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Expert cyclist route planning:

Hazards, preferences, and
information sources

Overview

Cycling continues to increase in popularity, but road safety remains a critical concern. Being safe means knowing where to ride.

Different needs for different situations

- Bicycle storage or parking
- Route distance
- Traffic volume
- Route stops or slowdowns
- Scenery

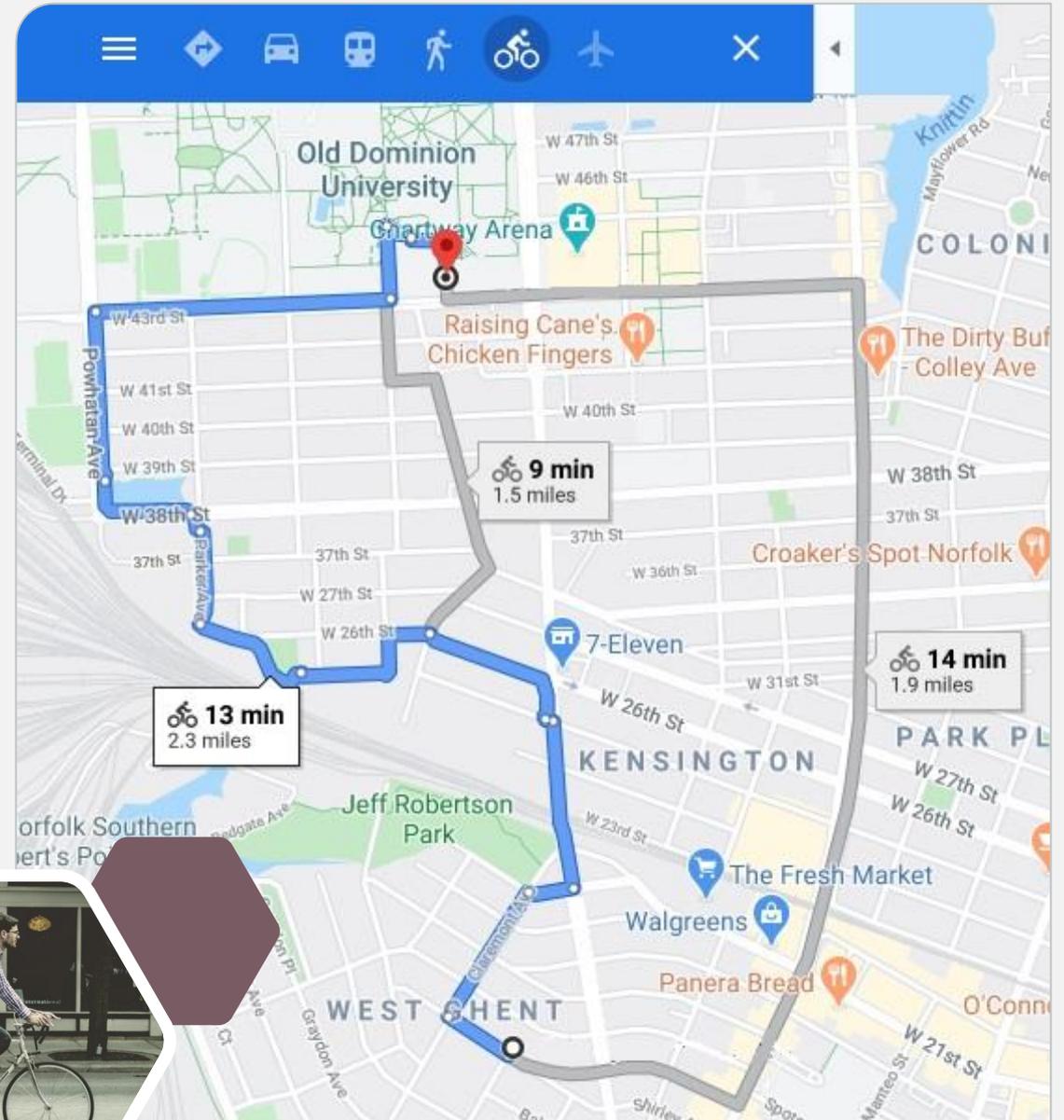


Mapping a route

Route planning for utilitarian trips is relatively constrained with fixed origins and destinations

Google Maps

- Route(s) generated based on specific destinations
- Superior integration of search information, maps, and navigation
 - Street view
 - Satellite overlay
- Includes cycling as a transportation mode
 - Known challenges but improving

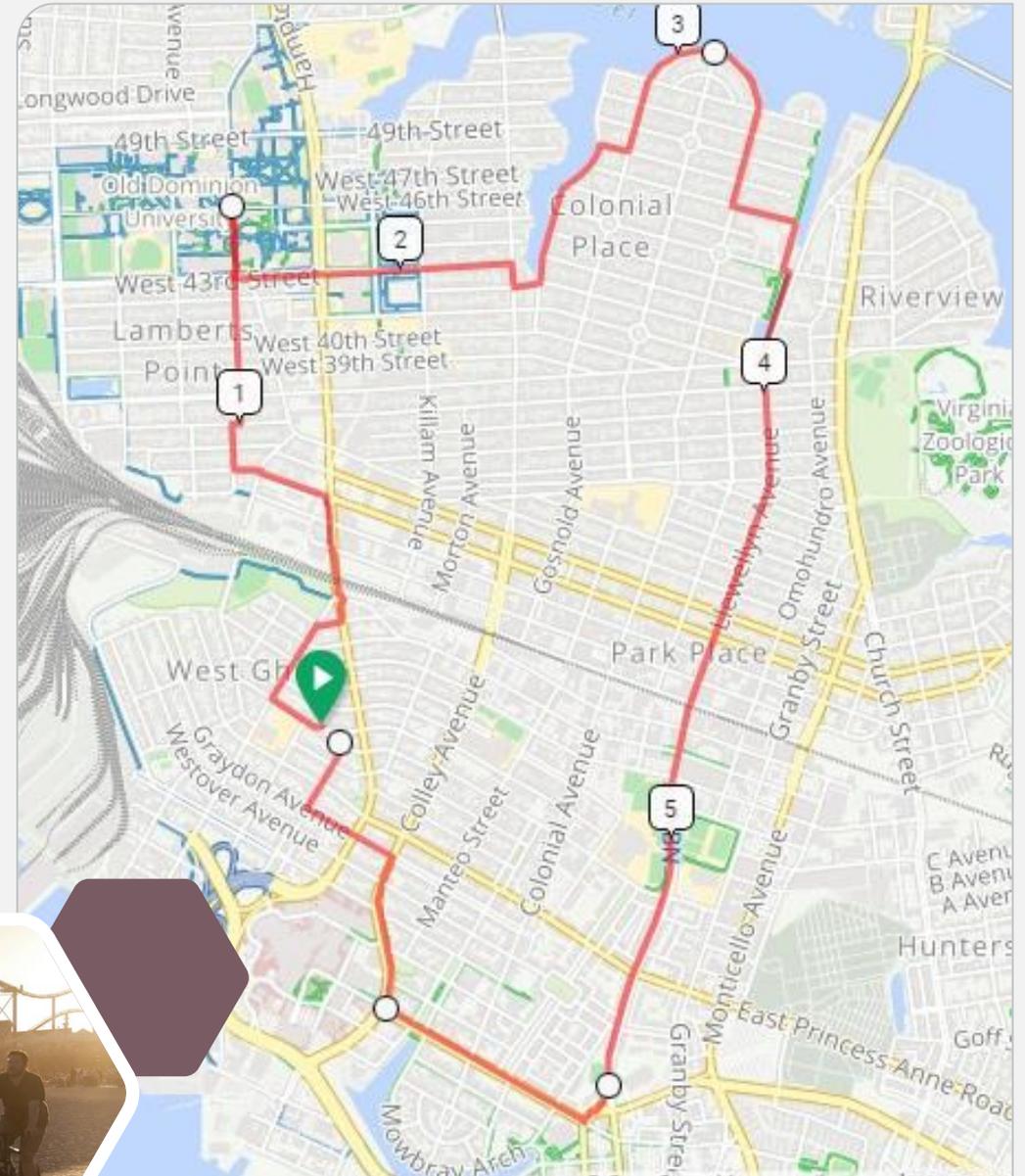


User-developed routes

Applications like Ride with GPS, Komoot, and Bikemap specialize in existing routes, highlighting social and recreational aspects of routes in the region.

Ride with GPS

- Maps, navigation, and points of interest based on OpenCycleMap
 - Satellite overlay
- Users and ambassadors create content-rich ride reports
- Point-and-click to route or use destinations
 - Search existing routes based on location, distance, elevation, events, and segments
- Arrival time estimates
- Useful tools for multi-day trips



On to Yorktown

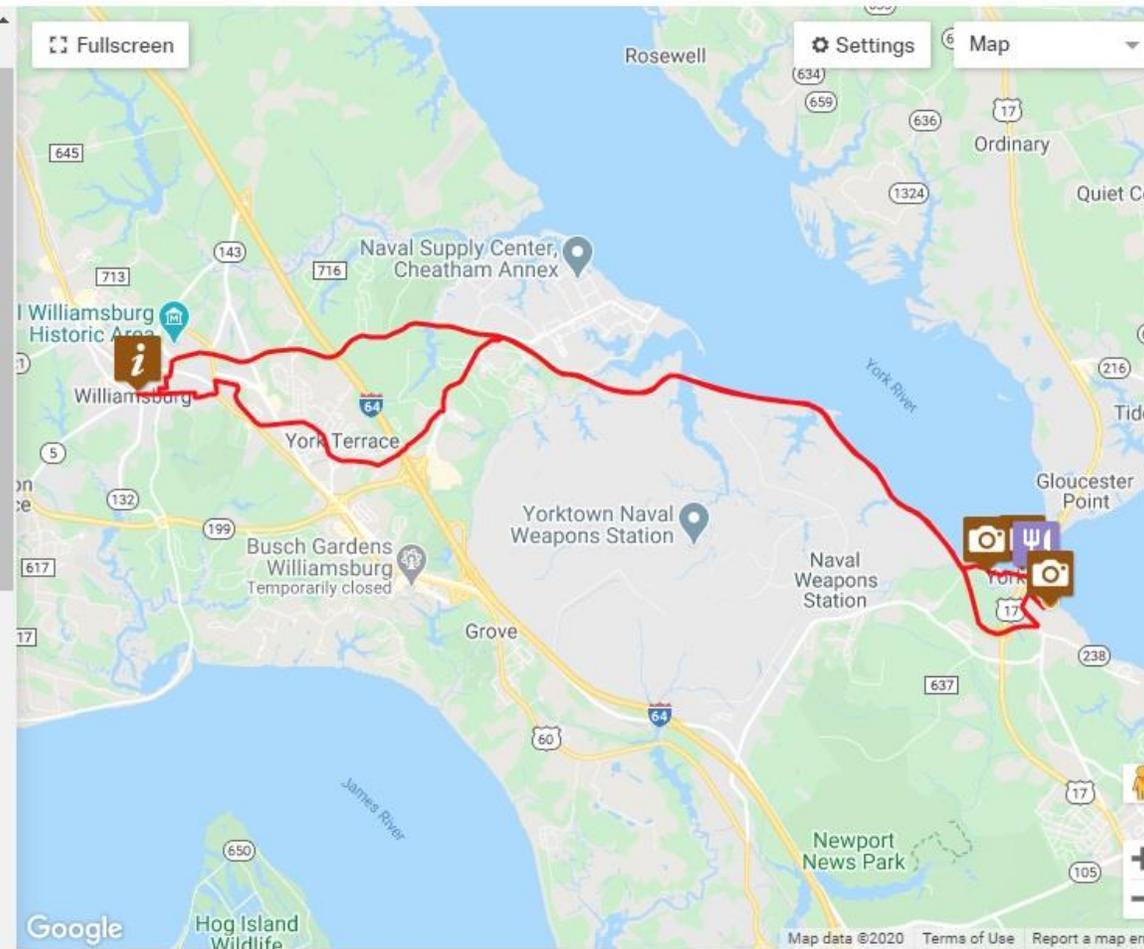
By Williamsburg Area Bicyclists - Area Rides

📍 28.4 mi + 853 ft ↗ 4.0 %

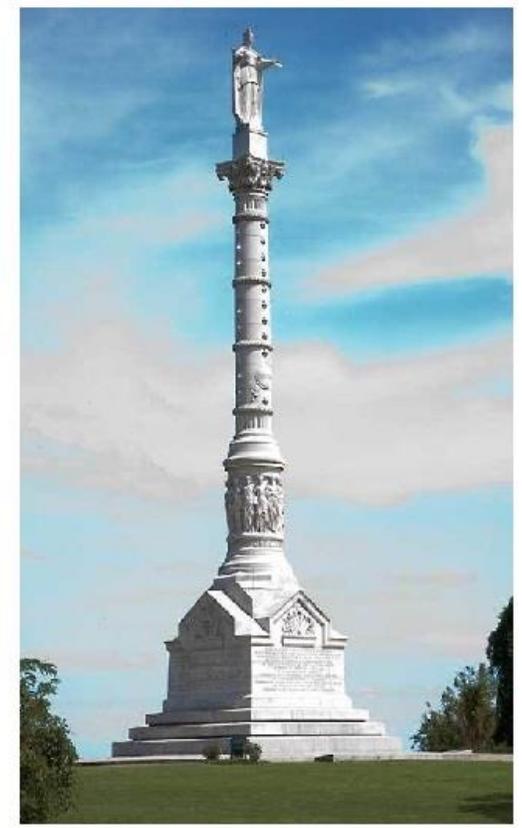
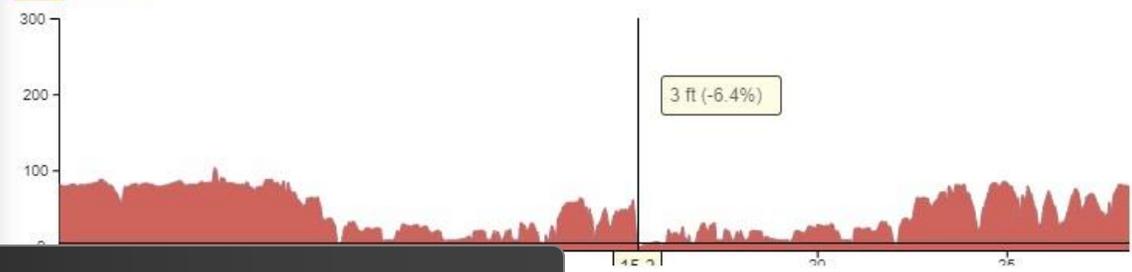
🕒 00:00 ⬆ - 853 ft ↘ -7.0 %

Send to Device

Starting in the colonial area, this scenic ride takes the cyclist, well, on to Yorktown. There are no difficult hills, but do expect a number of gentle rollers. The Colonial Parkway does contain some areas where the road surface is notoriously rough, but most riders feel the experience of cycling such a historic and picturesque byway is worth the few rattles. Once in Yorktown, consider touring the Battlefields and Encampment Tour Roads if you're looking for a few extra miles. You can also take in the Watermen's Museum, the Yorktown Victory Center or eat at one of the many eateries along Water Street. Since the ride on out to the Colonial Parkway was via Penniman Road, the return trip will take the Colonial Parkway all the way to Williamsburg for more variety. The Colonial Parkway can carry considerable traffic, especially during evening rush hour, but the road's extra width makes the cycling fairly comfortable. The market at mile 2.9 early into the ride is a good place to pick up supplies if you need any. Restrooms are available at the ride's start and at various locations in Yorktown.



Elev **Grade** 28.4 miles · +853 ft / -853 ft Drag on graph to zoom/select



Ride with GPS

Fitness trackers

Applications like Strava, Garmin Connect, and Map My Ride specialize in route tracking and navigation highlighting performance measures.

Strava

- Maps, navigation, and segments are key features
 - Satellite overlay
- Users can create routes and can share information
- Point-and-click to route
 - Use locations, segments, and heatmaps
- Arrival time estimates

A screenshot of the Strava mobile app's route planning interface. The screen is divided into several sections. On the left, there are 'Routing preferences' and 'Map preferences' sections. The 'Routing preferences' section includes options for 'Ride', 'Follow most popular', 'Any elevation', 'Any surface type', and 'Use manual mode'. The 'Map preferences' section includes 'Show Global Heatmap', 'Show segments', and 'Show distance markers'. Below these are units for 'Miles' and a 'Standard' map style. The main part of the screen is a map showing a route in an urban area with various streets labeled. The route is highlighted in orange and consists of several segments labeled with letters A through H. A search bar at the top right says 'Search or click map to add'. At the bottom, there is a summary bar with the following data: Distance 6.55 mi, Elevation Gain 25 ft, Elevation Loss 27 ft, Est. Moving Time 21:37, and Surface Type (68% PAVED, 0% DIRT, 32% NOT SPECIFIED).

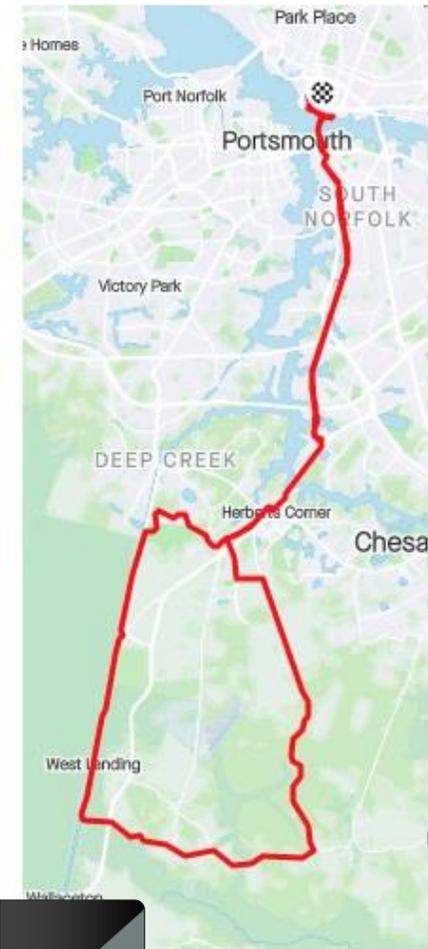
Routing preferences

- Ride
- Follow most popular
- Any elevation
- Any surface type
- Use manual mode

Map preferences

- Show Global Heatmap
- Show segments
- Show distance markers
- Miles
- Standard

Distance **6.55 mi** Elevation Gain **25 ft** Elevation Loss **27 ft** Est. Moving Time **21:37** Surface Type: 68% PAVED, 0% DIRT, 32% NOT SPECIFIED



f
🐦
🔗
👍 21
💬 0

43.68 mi **2:18:33** **463 ft** **231**
 Distance (?) Moving Time Elevation (?) Massive Relative Effort

168W **1,306 kJ** **133** **75%**
 Weighted Avg Power Total Work Training Load Intensity

	Avg	Max
Speed	18.9mi/h	32.4mi/h
Heart Rate	146bpm	166bpm
Cadence	88	114
Power	157W	466W
Calories	1,297	
Temperature	77°F	
Elapsed Time	2:22:43	

Clear
 Temperature 77 °F Feels like 79 °F
 Humidity 93% Wind Speed 5.8 mi/h
 Wind Direction N

Garmin Edge 520 Bike: Venge

- ☆ 🏆 3 **Dominion South Burpee** 3:41 23.5mi/h 202W █
 1.44mi 21ft 0%
- ☆ 🏆 2 **Dominion High-Rise Bridge Southbound Climb** 2:10 20.3mi/h 251W █
 0.73mi 98ft 3%
- ☆ **Sweets Passage** 2:35 20.5mi/h 152W █
 0.88mi 3ft 0%
- ☆ **17 to Vincek Way** 1:37 20.5mi/h 150W █
 0.55mi 3ft 0%
- ☆ **Vincek Way Sprint** 1:11 20.2mi/h 159W █
 0.39mi 7ft 0%
- ☆ 👑 **shill-beni-doug-old 17** 40:45 21.6mi/h 189W █
 14.69mi 14ft 0%
- ☆ 🏆 5 **Shillelagh Rd. to Benefit Rd.** 13:19 22.7mi/h 193W █
 5.02mi 12ft 0%
- ☆ 🏆 2 **Douglas (west bound)** 6:22 21.4mi/h 192W █
 2.27mi 0ft 0%
- ☆ **Sprint to the Bear** 1:10 20.4mi/h 172W █
 0.39mi 7ft 0%
- ☆ **New Swamp Trail Northbound** 5:45 19.9mi/h 171W █
 1.90mi 8ft 0%

Strava

Present Study

What do expert cyclists consider when planning a route?

- Factors related to the route and conditions
- Resources used to plan the route
- Impact of familiarity with area on resource usage

Who were our experts?

- 90 cyclists who ride 2000+ miles (3219+ km) yearly
- Average 20.85 years riding experience
- 69% male, average age 52 years old, 88% Bachelors' degree or higher



Survey



Factors related to the route and conditions

- Select all factors you would consider when riding a bike
 - E.g., time of day/night, ease of navigation, automobile speed, proximity to attractions
- Rank order general factors by how influential they are when planning a typical ride
 - E.g., traffic concerns, weather conditions, road surface quality, time constraints
- Rate how often specific conditions impact route selection
 - *1-never, 2-sometimes, 3-about half the time, 4-most of the time, 5-always*
- Rate how hazardous specific conditions would be when riding a bicycle
 - *1-not at all hazardous, 5 -very hazardous*



Survey



Resources used to plan a route

- Select the resources you would consider when planning a new route in a *familiar area*
- Select the resources you would consider when planning a new route in an *unfamiliar area*
 - E.g., Routes recommended by a cycling club, Google Maps, heatmaps, segments, accident data
- Rate how safe/enjoyable/fast or efficient you expect a local route informed by if recommended or created using each resource
 - *1-not at all likely, 5-very likely; 6-do not know*



Results

Select all factors you would consider when riding a bike

Most consider (70 - 90%)	Amount of automobile traffic	.89
	Time of day or night	.81
	Automobile speed	.78
	Road surface quality	.74
	Presence of snow or ice on the road	.72
Majority consider (50 - 69%)	Personal experience with close calls or accidents on the route	.63
	Wind direction or strength	.62
	Presence of water on the road	.61
	Presence of shoulders on the road	.59
	Availability of bike lanes	.51
Some consider (30 - 49%)	Availability of separate bike paths	.49
	Road width	.49
	Number of stops (stop signs or lights)	.48
	Ease of navigation (number of turns or road changes)	.46
	Picturesque sights during the ride	.44
	Availability of marked bike routes	.42
	Availability of food and drink (e.g., coffee house, brewery, restaurants)	.30
Few consider (0 - 30%)	Availability of nutrition (e.g., gas stations, vending machines)	.27
	Availability of aid (e.g., other cyclists or emergency services)	.21
	Amount of pedestrian traffic	.21
	Proximity to attractions (tourist stops, activities, events)	.11

Results

Rate how often specific conditions impact route selection (1-never, 5-always)

Condition or Situation	Route Influence Rating	Hazard Rating	Correlation
Risk of motor vehicles passing too closely	3.68 (1.18)	4.73 (0.54)	.39 ***
Risk of being hit by a distracted driver	3.69 (1.30)	4.32 (1.04)	.30 **
Risk of colliding with an open car door	2.82 (1.34)	4.33 (0.87)	.23 *
Risk of crash with a pedestrian	2.17 (1.35)	3.79 (1.14)	.25 *
Risk of crash with another bicycle	2.01 (1.23)	3.17 (1.13)	.46 ***
Risk of unexpected pedestrian crossing	2.04 (1.16)	3.54 (1.16)	.29 **
Risk of unexpected animal crossing	2.09 (1.15)	3.66 (1.08)	.45 ***
Potholes or broken road surfaces	3.06 (1.21)	3.89 (1.00)	.51 ***
Broken glass or other sharp objects in the road	3.07 (1.41)	3.98 (0.96)	.36 ***
Sticks, rocks, or other small debris in the road	2.61 (1.26)	3.44 (0.91)	.48 ***
Boxes, furniture, other large debris in the road	2.54 (1.51)	3.74 (1.18)	.51 ***
Speed bumps or other uneven road surfaces	2.48 (1.15)	3.21 (1.00)	.42 ***
Metal grates, manhole covers, storm drains	2.46 (1.21)	3.51 (1.00)	.39 ***
Standing water on the roadway	3.06 (1.31)	3.44 (0.97)	.49 ***
Gravel or sand on the roadway	2.94 (1.31)	3.59 (0.97)	.50 ***
Number of stoplights/stop signs on the route	2.33 (1.05)	2.63 (1.02)	.42 ***
Hills and road gradients	2.30 (1.26)	n/a	n/a
How fast you will be able to go on the route	3.04 (1.13)	n/a	n/a
Likelihood of ticketing for traffic violations	1.20 (0.62)	n/a	n/a

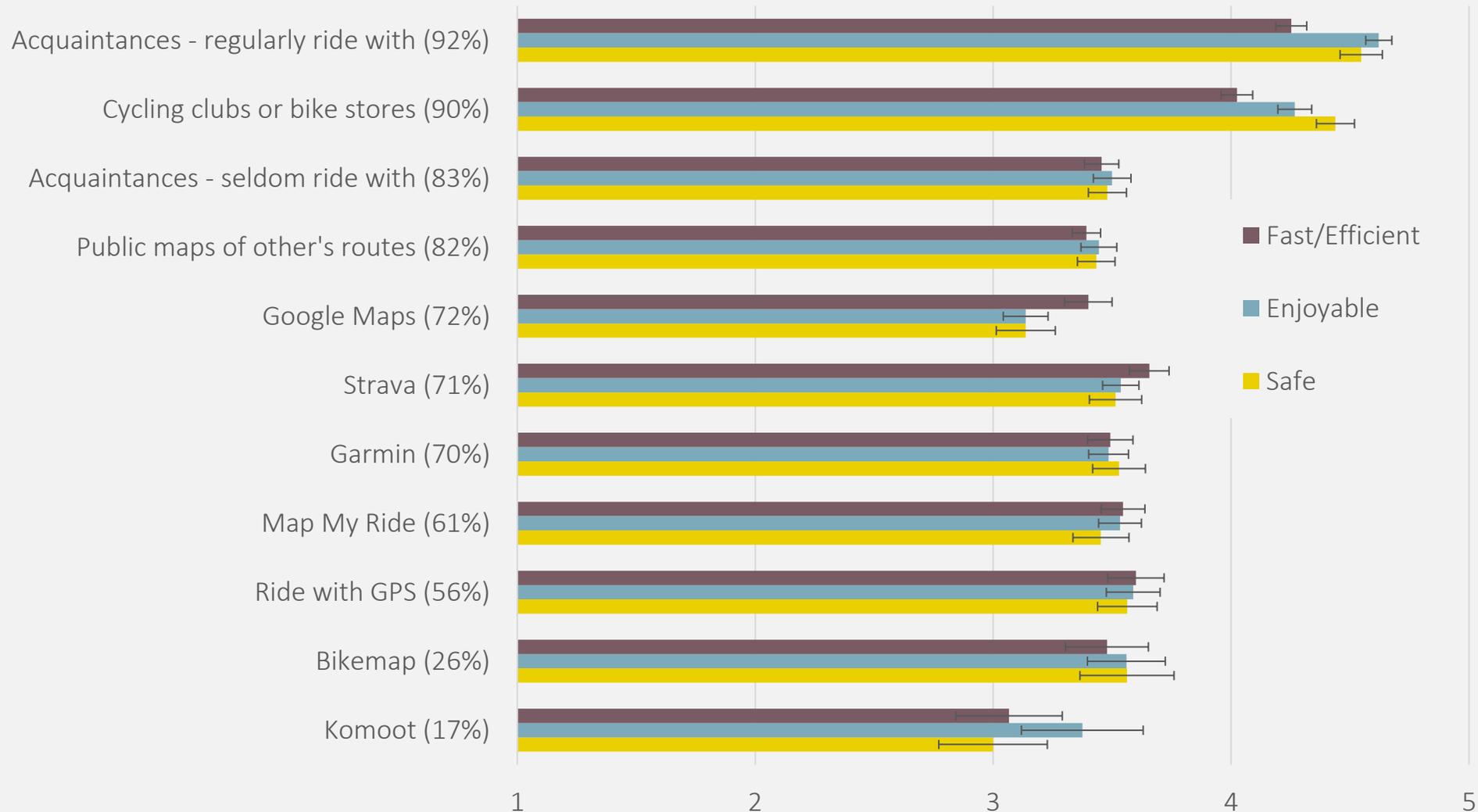
Results

Select the resources you would consider when planning a new route in a *familiar vs. unfamiliar* area

Information Source	Familiar Location	Unfamiliar Location
Routes recommended by a local cycling club or bike store	.80	.88
Routes recommended by acquaintances familiar with the area	.66	.81
Google Maps	.54	.52
Public maps identifying full routes others have ridden (e.g., Map My Ride)	.47	.61
Public maps showing frequency of logged rides on specific roads (e.g., Strava heat maps)	.40	.57
Public maps identifying specific section of roads or routes (Strava Segments)	.47	.48
Private maps of routes acquaintances have ridden (e.g., Garmin friends' activity)	.43	.52
Other map programs with no street view	.10	.10
Accident data	n/a	.07
No outside resource, only use own knowledge of the area	.10	.01

Results

How safe/enjoyable/fast or efficient do you expect a local route to be if created by or using these resources?

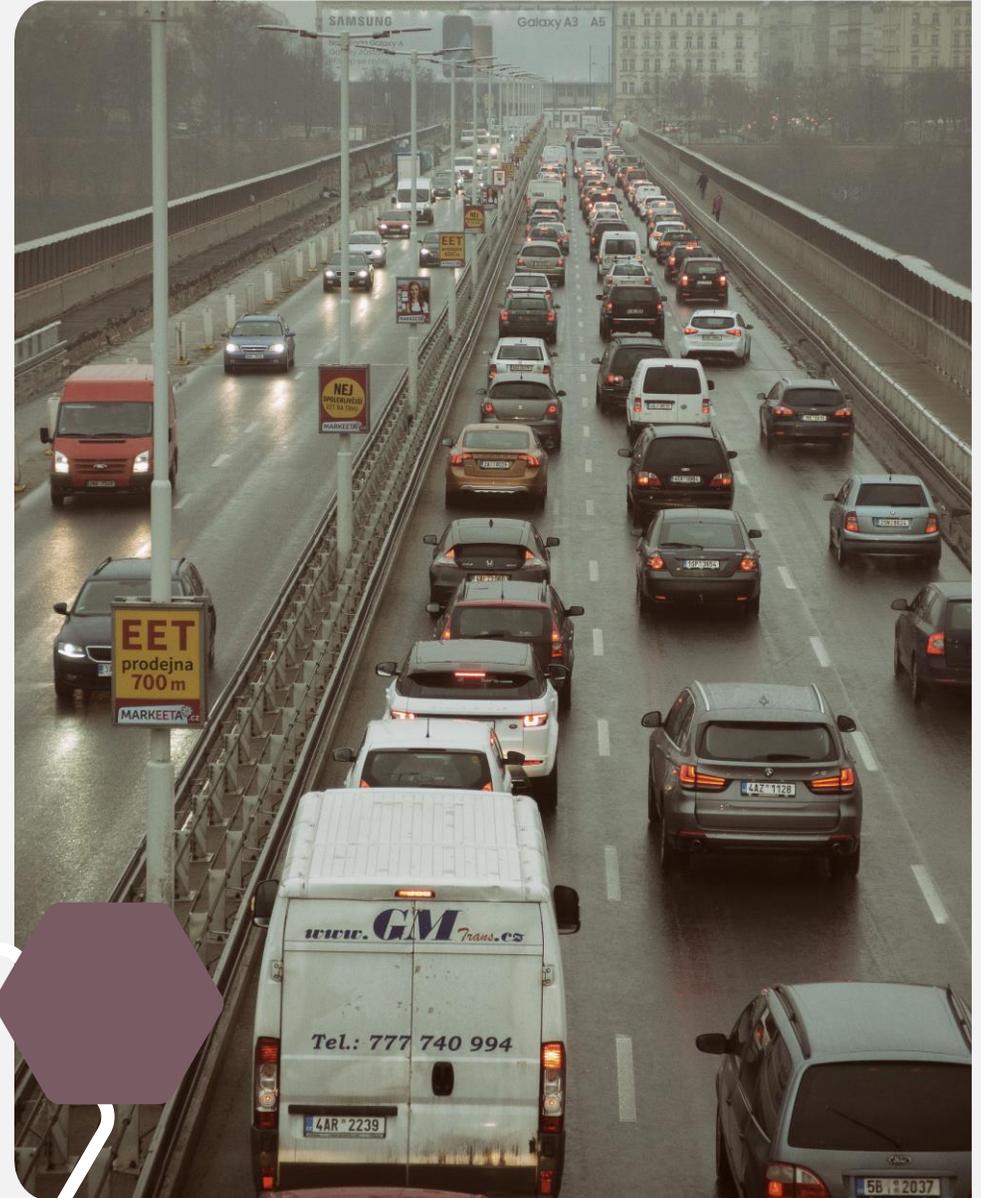


Discussion

Expert cyclists are concerned with safety

Does safety impact route planning?

- Most say they consider motor vehicle traffic volume and speed, bicycle infrastructure, and road surface conditions
- The more hazardous the condition is, the more likely cyclists are to say it influences their route selection
- Few of cyclists' top route-planning considerations are integrated into existing applications



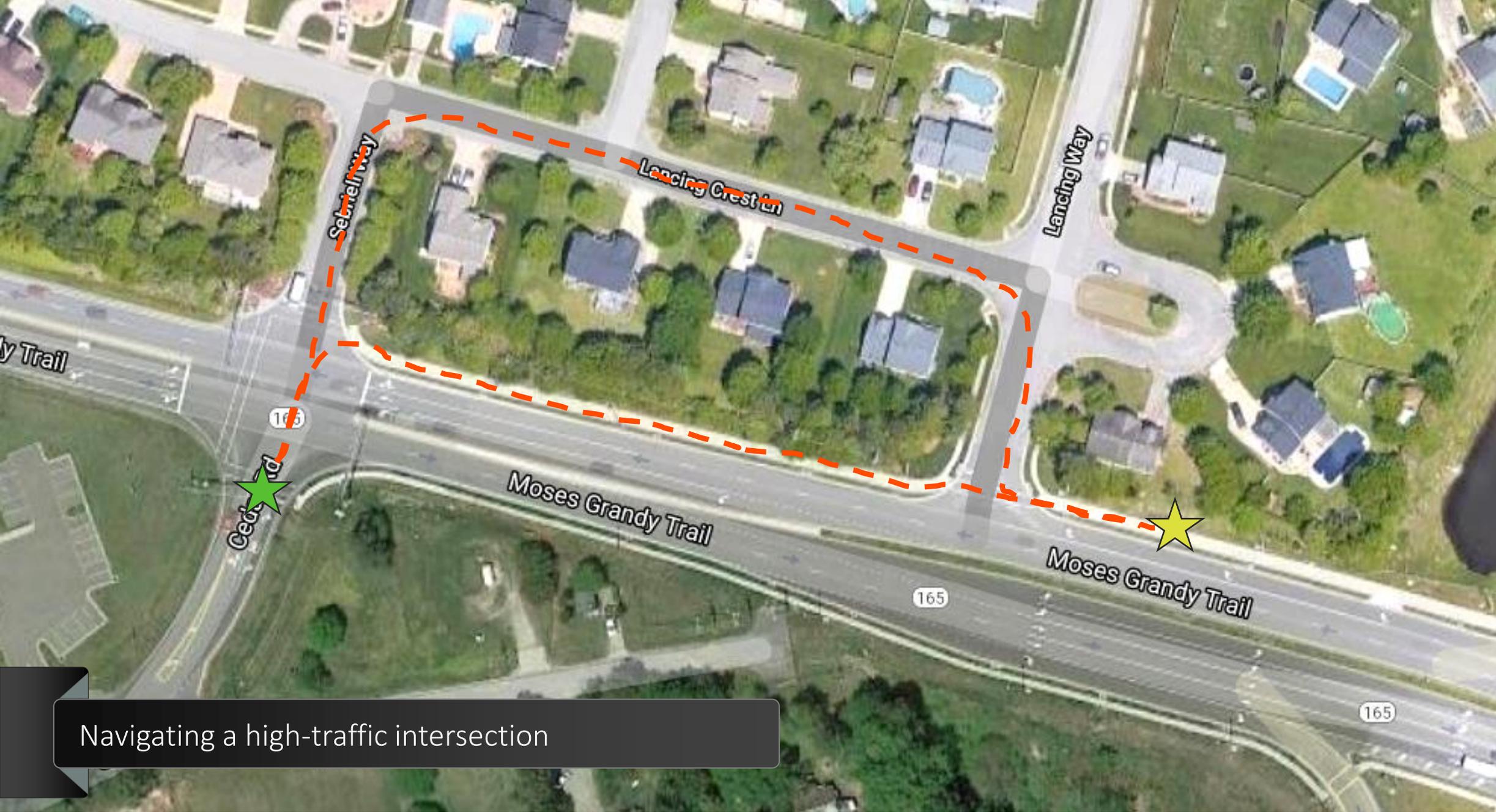
Discussion

Expert cyclists rely on friends who bike or groups with expected cycling experience (clubs and shops)

What do “people” provide that current applications do not?

- Warning or tips regarding route features
 - Take the lane on Ocean View Boulevard
 - That bridge often has glass in the shoulder
 - There’s a huge pothole under the I-64 bridge





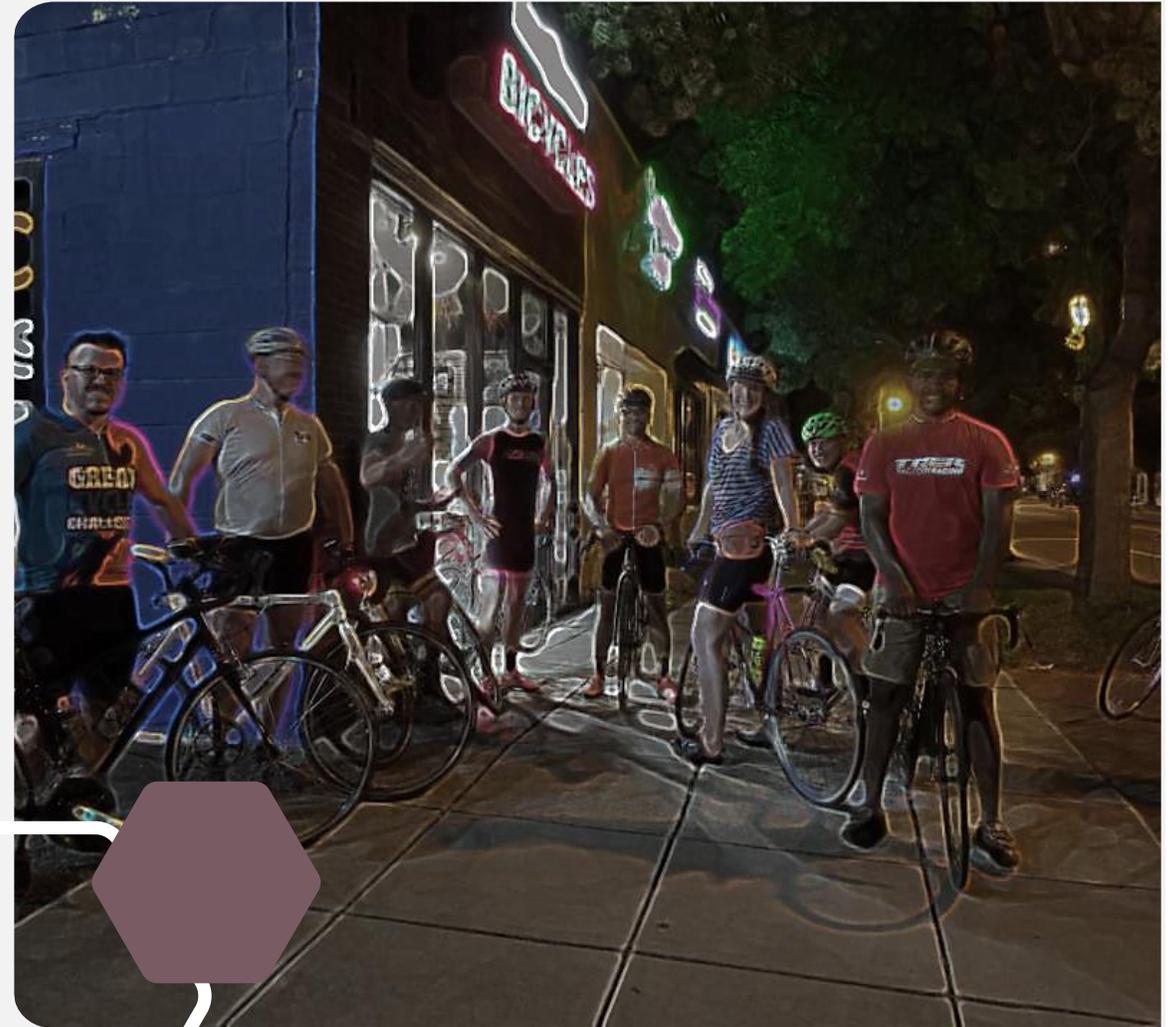
Navigating a high-traffic intersection

Discussion

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What do “people” provide that current applications do not?

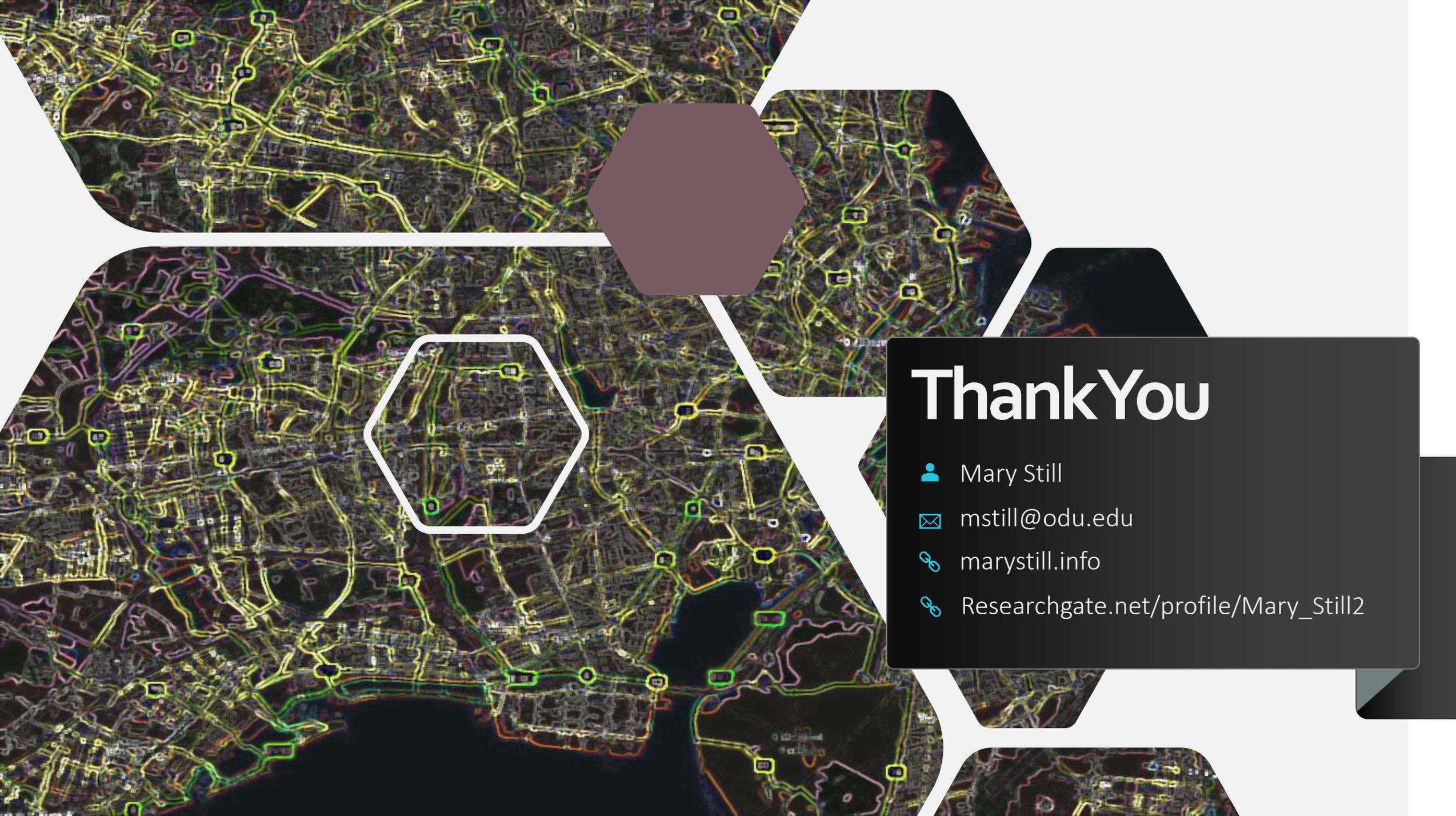
- Context and shared mental models
 - Needs differ for commutes, other utilitarian, sightseeing, and fitness rides
 - Apps could have profiles or settings to better cater to rider demands



Conclusions

- Expert cyclists who ride primarily for fitness and recreation share safety concerns with commuters; beyond that, their needs are different
- Most, but not all, cycling hazards are considered when planning a route
 - Are hazards dismissed because cyclists believe they are unavoidable, unpredictable, or not accounted for by available route planning resources?
- Further investigation is needed to understand why expert cyclists prefer “people” to apps in route planning
 - What if key factors were addressed? E.g., how to extract and utilize dynamic information to improve routes
 - What about usability?



The background of the slide is an aerial photograph of a city, likely Columbus, Ohio, with a complex network of roads and green spaces. Overlaid on this map are several hexagonal shapes: a solid purple one at the top center, a white outline one in the middle left, and a solid black one at the bottom right. A dark grey rectangular box is positioned in the bottom right corner, containing contact information.

Thank You

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