The Marriage of Roundabouts and Access Management

A TRB Webinar for Professional Development: Organized by the TRB Standing Committee on Roundabouts. TRB Registered Continuing Education Program

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Denver, Colorado
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What is Access Management

- The management of the location and design of access points on any street or highway.
- Includes driveways and intersections
- Objective: to reduce conflicts between vehicles and between travel modes
Access Control is Based on Hierarchy

- Access management should vary with roadway importance
- Arterials are important
- Location and design standards can be more flexible with lower speeds
- How much access related turbulence can your roadway tolerate and still perform well?
Why Access Management?

- Over 55% of ALL crashes on arterials are access related.
- Urban areas can be higher, 65 to 75%
- Direct correlation between access frequency and crash rates.
- Improves capacity

From NCHRP 420
Every Access Point is Fundamentally a Safety Problem

- Allowing a driveway, any access connection, is a decision to diminish public safety and roadway performance.
Two basic principles to apply to all design and traffic control decisions:

- Make choices that reduce the conflict rate experienced by travelers, and
- Reduce the potential severity of the conflicts that are allowed.

Apply this strategy to all design analysis and alternative comparisons.
What do we mean by roadway “Conflicts”? 

- Where paths cross, diverge or merge are considered potential conflicts.
‘Conflict Rate’
When you travel, do you experience 1,000 potential conflicts per mile? or 100?

Demosthenes

From Google
In its simplest form, Access Management is Conflict Management

- If you reduce the rate and severity of conflicts the motorist encounters, you will reduce the crash rate, the injury rate and increase the smooth flow of traffic.

Source: Florida DOT
Not all conflicts are the same

22 crossing conflicts
The “kill zone”

8 merging
8 diverging conflicts

Graphic from Teachamerica and Florida DOT
The Foremost Access Management Technique – Non-traversable Median

- It eliminates the Kill zone, restricts left turns

Graphic from Teachamerica and Florida DOT
• Roundabouts eliminate the kill zone
• 24 angle conflicts for 2 lane RBTs
• 8 angle conflicts for single lane RBTs
Another AM Principle

Proof of Necessity

- Every access point contributes to crash potential
- Is the access really necessary?
  - Is “convenience” a necessity compared to safety?
- Is the location the best for the public?
- Has the least potential harm to the public?
- There is no property right to cause harm
Bird Rock San Diego Before Roundabouts
5 New Roundabouts, new median, keep on-street parking. The Marriage – elimination of left turns from all access connections – no driveway closures
The Pairing of Access Management (medians) & Roundabouts has the greatest reduction in crash rates and accommodates all modes of travel.
Edwards, Colorado (along I-70)
Almost every roundabout installation is a retrofit situation.
Apply principles: Necessity? Eliminate lefts. Separation
Then, apply AM principles to your plans. Necessity? No left turns, Spacing (low conflict rate)
Some full movement left turn conflicts – the most dangerous intersections on Golden Road
Before two roundabouts – all access connections have left turns
Driveways near a busy collector intersection – all full movement
No turn restrictions, yet this is a higher volume residential collector

From Google
Questions

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AM is preserving capacity, safety, performance according to functional purpose. Hierarchy of AM standards by function.

- Principals. Necessity, use turn lanes to reduce speed differential problems
- Reduce conflicts – especially severe types – eliminate left turns.
- Spacing, separation of conflict areas to reduce driver work-load
- Allowing left turn access is adding conflicts you just removed
- Close spacing compromises the principles and increases the crash potential while also increasing potential for operational problems
- Left turns are the big problem. RBTs and Medians are excellent strategies because:
  - 1. removal of left turns and severe injury potential.
  - 2. Eliminates left turn queues, no need for a lane width median (more for peds and bike paths), and no risk that queue storage is too short.
- If a right turn – the further, more corner clearance; – the better.
- Right turns don’t kill motorists – but they can injure pedestrians and cyclists.
RBT, Road Diet, AM, Ped & Bike paths
(Avon Colorado)
Best Resource for Information on Access Management

Access Management Manual

www.accessmanagement.info

TRB Committee on Access Management
The Marriage of Roundabouts and Access Management

Ken Sides, P.E, PTOE, CNU-a

Sam Schwartz Engineering

Transportation Research Board

National Academy of Sciences

Tampa, Florida, September 26, 2016
Transportation Engineering Graduate Program
Parking lot entrances = A-OK
The Acacia Roundabout …

…opened in December, 2001
Transit = A-OK
Angle parking = A-OK
Crosswalk at d/w = A-OK
Driveway = A-OK
J.F. Kennedy Middle School with New Low-Speed Modern Roundabout
Dismissal Observation 8/27/03

Schools = A-OK
63 K-12 School Roundabouts in the USA
A-OK to trade d/w for corner clip
Splitter island at grade = A - OK
Intersection Queue Blues
Intersection Queue Blues

- Volume
- Queues
- Access
- Customers
- Investment
Five Points Roundabout

Before
Five Points Roundabout
Downtown Asheville

Let's count lanes!
Downtown Asheville, NC

A lot of lanes
Downtown Asheville

18 Lanes
More green, more beauty downtown, ped friendly
More parking, more access, more biz-friendly
Downtown Asheville, NC

18 lanes ➔ 8 lanes

Downtown roundabouts = A-OK
Downtown Sarasota, FL
Downtown Sarasota, FL
Golden, CO

Big box retail corridor
> access management <

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<td>Crashes</td>
<td>60%</td>
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<td>Injuries</td>
<td>96%</td>
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Retail sales revenue

- Still some left turn conflicts
- Left-turners cross two opposing lanes, disrupt traffic flow
- The classic crash scenario for older drivers

Crashes - 60%
Injuries - 96%
Eliminate median gaps
- Eliminates left-turns
- Eliminates left-turn conflicts

Add green for aesthetics, to attract customers and investment

Golden, CO

Big box retail corridor
Mt. Pleasant, SC
Johnnie Dodds Boulevard master plan
Johnnie Dodds Boulevard

Action Plan

Dover, Kohl & Partners
Hall Planning & Engineering
ZHA Inc.

February 2006
The plan supports managed speeds increasing pedestrian and vehicular safety
Why Is Access Management Necessary?

Failure to manage access is associated with the following adverse social, economic, and environmental impacts:

- Increased numbers of vehicle crashes;
- More collisions involving pedestrians and cyclists;
- Accelerated reduction in roadway efficiency;
- Unsightly commercial strip development;
- Degradation of scenic landscapes;
- More cut-through traffic in residential areas, because arterials are overburdened;
- Homes and businesses adversely affected by the widening of roads; and
- Increased commuting time, fuel consumption, and vehicle emissions, as driveways and traffic signals intensify congestion and delay along major roads.

Roundabouts can mitigate or eliminate these adverse impacts.
The 10 Principles of Access Management

1. Provide a Specialized Roadway System
2. Limit Direct Access to Major Roadways
3. Promote Intersection Hierarchy
4. Locate Signals to Favor Through Movements
5. Preserve the Functional Area of Intersections and Interchanges
The 10 Principles of Access Management

- 6. Limit the Number of Conflict Points
- 7. Separate Conflict Areas
- 8. Remove Turning Vehicles from Through Traffic Lanes
- 9. Use Nontraversable Medians to Manage Left-Turn Movements
- 10. Provide a Supporting Street and Circulation System
Suitability Checklist

- Intersection establishments get access – Finally!
- Driveways into roundabouts are OK
- Continuous medians are practical
- Continuous parking OK, even angle parking
- Green attracts customers, investment
- Fewer worries about signal spacing, signals for shopping centers
- Quiet, fume-free corners can be vital again
Ken Sides, PE, PTOE, CNU-a

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Are Roundabouts Right for Older Users?

USA Population

12.5% 65 and older
16% Younger than 16
3-5% Can’t, won’t, or choose not to drive
¼ - 1/3 of US population not in driving prime
I. Demographic Trends

Older users are becoming more numerous

• The segment of the population aged 65 and older grew nearly twice as fast as the total population between 1990 and 2000.

• The size of the older generation is projected to double over the next 30 years.

• Americans aged 85 and older are the fastest growing part of the population.

• By 2020 one in five people will be aged 65 or older.

• By 2020, the 85\textsuperscript{th}ile design driver will be someone aged 65.
And older roadway users are at increasing risk …

- Between 1991 and 2001 crashes involving at least one older driver increased 20 percent.
- And the number of Americans aged 70 and older killed in traffic crashes increased by 27 percent.
Older users are especially at risk at intersections

- 38% of pedestrian deaths among people aged 65 and older occurred at intersections (in 1988)
- Older drivers are about twice as likely as younger drivers to be killed while driving through an intersection.
- Drivers 85 years of age and older are more than 10 times as likely as drivers in the 40-49 age group to have multi-vehicle intersection crashes.

“There is agreement that elderly road users require mobility, and that they should be accommodated by the highway’s design and operational characteristics to the greatest extent practicable. Thus, designers and engineers should be aware of the problems and requirements of the elderly, and consider applying applicable measures to aid their performance.” — AASHTO Green Book
AASHTO Green Book: “An appreciation of driver performance is essential to proper highway design and operation.”

Performance profile of older roadway users

Compared to their younger selves:

- **Diminished visual acuity**, the ability to discriminate high-contrast features

- **Yellowing of our eyes’ lenses and increased density**, which makes it harder to see in low light conditions

- **Diminished contrast sensitivity**, which makes it harder to distinguish an object from its background. Also, persons over 60 have an increasing risk for developing cataracts and other conditions that reduce contrast sensitivity.
Increased sensitivity to glare, which makes it harder to see in the presence of oncoming headlights, at night, or in the presence of sun glare in the daytime. Glare introduces stray light into the eyes; it reduces the contrast of important safety targets.

Slower dark adaptation, which makes it harder to see targets when moving from areas of light to dark.

Loss of limb strength, flexibility, sensitivity and range of motion, needed for tasks such as rapidly shifting the right foot from the accelerator pedal to the brake pedal or arm movements to steer around obstacles.
Especially Relevant to Intersections

- Narrowing of the visual field, which diminishes the ability to see objects in the periphery, such as signs, signals, vehicles, pedestrians and cyclists.

- Restricting of the area of visual attention, which diminishes the ability to see potential conflicts in the periphery and to discriminate relevant from irrelevant information.

Both abilities are necessary for responding quickly and appropriately to a changing traffic scene. Restrictions in the area of visual attention can lead to “looked but didn’t see” crashes, where a stimuli can be detected, but cannot be recognized and understood sufficiently to permit a timely response.
Especially Relevant to Intersections

- Decreased motion sensitivity, which diminishes the ability to accurately estimate closing speeds and distances and is needed for judging gaps to safely perform left turns at conventional cross intersections with oncoming traffic or to cross an intersecting traffic stream.

- Decline in selective attention, the ability to filter out less critical information and continuously re-focus on the most critical information, such as detecting a lane-use restricted message on an approach to a busy intersection or detecting a pedestrian crossing while watching oncoming traffic to locate a safe gap.
Especially relevant to intersections

- Decline in divided attention, the ability to perform multiple tasks simultaneously and process information from multiple sources
- Decline in PRT (perception-reaction time), the time required to perceive a situation, evaluate it, decide what response is appropriate and make a vehicle control action such as steering or braking. PRT increases disproportionately for older motorists with increase in complexity of the driving situation.
- Decline in working memory, the ability to store, manipulate and retrieve information for later use while driving
- Loss of head, neck and trunk flexibility, needed to rapidly glance in each direction from which a vehicle conflict might be expected when approaching an intersection
What Older Users Need

An older-friendly intersection provides

• More time to perceive and evaluate situations, more time to make decisions, and more time to take action

• Reduced demands to accurately judge gaps in fast oncoming traffic

• Less complicated situations to interpret

• Reduced demands to quickly perform wide visual scans of rapidly changing situations
The END
Marriage of Access Management & Roundabouts

Case Studies

Mark T. Johnson, P.E.
MTJ Roundabout Engineering

- City of Loveland CO 1994-1998
- Consulting Firm 1998-2001
- Key Contributor to WIDOT Roundabout Design Program 2001 - 2005
- Co-Author of FHWA 2010 Roundabout Guide
- FHWA Authorized P2P Reviewer
Access Management with Roundabouts

Learning Objectives

– Discuss the **Operational Characteristics of Roundabouts** vs Signals & How this effects access decisions

– Review 5 State/Cnty Trunk Highway **projects examples** that facilitated Access Management Solutions with Roundabouts w/o detrimental effects to roadway operations/safety

– Illustrate Application of **Principles** to include:
  • Evaluation of Context
    – Speeds, Volumes, ingress egress flows
  • Traffic, Roadway and Roundabout Engineering
  • Together with Access Management Principles
Access Management with Roundabouts

Operational Characteristics of Roundabouts:

- Slower / Consistent Speeds & Less Q’ in Functional areas
- No Progression = Intersection/Access Spacing Versatility
- Less roadway/structure widths = fewer impacts to surrounding properties = reduced costs
- Balance access with Thru-Put
  - U-turn, left turn same Priority as thru movement

Huffman Road Corridor, Anchorage, AK
Access Management with Roundabouts

Intersection/Access Spacing

- No progression required
- No Q spill back between roundabouts

Opened in 1997
Mark Johnson was the Project Manager for City
Access Management with Roundabouts
Example #1

STH 78/92 (Main Street)
Village of Mt. Horeb, WI

Design and Analysis by Mark T Johnson
Alternatives Evaluation

Signalized Roundabout

Access Management with Roundabouts

Flared Entry, Hybrid Design
Constructed in 2004
Less than 8 PDO's/Year over 5 years of data
Access Management with Roundabouts

28k ADT
2 Lane x-section  2-Lane Flared Entries x 1

~35k ADT
4 Lane x-section, 2x 1 roundabouts
Example #2

STH 119 / CTH Q (Main Street)
Village of Waunakee, WI

Roundabout Design and Analysis by MTJ Roundabout Engineering

Project Team:
Wisconsin DOT
One Source Consulting
Alternatives Evaluation

4-Lane Widening - Signal

3-Lane section with 2-Lane Flared Entry Roundabout
Alternatives Evaluation

See video at:
https://youtu.be/psxlqc89dXE
Access Management with Roundabouts

Reduced Congestion,
fewer impacts, business vitality,
maintain on-street parking thru Downtown area
Access Management with Roundabouts

Reduced Congestion,
fever impacts, business vitality,
maintain on-street parking thru Downtown area
Example #3

South Towne Dr. / Industrial Dr.
Monona, WI

Design and Analysis by MTJ Roundabout Engineering
Proposed Super Center
225,000 sq ft.
$30M Project
Vacant Land Assessed @ $6M

Full or LT Access
Precluded by proximity to signal

Proposed Super Center
225,000 sq ft.
$30M Project
Vacant Land Assessed @ $6M

Equal Priority: U-turn, left turn same priority as thru movement
Business Access on Roundabouts

Equal Priority: U-turn, left turn same priority as thru movement
Two-lane approach
Two Lane Entry

One-lane approach
Flared Two-Lane Entry

135' ICD

Photo: MTJ
Example #4

STH 83 USH 18
Wales, WI - Waukesha County

Design and Analysis by MTJ Roundabout Engineering
Alternatives Evaluation
Alternatives Evaluation

70,000 sq. ft. Mixed Use Commercial Retail Development

- 600'
- C-Store
- Bank
- Grocery Store
Alternatives Evaluation

70,000 sq. ft. Mixed Use Commercial Retail Development
Alternatives Evaluation

70,000 sq. ft. Mixed Use Commercial Retail Development

600'
Access Management with Roundabouts
Access Management with Roundabouts

Business Access

Photo: MTJ
Access Management with Roundabouts

- 125’ ICD
- Short Flared Two-Lane Entry
- Single-Lane Entry
- Aux RT Lanes (two types)
Access Management with Roundabouts

- 155' ICD
- Short Flared Two-Lane Entry
- Single-Lane Entry
- Aux RT Lanes (two types)
Interchange Case Studies

STH 83 USH 18
Wales, WI - Waukesha County

Roundabout Design and Analysis by MTJ Roundabout Engineering
US 23 Lee Road City of Brighton MI
Access Management with Roundabouts

600,000 square foot mixed retail development, ‘Green Oak Village Place

Roundabout Design and Analysis by MTJ Roundabout Engineering

Project Team:
MI DDOT
Livingston County
Parsons Consulting
Summary Operational Characteristics of Roundabouts:

- Slower / Consistent Speeds & Less Q’ in Functional area
- Intersection/Access Spacing Versatility - No Progression
- Equal priority for all movements – U-turn, left turn same as Thru movement
- Maintain Integrity of Arterials with less roadway/structure widths fewer impacts to surrounding properties
- Balance Mobility and Access
Thank You / Questions

MTJ Roundabout Engineering

Mark T. Johnson, P.E.
MTJ Roundabout Engineering

- Key Contributor to WIDOT Roundabout Design Program 2001 - 2005
- Co-Author of FHWA 2010 Roundabout Guide
- FHWA Authorized P2P Reviewer
City of Norwich

- “Rose of New England”
- Population just over 40,000
- City Council-Manager Government, Mayor is on Council
Typical Conditions
Route 82

- Four lane, undivided road
- No left turn lanes (except at New London Tpke.)
- 2040 projected ADT: 32,100 (west), 27,400 (east)
- Moderate pedestrian, low bike volumes, transit route
- Conflicting needs – arterial traffic, local access
Curb Cut Issues

- Number and close spacing lead to conflicts
- Left turns in
- Left turns out
Crash History

Locals call the road “Crash Alley”

- Average of 11 crashes per month
- Average of 4 injuries per month
- Typical crashes at signalized intersections
- 9 locations on DOT’s list of high crash rate locations (7 are between signals)
- 37% of all crashes occur at non-signalized driveways and side streets—primarily left turns
Typical Crashes at Driveways
Operational Issues

- Violations of current left turn prohibitions
- Congestion at 7 existing traffic signals
- Drivers avoid area due to congestion, safety
- Multiple problems due to lack of left-turn lanes
Route 82 Westbound

Three cars waiting to make left turn into driveway

Left-turning car crossing centerline to see oncoming traffic

Truck swerving to right lane to avoid queued left-turning cars
Alternatives Considered

Safety projection using Interactive Highway Safety Design Model (IHSDM) looked at:

• Widen Route 82 to 5 lanes, provide Two-Way Left Turn Lane (TWTL)
• Median with signals
• Median with roundabouts – **only option that showed a reduction in crashes**
2015 Concept Plan
Access Management

Raised median on Route 82:

- Consolidates left turns at controlled locations
- Substantially reduces turning crashes at driveways
- Reduces congestion and conflicts caused by left-turning vehicles “freezing” the left lane
2015 Concept Plan
Roundabouts

Signals replaced with roundabouts:

– Safer than signals
– Traffic calming (15-20 MPH)
– Creates pedestrian/bike friendly environment
– Aesthetic enhancement opportunities
– More efficient than signals
– Allows east half to be reduced to 2 lane road
– Accommodates U-turns better than signals
2015 Concept Plan
2015 Concept Plan – East Half

- Single Lane Roundabouts
- Raised Median
- 2 lanes (1 in each direction) Road Diet
2015 Concept Plan
2015 Concept Plan – West Half

“Hybrid” 2X1 Roundabouts

Raised Median

4 lanes (2 in each direction)
Bold Approach

• Raised Median:
  – Restricting access to/from businesses always controversial

• Roundabouts:
  – Still considered “new” in Connecticut
  – Half are not simple single lane roundabouts
  – First roundabout corridor in the state

• Anticipated opposition from business owners and customers

• Expected pushback from City officials
Public Involvement

Met with:

• Mayor, City officials, Regional Planning Agency (several times)
• Chamber of Commerce (about 30 business owners)
• Public
• City Council (twice)
• Public Safety Committee
Public Reaction

• City officials, Police, RPA: strong support
• Business owners and residents: surprisingly positive overall, some strongly opposed
• More concern about the roundabouts than the medians
• Consensus that crashes need to be addressed, not all convinced that roundabouts are safer
Roundabouts and Safety

Safety Benefits:

IIHS study:

- 39% reduction in crashes
- 76% reduction in injuries
- 90% reduction in fatalities
- 30% reduction in pedestrian crashes

Some in the public still skeptical, wanted local examples
2013 National Roadway Safety Award
for Killingworth, CT Roundabout

50% Reduction in Crashes
78% Reduction in Injuries
Salem Roundabout

- Located on Route 82, next town, about 10 miles away
- Roundabout replaced signal
- Crashes reduced from 24 per year to 6 per year (**75%** reduction)
- Injuries reduced from 9 per year (included one fatal) to <1 per year (**93%** reduction)
Salem Roundabout

• Bonus: Congestion virtually eliminated

Before: Signalized

After: Roundabout
Bumpy Road to Approval

- Town Council asked to approve design initiation
- Became political - Mayor’s party lost majority rule on Council before proposal was brought up
- Council’s initial reaction was skeptical, but they kept an open mind, agreed crashes needed to be addressed
- Second presentation to Council, met with Public Safety Committee
- Third Council meeting – vote was 5-2 in favor!
- Preliminary Design has begun
Lessons Learned (so far)

• Public understood the need to address the problem
• Support from City officials, especially Community Development leader and Police Chief, was crucial
• Medians less of an issue than roundabouts
• National statistics help, but local successes more impressive
• Willing to meet and discuss with anyone, anytime
Transforming “Crash Alley”