2023

WSDOT - Transportation Planning Intern

Sean Hakala
Western Washington University

COLLEGE OF THE ENVIRONMENT

Internship Title: Transportation Planning Technician 1

Organization Worked For: Washington State Department of Transportation

Student Name: Sean Hakala

Internship Dates: 9/28/22 6/30/23

Faculty Advisor Name Tammi Laninga

Department UEPP

STUDENT SIGNATURE Sean Hakala Digitally signed by Sean Hakala Date: 2023.06.09 14:17:19 -07'00'

DATE: 6/9/23

I. STUDENT/INTERN INFORMATION
NAME: Sean Hakala
MAJOR: Urban Planning and Sustainable Development CONCENTRATION: Native Planning Specialization
INTERNSHIP TITLE: Transportation Planning Technician 1, WSDOT
PERIOD OF INTERNSHIP: Sep. 28 2022 – June 30 2023
AVG. HRS. PER WEEK: 10-15 TOTAL HRS. WORKED: Over 120 over the two quarters being registered for credits

II. HOST INSTITUTION INFORMATION
INST. NAME: Washington State Department of Transportation
INST. ADDRESS: 310 Maple Park Avenue SE P.O. Box 47300 Olympia, WA 98504-7300
INST. MISSION: "We provide safe, reliable and cost-effective transportation options to improve communities and economic vitality for people and businesses." (WSDOT Strategic Plan)
SUPERVISOR NAME: John Milton SUPERVISOR TITLE: Director of Transportation Safety and Systems Analysis
SUPERVISOR CONTACT INFORMATION: MiltonJ@wsdot.wa.gov; 360-704-6363

III. INTRODUCTION
My role in my internship is to be a researcher for John Milton. My assignments have been to investigate anything that he is interested in with regards to safety, particularly with a lens of looking at what other states or countries have done regarding the specific topic of inquiry, as well as what academic writing is available on the topic. Transportation Safety and Systems Analysis is a department of the Division of Multimodal Development and Delivery, which deals with all different divisions of modes of transportation, project development, construction, maintenance, and multimodal planning.

IV. DESCRIPTION OF DUTIES AND RESPONSIBILITIES
It was my duty to research the topics which John Milton assigned to me and write reports summarizing my findings. This includes my interpretation of the findings and how I believe the findings should influence WSDOT policy, where appropriate. Though the position was advertised as hybrid I did all of my work remotely. The only time I went to Olympia was to pick up my computer, keyboard, and to verify my passport in person. John and I met on teams to discuss next steps between every two weeks to every month. I discuss the main projects below.

V. OUTCOMES

To date I have worked on three research projects, one of which is still currently underway.

The first was researching international precedents regarding the design of roundabouts for the inclusion of vulnerable road users. I produced two written reports for that project, those being a preliminary overarching literature review and a final summary of findings and recommendations, respectively. After that I produced a PowerPoint for a presentation to a committee which at the time of writing has yet to occur. The first version I submitted was sent back for revision to change the writing style to be more appropriate for an official presentation by removing language which could be construed as opinion or as subjective judgements of good vs. bad.

The second project was a review of the Intersection Control Evaluation procedures of as many states as I could find to recommend possible changes to Washington State's own procedure. For that project I submitted a final notes document and an excel document comparing the different policies based on their general quality (Regressive, Standard, Progressive, or Radical) and the breadth of their applicability (Narrow-Broad). As a part of the project I also reviewed Washington's Healthy Environment for All (HEAL) Act and made some recommendations for opportunities to align the state's policy with that piece of legislation.

The project I am currently working on is to find information about European speed management programs on roads with speed limits above 30 MPH. This project is hitting a dead end because I have not been able to find much information about such programs, if they even exist, and I am guessing that this project will either be cut short or shift in a new direction to focus on more fruitful endeavors.

VI. ASSESSMENT

I believe my most successful project has been the one concerning inclusive roundabout design because I spent the most time on it and produced a result which I am very proud of and that I believe was researched thoroughly. I have heard through the grape vine that other areas of the Transportation Systems and Safety division have been looking at the final presentation which I created for that project and have been interested in doing something with my work.

My contribution to all of the projects which I have worked on has been completely my own, as I have been working alone. Thereby, the outcome of the research projects begins and ends completely with me. All of the projects which I have worked on, but especially the one concerning inclusive roundabout design, have advanced the ability of the division within which I work to carry out the safety portion of WSDOT's mission.

I have gained a lot of skills regarding research which I have been using in my academic affairs, and will continue to use in whatever professional career I enter later. I have become practiced with file management, effective and efficient note-taking, and appropriate and effective communication of the results of research. I believe that my time management has also improved because of having to balance this internship, my Student Senate position, and my academic responsibilities.

Appendix:

Traffic Levels and Associated Treatments Report
Bicycles at Roundabouts Presentation Revised
Roundabout Report Outline First Draft (page 1)
Roundabout Report Second Outline (page 1)
ICE Policy Comparison (charts)
ICE Policy Notes Document (page 1)

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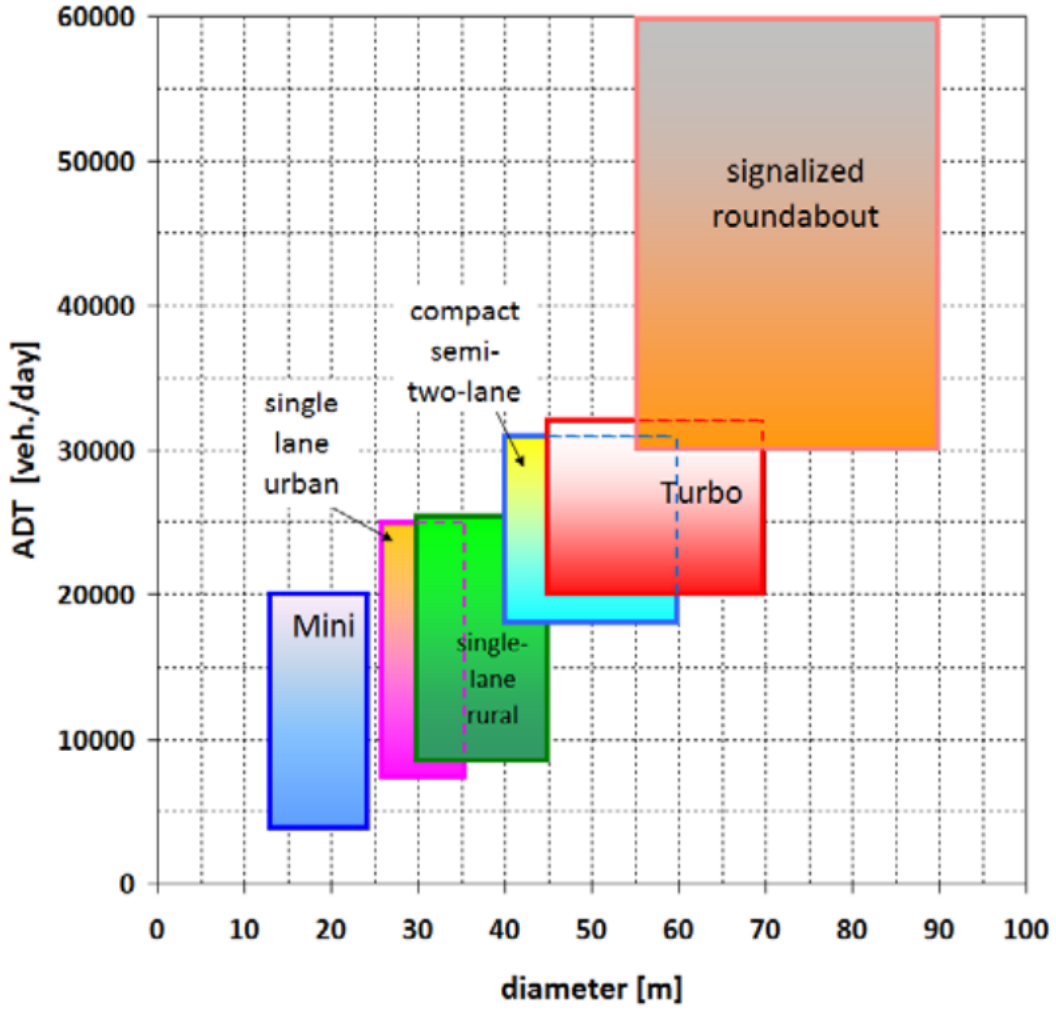
11/22/2022
Third Roundabout Report

Brilon 2005 (Somewhat old)



Brilon 2005

1. Mini
    a. No facilities, no flaring
2. Compact Single Lane
    a. 7,500-25,000 ADT
    b. Radial design
    c. Single lane entrances and exits only
    d. Cycle track ought to be at least 4 if not 5 meters behind entrance/exit to allow proper sight for entering/circling vehicles.
    e. Urban
        i. One-way cycle track
        ii. Cycle priority
        iii. Inscribed diameter between 26 m (better: 30 m) and 45 m
        iv. No cycle tracks recommended for any roundabout busier than 15,000 ADT

    f. Rural
        i. Two-way cycle tracks more common
        ii. Vehicle priority
        iii. Inscribed diameter between 30 m and 50 m
3. Compact Semi-Two Lane
    a. Typology not typically seen in America
    b. Single wide lane used as double lane by passenger vehicles and single lanes by wide-tracking vehicles like busses and trucks
4. Turbo
    a. Single lane on exit can handle up to 1,500 veh/h (30-35,000 ADT).
    b. Recommendations for bicycle accommodations Fortujin 2009

<u>DCE Knowledge Video (Informed by CROW Manual 2017)</u>

- Single Lane Roundabout with segregated cycle track has maximum vehicle capacity of 25,000 motor vehicles/day
- Priority is determined urban vs. rural
- At least 5-6 meters between circulating lane and cycle track

<u>Austroads Guide to Road Design 2021 Part 4B: Roundabouts (Aumann 2021)</u>

- 4 contextual considerations when designing cycle treatments (p. 51)
    - Daily vehicle traffic volume and peak hour flows
    - Proportion of cyclists in the total traffic flow
    - Functional classification of the roads involved
    - Overall traffic management strategies for the location
- No facilities
    - 20 km/h (12 mph) entry speed specified
    - Geometric design guidance about how to achieve this low speed is still being developed, but vertical displacement is specifically mentioned as a possible tool.
    - Entrances if possible should be less than 3 m wide to prevent drivers from squeezing cyclists into the curb (p. 53)
    - Should be in the context of roads with 30 km/h (20 mph) speed limit and low volume (<3,000 vpd)
- Shared paths
    - Only recommended for situations where low volumes of cyclists and pedestrians are expected.
- Multi-lane roundabouts
    - Speeds must be reduced to 30 km/h and if that cannot be achieved separated facilities are to be provided. If vehicles can track across lanes it is impossible to achieve 30 km/h.
- General design
    - Reverse curves only recommended on roads where approaching speeds are expected to be ≥ 80 km/h (50 mph).

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Third Roundabout Report

    - Layout of entrances in Australian standards are tangential (curved into the circle as opposed to straight in) but use significantly tighter entrance widths than American standards.

Sight Lines

- Too little visibility and too much visibility are both bad for bicyclist safety. (Wilke et al. 2014)
    - Turner et al. 2009
    - Campbell et al. 2012
- Largely dependent of the context of the site

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11/22/2022
Third Roundabout Report

References

BRILON, W. 2005. Roundabouts: A State of the Art in Germany. TRB National Roundabout Conference.

Wilke et al. 2014. Assessment of the Effectiveness of On-road Bicycle Lanes at Roundabouts in Australia and New Zealand. Austroads Ltd.

Dutch Cycling Embassy 2021. Protected Roundabouts and Cycling. Dutch Cycling Embassy on YouTube.

Aumann et al. 2021. Guide to Road Design Part 4B: Roundabouts. Austroads Ltd.

ROUNDABOUTS

DESIGN GUIDELINES FOR BICYCLE SAFETY

Sean Hakala, Transportation Planning Technician I

[Month Day], 2023

WHAT THIS IS FOR

Bike Rider at Railroad Avenue and Champion Street in Bellingham (The Planet)

- We’re building lots of roundabouts throughout Washington State
- Global trends suggest crash rates between vehicular and cycle traffic are disproportionately greater at roundabouts than other junction types (Poudel & Singleton 2021, Aumann et al. 2017)
- We need clear guidance on how to include cyclists in roundabout design

CYCLISTS HAVE DIFFERENT NEEDS TO OTHER MODES

- Cycling is a vital part of our transportation future
- A primary need for cyclists is to maintain momentum
- The average comfortable speed for cyclists is around 15 MPH
- We have design standards for reducing modal conflict outside of roundabouts, but no comprehensive design guidelines for reducing modal conflict within roundabouts.
- There are 3 basic types of treatment to deal with modal conflicts at roundabouts.
    1. Grade Separation
    2. Physically Segregated Cycle Tracks
    3. No Cycle Tracks, Tightened Geometry

1. GRADE SEPARATION

- Eliminates conflicts, most effective
- Most expensive
- Necessary in circumstances of very high expected cycle traffic and high vehicle traffic
- Priorities, in order
    1. Safety Performance
    2. Directness
    3. Cost

The “Hovenring” in Eindhoven, Netherlands, competed at a total cost of 8 Million 2022 USD (Google Earth)

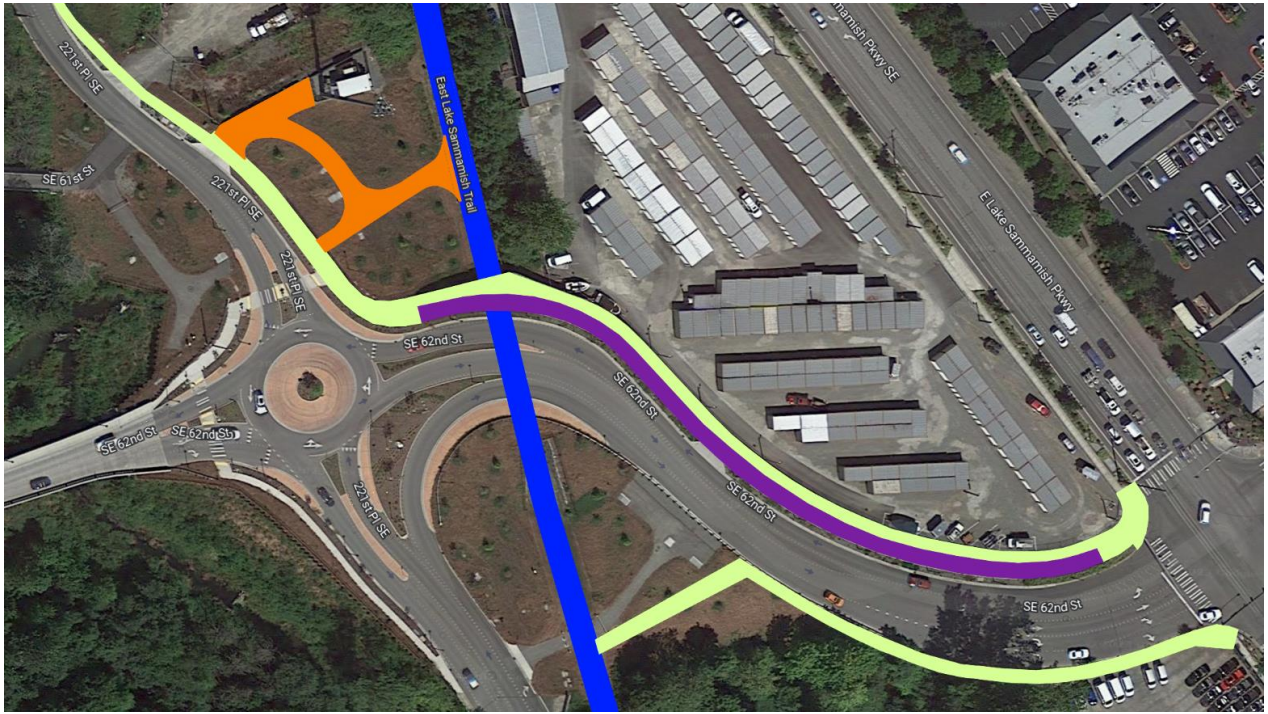
ISSAQUAH 62ND & 4TH & 221ST ROUNDABOUT

CONCEPT VS. EXECUTION

- The navigation to the sidewalk and cycle track at the trail underpass could have benefited from a human factors review
- More direct paths for pedestrians and cyclists were not built
- A connection from the trail to the sidewalk which was part of the original plan was not built

THE CURRENT CIRCUMSTANCES

- Planned Connection: Blue Shade
- Constructed Access Road: Orange
- Sidewalk: Green
- Two-Way Cycle Track: Purple
- East Lake Sammamish Trail: Solid Blue



POSSIBLE ALTERNATIVE

This alternative simply extends the southern leg of the access road to connect directly to the sidewalk on 221st Pl SE, and constructs a new sidewalk from the trail along the southern side of SE 62nd Street to E Lake Sammamish Pkwy

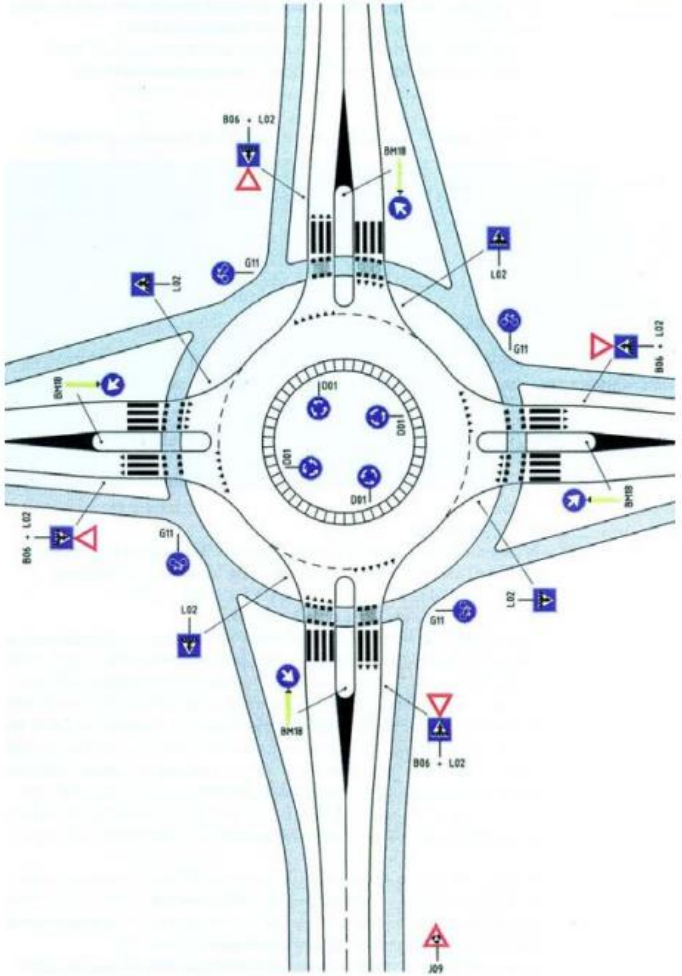
Roundabout in Nijmegen, Netherlands, with cycle tracks squished to fit its surroundings (Google Earth)

2. SEGREGATED CYCLE TRACKS

- Solution for low-speed, single lane, high cycle traffic contexts
- These give cyclists a dedicated, comfortable space

SEGREGATED CYCLE TRACKS- BASIC PARAMETERS

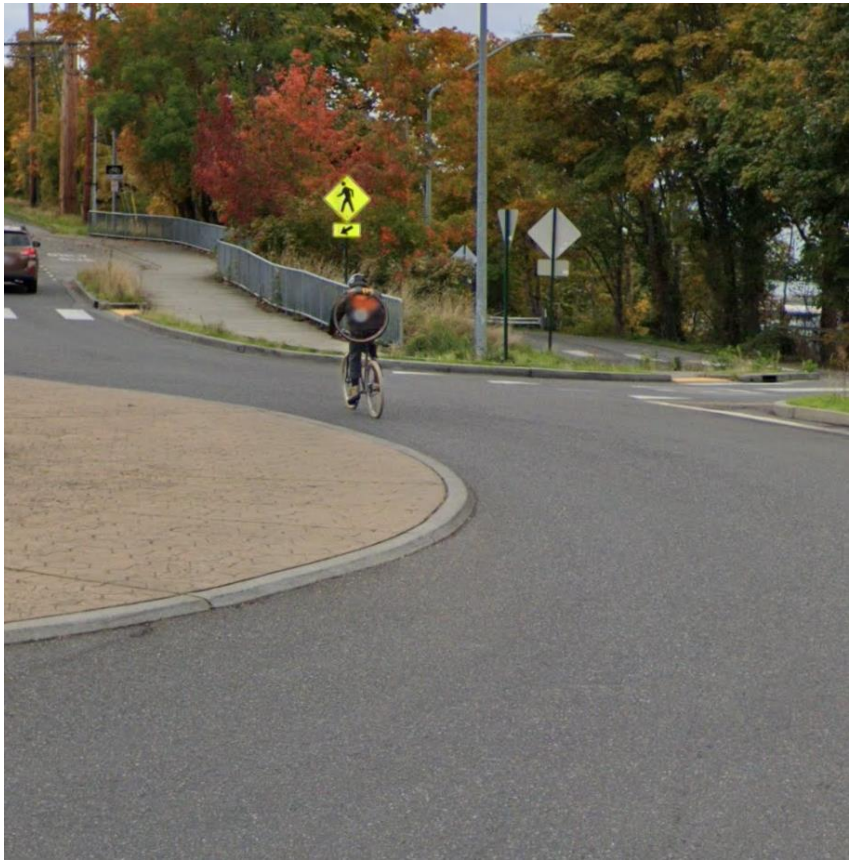
- 10,000 – 25,000 ADT
- Design speed of 15 MPH upon entrance and exit
  - Our current roundabout designs restrict circling vehicles to design speed but allow significantly greater speeds on entrance and exit
- 13-16 feet between outside edge of vehicle circle and inside edge of bicycle circle
- Design to allow entering drivers a clear sight triangle 65’ before crossing the cycle track



Standard Dutch design of roundabouts with protected cycle tracks designed for cycle priority (CROW 1998 via Fortujin 2003)

RECOMMENDATIONS FOR A SEGREGATED CYCLE LANE DESIGN STANDARD POLICY

- Adopt the design standards of a European country such as The Netherlands or Germany
- Use these types of roundabouts only in very specific circumstances



Roundabout at State, Wharf, Boulevard, and Forest Streets in Bellingham
(Google Earth Streetview)

3. NO DEDICATED CYCLE FACILITIES

- No segregated cycle tracks or grade separation
- Core issue: Looked-But-Failed-To-See
- Cyclists are most reliably seen when riding in the center of the lane

NO DEDICATED CYCLE FACILITIES – BASIC PARAMETERS

- Most exclusive treatment
- 6,000 ADT for 10 MPH and 15,000 ADT for 15 MPH (design speeds upon entrance and exit)
- Relies heavily on speed reduction and good sight lines
- Cyclists must either merge with traffic or enter the sidewalk

An example of use of aprons to narrow an entrance in Germany (Road and Transportation Research Association Road Design Work Group)

RECOMMENDATIONS FOR A NO DEDICATED CYCLE FACILITIES POLICY

- Entry and exit speeds of 10-15 MPH depending on ADT
- Smaller throats on entrances and exits
  - Use aprons to restrict width for private vehicles
- Designs with tighter curves into the circle should be adopted, especially at lower-traffic locations
- Wide center island radius
- Traffic should be slowing before cyclists are meant to merge

Roundabout in Brussels, Belgium (Google Earth).

CAVEATS

- Roundabouts with or without segregated cycle tracks may only have a single circulating lane
- Cyclists should not be expected to navigate any roundabout with more than two lanes on any leg, regardless of whether they are in segregated cycle tracks or not.

Sean Hakala
Bicycle Roundabout Safety Report Annotated Outline
10/12/2022

Roundabouts are inherently safer than traditional intersections for vehicles, but research is much less sure about the safety of bicycle riders using roundabouts. Different inquiries have found different results, ranging from a 27-40% increase in bicyclist injury collisions, and a similar study found a 65% increase in total bicycle crashes [quotes/citation from Poudel & Singleton 2021 618-625].

Across a wide review of literature there seems to be 3 basic safe design options for bicycles at roundabouts, based primarily on traffic volume.

1. Grade Separation (best, most expensive, for all intents and purposes eliminates user error)
    a. Recommended for very busy intersections where roads exceed two lanes
    b. Best for highest ADT.
2. Segregated cycle track (Best for all riders, requires space, user error can occur due to lack of attention or poor engineering)
    a. "Roundabouts with segregated cycle tracks had significantly less casualties for all road users, and specifically cyclists, than those with on-road circulating bicycle lanes" (Schramm et al. 2014 pg. 8)
    b. Single lane roundabouts with 90 degree entrances and segregated bicycle paths can still achieve a flow of 1,550 vehicles/hour at 20 MPH (Fortujin 2003 pg. 4)
    c. Right-of-way for cyclists should primarily be given and designed for when there will be high demand. Giving cyclists right of way at roundabouts has been shown to be somewhat less safe, but keeps people flowing better. In places where bike traffic will not be high, a design for vehicle priority should be used.
    d. Segregated facilities are best for low to high ADT, and design/priority rules differ based on expected traffic volumes and types.
3. No in-circle facilities (cheapest and most space efficient, unsafe for unsure, inexperienced, or young/old riders, sets up riders for user error because of tendency to not go to middle of lane)
    a. "The most important prerequisites for good safety seem to be single-lane and comparatively small roundabouts" (Brüde and Larsson 1996 I).
    b. This sentiment is mirrored in all other literatures as well, thus the need bare roundabouts to only be small and have low traffic has been known for a long time.
    c. Inclusivity is compromised significantly when no facilities are provided because only the most confident riders will be able to consistently use the roundabout [Schramm et al. quote]
    d. Most important part of providing no facilities is ensuring that bicycle riders take the center of the lane to reduce Looked-But-Didn't-See events [Schramm et al quote].
    e. Good for only the lowest of ADT

Bicycle lanes inside roundabouts have been found to be inherently unsafe and roundabouts with them experience significantly more incidents that those without.

Moving forward I will be looking for other literature spaces which would allow me to put numbers to the different ADT categories that these 3 treatments fall into.

Sean Hakala
Bicycle Roundabout Safety Report Second Outline
10/12/2022

Creating a transportation system which treats all road users equitably is not something that the United States or Washington has been very successful in doing. The meta of transportation in this part of the world has been focused almost solely on vehicular traffic and the comfort and convenience of people using that mode, at the expense of others. We are now recognizing the negative outcomes of such reliance on vehicular mobility in terms of the health and safety of our communities, our finances, and our climate. However, the WSDOT complete streets program seeks to remedy some of the mistakes of the past by designing the infrastructure of today and tomorrow for all road users, particularly keeping in mind the comfort, convenience, and safety of vulnerable road users like pedestrians and cyclists.

To the end of creating a good transportation environment for cyclists, the Dutch Cycling Embassy lists five basic design principles from the CROW Design Manual for Bicycle Traffic which ought to be considered whenever planning for cyclists is done.

1) Cohesion

"Cycling as a means of transport means going by bike from anywhere to everywhere? A cohesive infrastructure ensures a uniformed network. These networks must consider multimodal transport. Thus, the grid of bike lanes has to reduce the number of crossings, and provide links and link alternatives among origins and destinations".

2) Directness

In order to make the most efficient balance between distance and time, it is essential to minimize detours for cyclists. To achieve this, it is necessary to reduce bends, prioritize the cyclist in traffic lights, and make exclusive/separate bike lanes. The goals of these strategies are to reduce journey times and guarantee less physical effort, making cycling a competitive transport alternative".

3) Safety

"Good cycling infrastructure design must guarantee both social and road safety. It is necessary to reduce stress and the exposure to pollutants and noise to assure personal health on the road, and specially to attract new people that are interested in cycling, but still concerned and fearful of the conditions. To achieve this, bike lanes work better when they are not parallel to main busy roads, but in neighborhood low speed streets. In addition, bike lanes that are physically that are physically separated from the roads will make cycling safer. To minimize the risk of collision, it is also crucial to build tunnels and bridges for intersections with busy traffic and high speed roads."

4) Comfort

"Looking for comfort is a human instinct. The goal of cycling policy is to make cycling a pleasant experience. To address this, planners have to consider that cyclists are the starting point of the strategies and infrastructure. Normally, bikes have no suspension system, are human operated vehicles, and require a balancing act. To guarantee a comfortable situation, it is imperative to minimize stops and nuisances in the network. Also, it is essential to make smooth pavements that reduce the vibration and height

	Broader Applicability	Average Applicability	Narrower Applicability	Other
California		x		
Florida		x		
Georgia			x	
Indiana				x
Massachusetts		x		
Minnesota			x	
Nevada	x			
Pennsylvania		x		
Wisconsin		x		

Details

Does not require ISOAP process for changes to lane configurations when pavement itself is not changed or installing warni

Allows District Design Engineer (DDE) and/or District Traffic Operations Engineer (DTOE) to determine whether ICE is a goo
safety. Such a change is classified as a "Minor intersection operational improvement" similar to changing signal timing. Su
with the general knowledge of how right turn lanes at intersections generally affect pedestrian safety in a negative way.

Applicability is determined based on jurisdiction and funding sources, rather than actual facts of the project itself. Waiver

No specific requirements for applicability, due to the document being a very early policy that is simply a recommendation

Allows for written exemption from the State Traffic Engineer

No specific requirements for applicability, but specifies that "the process should only be done for intersections in which tr
the minor leg of the intersection is less tha 1,000 vehicles per day, an ICE may not be required". Allows for reduction of req

Applicability is determined solely on whether or not the Chief Traffic Operations Engineer deems it necessary based on a St

	Radical	Progressive	Standard	Regressive
Nevada				x
California		x		
Florida			x	
Georgia			x	
Indiana				x
Massachussetts		x		
Minnesota			x	
Pennsylvania			x	
Wisconsin			x	

Relies heavily on Level of Service, delay, queue length, and when considering safety only considers crash frequency, rather

Allows for lower-capacity designs, does not rely on LOS, actively mentions the safe system approach and parts of that inclu
vulnerable road users in the form of physical separation, measures of effectiveness which include the Daily Person-Hour De
specific modes to be accomodated and studied,
Doesn't particularly focus on improving multimodal transportation despite Florida's leading safety problems regardings cy
Nothing particularly notable about the policy
Relies on LOS, average vehicle delay, volume-to-capacity ratio, etc as measures of effectiveness

Relies entirely on calculation of economic viability to determine a best alternative. The equation is constructed to evaluat
expenses and reduced crashes, to create a final number for each alternative. This doesn't account for EJ concerns, though,
most appropriate may end up simply causing greater harm to the context area of the intersection, even if crashes are reduc
all modes, thereby building in protection in the equations for pedestrians and cyclists. The policy is still very young as of A
of policy based on economic costs and benefits calculus rather than the traditional analysis yields better results, or is over
nuance.
Depends on Level of Service but figures pedestrians and cyclists into those calculations. Recommends roundabouts at inte
specifically for their ability to handle high turning traffic.
Nothing particularly notable about the policy
Pedestrian/cycle facilities only included as an "other" consideration.

California

ISOAP-replacement to ICE

- Performance-based approach
- Design for all users – Safe System approach

"Holistic 2-Stage Approach:

1. Identify viable alternative and an initial planning-level assessment of safety and operations for
    a. Pedestrians
    b. Cyclists
    c. Transit
    d. Freight
2. Detailed engineering analysis of safety and operational performance for each alternative
    a. Economic analysis is done to determine recommended alternative
    b. Stage 2 done at Project Approval and Environmental Document phase

Specifically consider intersection types which are proven to reduce the number or severity of crashes, with preference to "viable alternatives that best embody the Safe System Intersection principles of reducing speed, reducing conflict points and conflict severity, reducing exposure, and reducing complexity".

Process Considerations

Performance Measures

- LOS no longer the primary metric
- Safety for all users, accommodating all users, and Measures of Effectiveness like Daily Person Hour Delay (DPHD)

Applicability

- New intersections or major modifications of existing intersections

Design year

- 10/20 year designs, but can be designed for less than current demand to meet safety/multimodal goals

Florida

Stage 1: two tools – screening

1. CAP-X
2. SPICE
    - FDOT version includes two complimentary approaches – crash prediction based on Safety Performance Functions and Crash Modification Factors, and a Safe System – based analysis using FHWA's Safe System for Intersections method

Stage 2: Preliminary Control Strategy Assessment