G_t)s}{s-D_t} + 5.14 \left( \frac{D_t}{s-CV} \right)^2 + 1.72e^{4\rho_d}
\]

- **Deterministic queue** determined by demand and estimated green ratio
- **Downstream queue-to-bay ratio**
- The ratio between demand and the remaining capacity of the target intersection
DDI Queue Regression (2)

Type-2 Queue (Left-turn or Right-turn):

\[
\text{Queue} = 0.73 \frac{D_t (1-G_t) s}{s-D_t} + 5.54 \left( \frac{D_t}{s-CV} \right)^2
\]

Deterministic queue determined by the demand and estimated green ratio

The ratio between the demand and the remaining capacity of the target intersection
Type-3 Queue:

\[
\text{Queue} = 0.61 \gamma \frac{(\text{D}_t + \text{D}_l)(1 - G_t)s}{s - (\text{D}_t + \text{D}_l)} + 5.62 \left( \frac{\text{D}_t + \text{D}_l}{s - \text{CV}_n} \right)^2
\]

The ratio between the demand and the remaining capacity of the target intersection.

Deterministic queue determined by the demand and estimated green ratio.
Signal Optimization for DDI

- Due to the unique geometry features, a DDI typically has two signalized intersections, controlled with two-phase signals.

Note: $\Phi_1$ and $\Phi_3$ denote the yellow time and all-red time.

To optimize a DDI’s signal timings, one shall concurrently address the following three issues: green split at each intersection, cycle length, and offset.
Green Split Optimization

- One important issue for signal design is to maximize the capacity of an intersection given the geometric layout.
- Based on the assumption that traffic demand matrix can be multiplied with a common flow multiplier $\mu$ to represent the maximum amount of volume increased that would still allow the intersection to perform reasonably well.
- The optimization problem is becoming an issue of determining the maximum multiplier $\mu$.

Apply a multiplier $\mu$ to the demand pattern
Green Split Optimization

- With the increased demand, the flow conservation constraints could be set as:

\[ q_j = \sum_i \mu \beta_{ij} Q_i \quad \forall i, j \]

Where \( Q = \{Q_i; i \in N_T\} \) denotes the traffic demand of the entire DDI; \( q_j \) is the assigned traffic flow (multiplied by \( \mu \)) on lane group \( j \); a set of binary variables \( \{\beta_{ij}\} \) are used to indicate the resulting traffic assignment:

\[
\beta_{ij} = \begin{cases} 
1 & \text{if flow } i \text{ is assigned to } j \\
0 & \text{otherwise}
\end{cases}
\]

For Example:
\[ q = \mu Q_1 + \mu Q_2 \]
Green Split Optimization

- Two kinds of DDI design

  - For those DDIs with “left-turn only lane”, the left-turn on-ramp volume is allowed to move continuously without any signal delay.
  - For those DDIs without “left-turn only lane”, the through traffic queue may block the entry of the on-ramp.

Therefore, for those DDIs without a “left-turn only lane”, the left-turn volume is multiplied by a parameter $\gamma_i$ and equivalently converted to through volume during the optimization process.
Green Split Optimization

- Based on the same assumption as mentioned above, the following constraints should be satisfied to ensure that the degree of saturation in each movement is below the maximum acceptable limit:

\[
q_j \leq s_j \sum_m \sum_n \alpha_{mnj} g_{mn} \quad \forall j
\]

Assigned flow < saturation flow rate * total obtained green time

\[
\alpha_{mnj} = \begin{cases} 
1 & \text{if } j \text{ obtains its right of way in phase } m \text{ at intersection } n \\
0 & \text{otherwise}
\end{cases}
\]

\[
g_{\text{min}} \leq g_{mn} \leq 1 \quad \forall m, n
\]
Green Split Optimization

Thus, one can present the optimization model as follows:

Maximize $\mu$

S.t.

$q_j = \sum_i \mu \beta_{ij} Q_i \quad \forall i, j$

$q_j \leq s_j \sum_m \sum_n \alpha_{mnj} g_{mn} \quad \forall j$

$g_{mn} \leq 1 \quad \forall m, n$

$\sum_m g_{mn} = 1 \quad \forall n$
Cycle Length and Offset Optimization

Second step is to optimize the cycle length and offset between two intersections. MAXBAND model is adopted in this step.
Cycle Length and Offset Optimization

- Similar to the MAXBAND model in CFI, a set of constraints are given by:

For the inbound direction (East to West)
\[
\begin{align*}
\theta + w_{NL} + b_{NL} + t_{in} & \leq N \\
\theta + g_{E} + w_{WT} + b_{WT} + t_{in} & \xi \leq (N + 1) \\
w_{NL} + b_{NL} & \leq g_{E} \\
w_{WT} + b_{WT} & \leq 1 - g_{E}
\end{align*}
\]

For the outbound direction (West to East)
\[
\begin{align*}
w_{ET} + b_{ET} + t_{out} & \leq \theta + N \\
\theta + g_{W} + w_{SL} + b_{SL} + t_{out} & \xi \leq \theta + N \\
w_{ET} + b_{ET} & \leq g_{W} \\
w_{SL} + b_{SL} & \leq 1 - g_{W}
\end{align*}
\]
Cycle Length Optimization

- Delay increases rapidly when the CL is below the optimal CL (Co);
- Exact CL not critical as long as not less than Co;

To minimize the delay, Webster formulated an equation:

\[
C_{\text{webster}} = \frac{(1.5 \times \text{LostTime} + 5)}{1.0 - CLV / s}
\]

Then the range of cycle length (a constraint for the MAXBAND Model) is:

\[
C_{\text{webster}} \leq C \leq C_{\text{webster}} + \Delta C
\]

\(\Delta C\) is the given constant, and \(C_{\text{webster}} + \Delta C\) indicates the upper bound of CL.
Thus, the objective function is:

\[ \text{Max} : \sum_{i \in \cal{V}} \varphi_i b_i \]

S.t.
\[
\begin{align*}
\theta + w_{NL} + b_{NL} + t_{in} & \leq N \\
\theta + g_E + w_{WT} + b_{WT} + t_{in}^\xi & \leq (N + 1) \\
w_{NL} + b_{NL} & \leq g_E \\
w_{WT} + b_{WT} & \leq 1 - g_E \\
w_{ET} + b_{ET} + t_{out} & \leq \theta + N \\
\theta + g_W + w_{SL} + b_{SL} + t_{out}^\xi & \leq \theta + N \\
w_{ET} + b_{ET} & \leq g_W \\
w_{SL} + b_{SL} & \leq 1 - g_W \\
C_{\text{webster}} & \leq C \leq C_{\text{webster}} + \Delta C
\end{align*}
\]
Maryland Unconventional Intersection Design
Step 0: Start

UNCONVENTIONAL INTERSECTION OPERATION ANALYSIS TOOL

Version 2.0
Step 1: Create a new case for analysis

Click “Full CFI” to select the design.
Step 2: Input Demands

Change the demand settings of the intersection
Step 3: Edit Geometric Parameters

Change # of lanes, link Length

The selected link would be highlighted for convenience.
The display of intersection changed according to the input.

Buttons enable now.
Rotate the figure clockwise (counter-clockwise)
Change the figure color and background color
Step 4: Planning Analysis

Planning Analysis result (Queue length, QL Ratio, CLV)

Buttons enable now

Queue Length and QL Ratio

Saturation Flow Rate: 1700

CLV

Average Delay: 22.543
Step 5: Signal Optimization

Optimization for cycle length, green split and offset
Output Functions

Display demands
Output Functions

Display link length
Output Functions

Display Phase Plan
Output Functions

Display Queue Length
Output Functions

Display Queue-to-bay Ratios
Output Functions

Display Signal settings
Other Designs

User can perform analysis of different design at the same time
Other Designs
Thank You!