OCTOBER 30, 2022

ASSESSMENT 2: INTERSECTION CRASH SAFETY

ANALYSIS OF THE BROADWAY & HARRIS ST INTERSECTION

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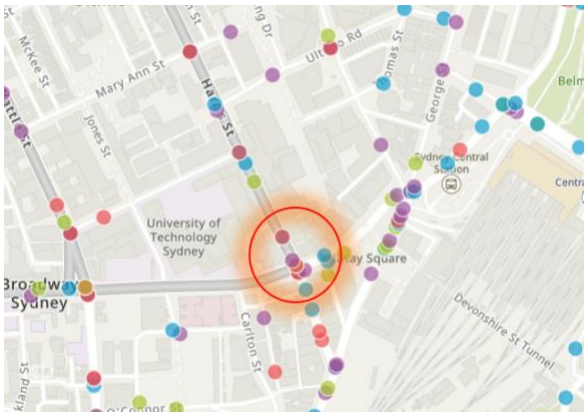
Aim

To identify and observe severe crash problems in a road length in NSW, and to propose an intervention that will mitigate the issue.

Desktop Investigation

The site chosen was the intersection of Harris Street and Broadway. The intersection is in the Sydney LGA, just West of Central station. There have been 3 serious crashes and 7 lesser injuries. Of the serious crashes, 2 (RUM 0,2) involved pedestrians. An additional 2 (RUM 0,3) pedestrians had minor injuries, meaning two-fifths of all injuries recorded involved pedestrians. There was only one injury involving cross traffic (RUM 10), with 3 (RUM 30, 30, 34) crashes with vehicles travelling in the same direction.



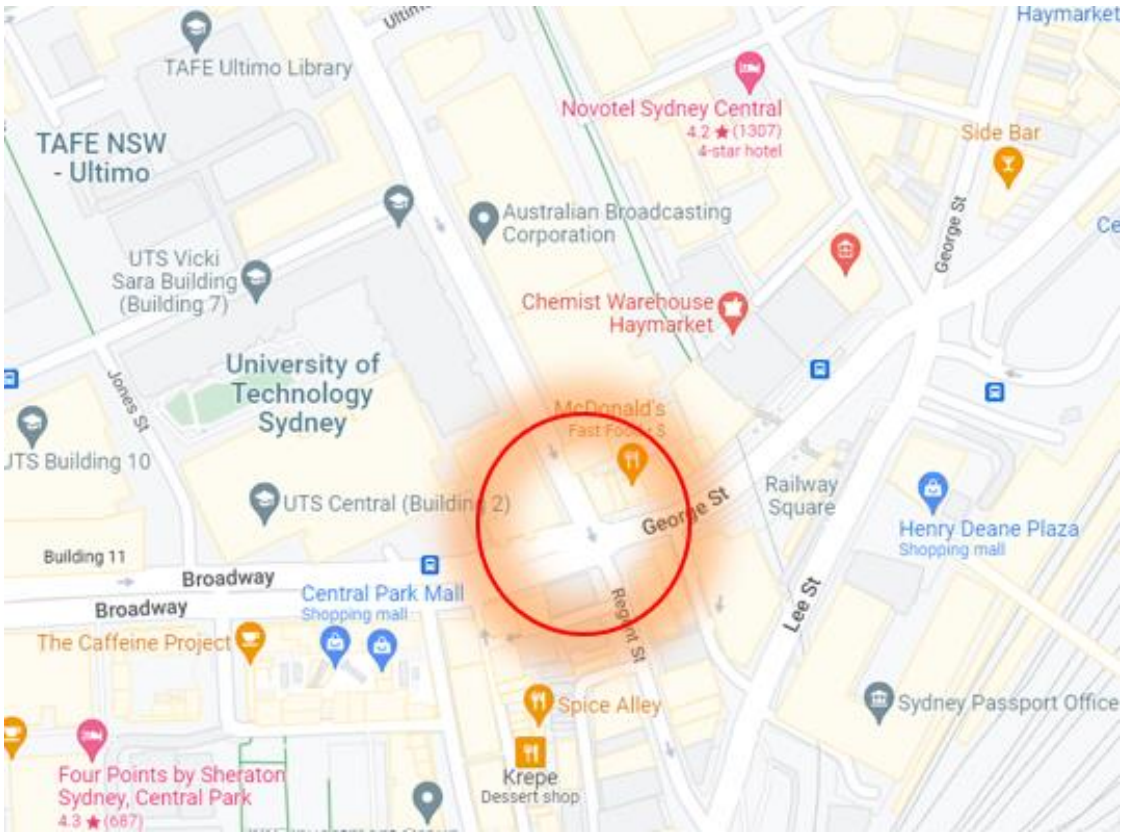


Figure 1 Map of the intersection

Roadway

Harris St runs North to South, starting as a two-way road, becoming a 5-lane one-way a block prior to the intersection. The road is reduced to 4 lanes and is renamed Regent Street South of the intersection. The street measured 20 metres wide on Google Maps with the lanes approximately 2.9m each. The posted speed limit is 40km/hr. Approximately 1.1 km North of the intersection, Harris St connects to the Sydney Harbour Bridge as well as Anzac bridge. It was observed that Harris St was slightly inclined, which may contribute to speeding.

Broadway is an eight-lane stretch of road, with two of those lanes being bus lanes. The West side of the intersection additionally has a narrow median and the speed limit is 50km/h. The east side does not have a median and has a posted speed limit of 40km/h. The street was measured to be approximately 30m wide with 3m lanes.

Infrastructure

Bus Stops

- One bus-stop 90m upstream of the intersection East and Westbound along Broadway
- One bus-stop 80m upstream of the intersection on Harris St

Signage

- Clearway signs on Harris St and Broadway (6am-10am, 3pm-7pm Mon-Fri)
- No left turn and no right turn from Broadway (Eastbound)
- Nor right turn from Broadway (Westbound)
- High pedestrian activity on Regent st
- 50km/h Broadway East side
- 40 km/h Broadway West side
- High pedestrian area 40km/h Harris St
- One-way sign Harris St

Local Context

Broadway is a major pedestrian corridor, being located right next to Central station and Railway Square. The land around the area is highly mixed use and pedestrian oriented. Educational institutions UTS and Tafe are located right next to the intersection along Broadway. There are also countless food and drink establishments around the area. Central Park mall is located just West of the intersection. Various high-rise residential apartments surround the area, which combined with its proximity to the CBD suggests high pedestrian activity.

Site Observation

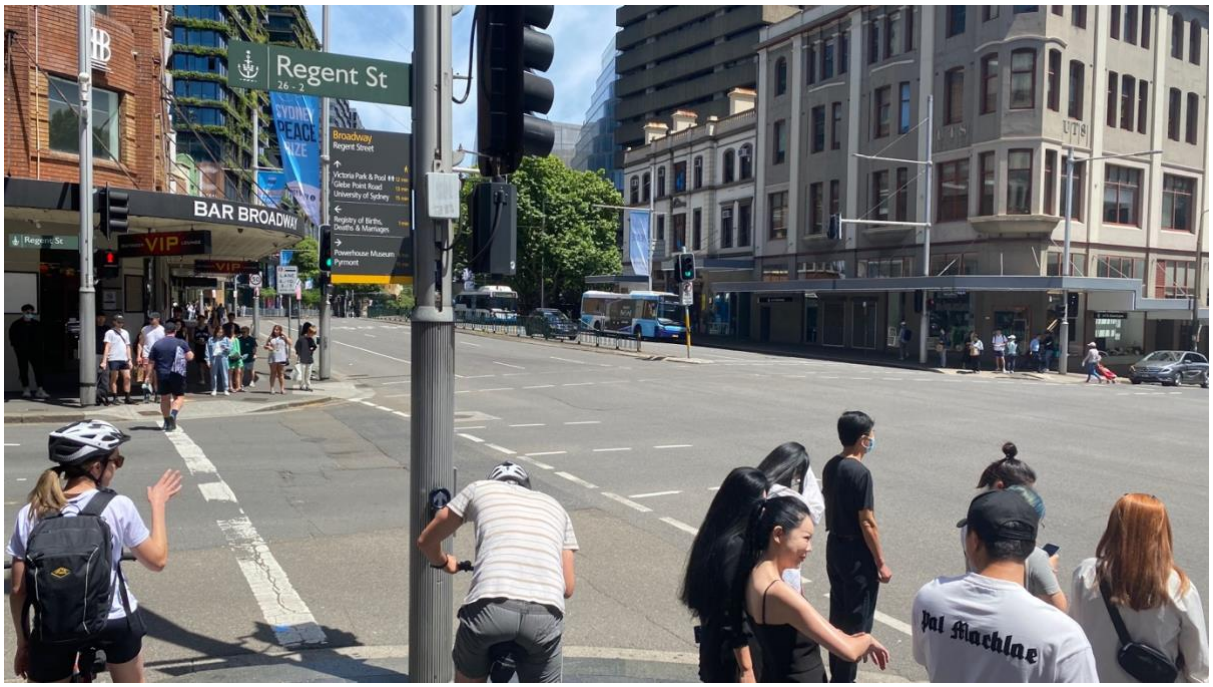


Figure 2 Site Visit

Volume

It was observed that this intersection has high pedestrian traffic. The volumes observed below were measured at approximately midday on a clear typical Wednesday.

Pedestrian

South-West Corner: 376 pedestrians/15 mins
North-East Corner: 663 pedestrians/15 mins
A total of roughly 4200 pedestrians/hr

Cars

758 vehicles/15 min (455+303)
Average Vehicle Occupancy 1.25* (chrisloader 2017)
A total of 3032 vehicles/hr, approximately 3800 people/hr

Other observations

- 6 car beeps were noted in one hour
    - Mainly due to risky driving behaviour, especially along Harris St due to jockeying (repeated lane changes to move through traffic) and getting out of the right turn lane
- One vehicle travelling in the wrong direction along Harris St
- Drivers seemed to be exceeding the speed limits on both Broadway and Harris St
- Pedestrian congestion was present at the traffic lights
- Queuing across the intersection along Harris St, obstructing cross-traffic Westbound drivers

*A cursory observation of vehicle occupancy found that it seems to roughly match the data

The observations made as well as the notes made on the checklist in Appendix 1 highlight that there is a fundamental incongruence with the designed use of the intersection. It is simultaneously acting as a street with vibrant life and a road funnelling large traffic flow from point A to B. These two uses are incompatible with each other, and the crash data seems to agree. A massive overhaul of the road network surrounding this area will need to be undergone to rectify the problem.

Countermeasures

The high pedestrian volumes and mixed land uses highlight the area surrounding this intersection as pedestrian oriented. Crash statistics also underline the need to improve the safety around these users, as almost half of all crashes and two-thirds of serious crashes involve pedestrians. Therefore, the proposed changes should revolve around this basis.

Figure 3 Before (top) & after (bottom) conversion of Harris St

Figure 4 City of Sydney Proposal for Broadway (Gorrey 2021)

One of the biggest factors in safety is vehicle speed. The '20's Plenty' campaign in the UK advocates for speed reductions for a safer environment for pedestrians. The likelihood of fatalities reduces from 45% with cars going at 30mph to 5% at 20mph (European Transport Safety Council 1995), reducing speed should be the main priority. Design speed of 30km/h on Broadway and 40km/h along Harris St should suit the land use of the area surrounding the intersection. To enforce these speed limits, extensive traffic calming tactics should be used. A combination of lane-narrowing, tree linings along street sides and the use of medians will create a slower speed environment. In addition, raised crossings emphasise the presence of pedestrians while also creating a speed bump for cars.

Figure 5 Before (top) & after (bottom) conversion of Broadway

The geometry of the road should also be redesigned. The main problem present at this intersection is the multi-lane one-way along Harris St. Reversion to a two-way should, as seen in figure 3, help to reduce crashes caused by jockeying drivers. Figure 4 outlines the plans of the City of Sydney government, following similar principles to the pedestrianisation of George St. Figure 5 outlines this group's proposal, adding the previously mentioned design solutions. The major deviations from the council's plan include the change from a bidirectional to unidirectional bike lane and the further reduction to two lanes of motor traffic. Furthermore, 'complete' intersections would also greatly improve the safety of the intersection itself. Figures 6 and 7 depict the layout of this type of intersection, highlighting the important features. A forward stop bar gives cyclists a head start against cars as well as ensuring that they are visible to turning vehicles. The corner refuge island and setback crossings both help to reduce the crossing distance for pedestrians and cyclists as well as create an acute turning angle, which result in lower speeds and further visibility of cyclists as the vehicle will cross head-on. Finally, bicycle and pedestrian friendly signal phasing, such as leading intervals should be used to increase the visibility of these road users. All these designs combined should create a safer intersection for pedestrians and foster a better environment for the economy around this area.

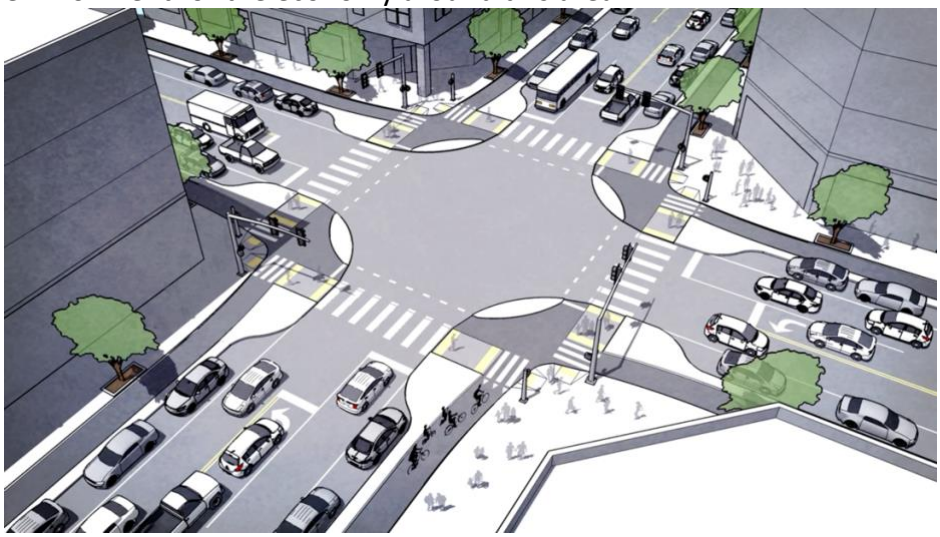


*Figure 6 Complete intersection (*Protected Intersections for Bicyclists *n.d.)*

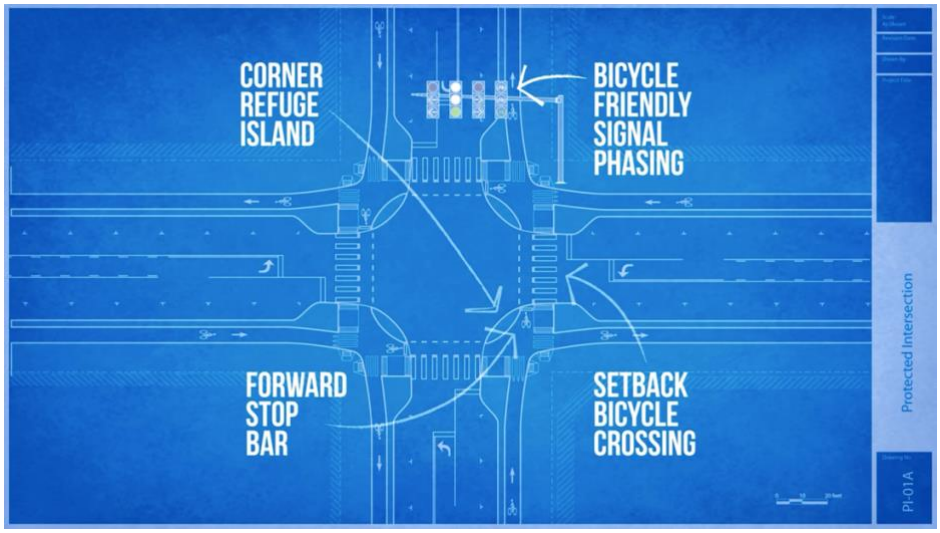


*Figure 7 Complete intersection (*Protected Intersections for Bicyclists *n.d.)*

Study Design

Aim: To evaluate the perception and efficacy in reducing crashes and injuries after implementing a protected intersection for bicycles and pedestrians.

Hypothesis: The new protected intersection will lead to fewer bicycle and pedestrian injuries as the various features reduce car speeds.

1000 participants will be asked to take part in a longitudinal experimental study. These participants will be regular users of this intersection, whether they be motorists, pedestrians or cyclists. Drivers will be tasked with keeping a travel diary, noting travel speed approaching and travelling through the intersection. As well as observations regarding the visibility of other road users. Notes on driving behaviour, such as the presence of jockeying, is also necessary. Pedestrians and cyclists will be surveyed about their perception of safety. Noting whether they have had any dangerous encounters with vehicles. Questions regarding the shorter crossing distance and enhanced safety features will also be asked to gauge their comfort in navigating the intersection. The participants will be surveyed before and after the changes to gauge their perception of safety around these changes. Combining these observations with the crash data that Transport for NSW collects will determine whether the perception of safety correlates with injury levels.

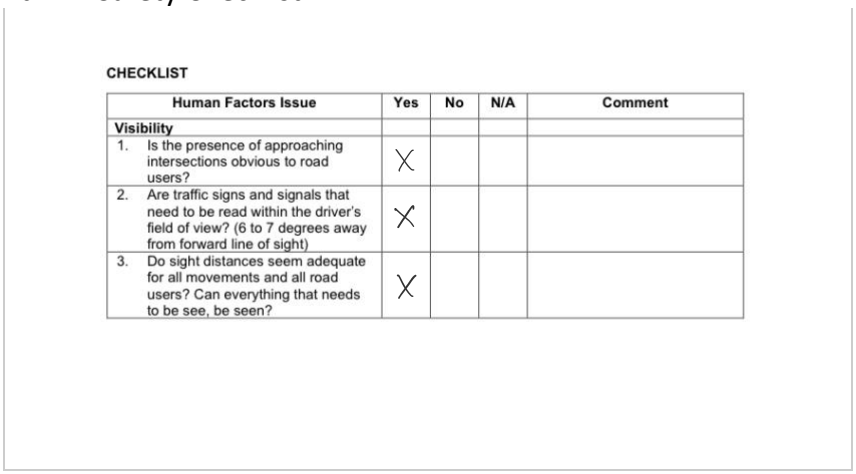
The survey model was chosen to gather large amounts of observational data, which could not be gathered as efficiently with other methods. By conducting interviews with regular road users, little details about their perception of safety can be obtained in large quantities. The speed reducing and risk homeostasis adjusting capabilities of this change have already been observed in other implementations of these designs. Therefore, it is useful to gather data on the perception and intuitiveness of this design.

Implications

While new data and research is always useful, the proposals suggested in this report are nothing new. The principles that make the foundation to these designs are standard in other areas of the world, namely Europe. The efficacy of 'complete'/protected intersections have been proven in countries such as the Netherlands and Denmark where they have halved fatalities relative to 2000 (Netherlands 2022). However, this intersection can hopefully persuade Australian road engineers to adopt this style of safety engineering. A systemic change in priorities needs to occur among engineers, reducing the importance of traffic speed and flow for vehicles and focusing on safety and flow for all road users. An overall shift away from car-centric design is needed to combat the many issues engineers and society alike is faced with. If Sydney is to compete with other global cities, it will need to solve its car-dependency problem.

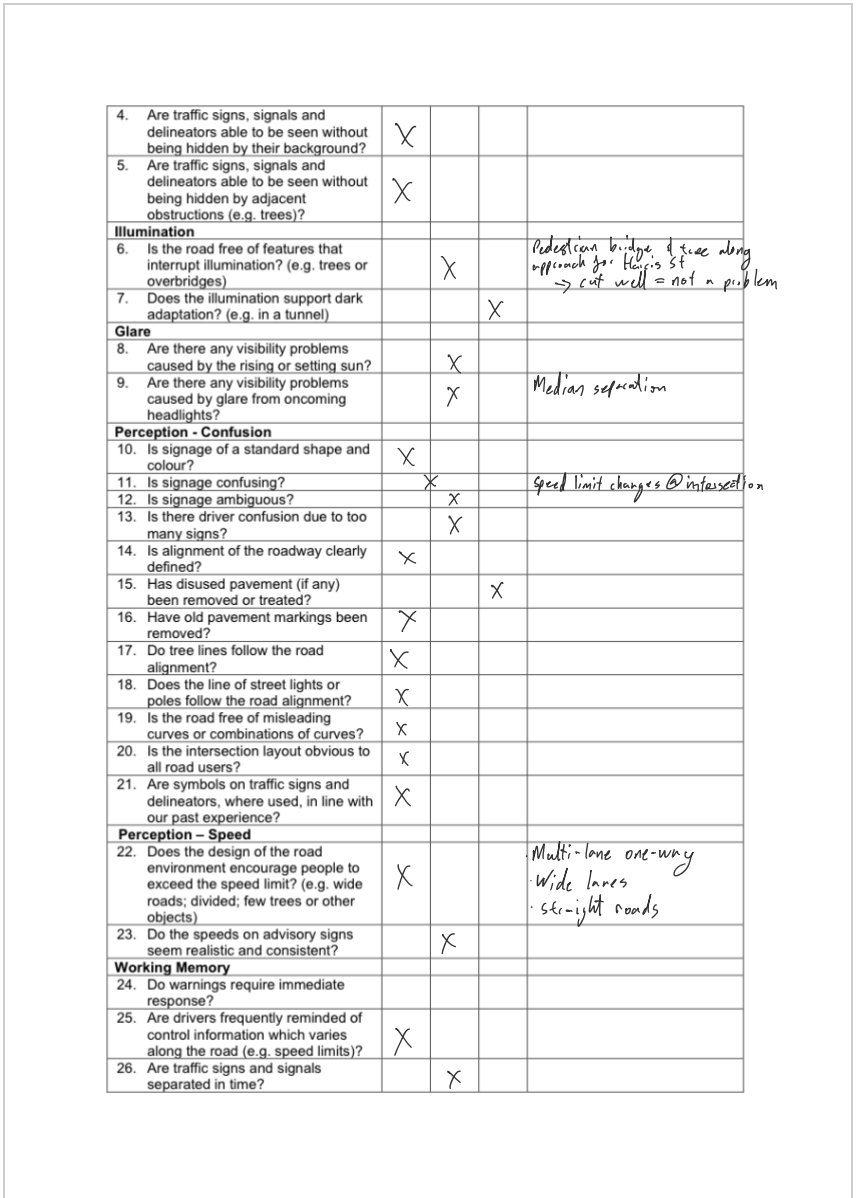
Appendix

Appendix 1: Safety Checklist



CHECKLIST

Human Factors Issue	Yes	No	N/A	Comment
Visibility				
1. Is the presence of approaching intersections obvious to road users?	X			
2. Are traffic signs and signals that need to be read within the driver's field of view? (6 to 7 degrees away from forward line of sight)	X			
3. Do sight distances seem adequate for all movements and all road users? Can everything that needs to be see, be seen?	X			

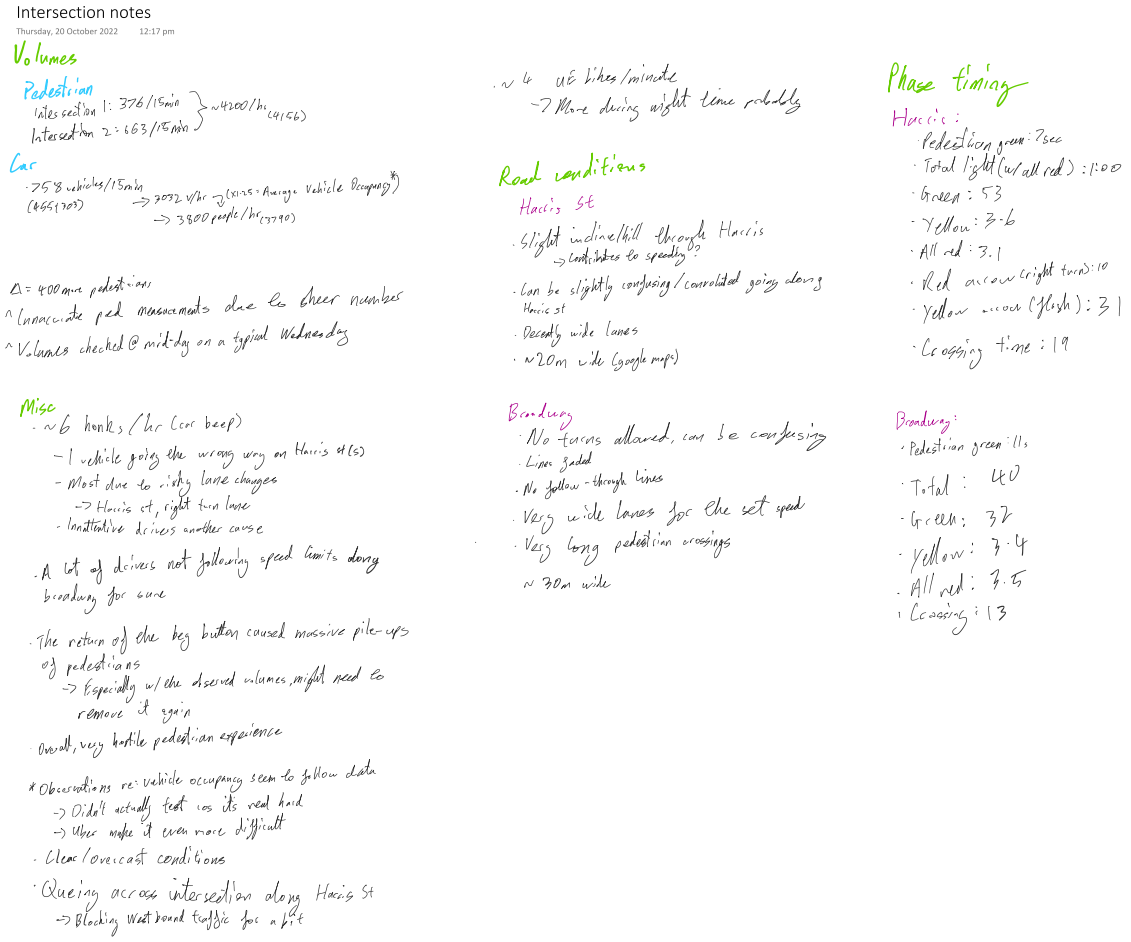


4. Are traffic signs, signals and delineators able to be seen without being hidden by their background?	X			
5. Are traffic signs, signals and delineators able to be seen without being hidden by adjacent obstructions (e.g. trees)?	X			
Illumination				
6. Is the road free of features that interrupt illumination? (e.g. trees or overbridges)		X		Pedestrian bridge & trees along approach for Hicks St → cut well = not a problem
7. Does the illumination support dark adaptation? (e.g. in a tunnel)			X	
Glare				
8. Are there any visibility problems caused by the rising or setting sun?		X		
9. Are there any visibility problems caused by glare from oncoming headlights?		X		Median separation
Perception - Confusion				
10. Is signage of a standard shape and colour?	X			
11. Is signage confusing?		X		Speed limit changes @ intersection
12. Is signage ambiguous?		X		
13. Is there driver confusion due to too many signs?		X		
14. Is alignment of the roadway clearly defined?	X			
15. Has disused pavement (if any) been removed or treated?			X	
16. Have old pavement markings been removed?	X			
17. Do tree lines follow the road alignment?	X			
18. Does the line of street lights or poles follow the road alignment?	X			
19. Is the road free of misleading curves or combinations of curves?	X			
20. Is the intersection layout obvious to all road users?	X			
21. Are symbols on traffic signs and delineators, where used, in line with our past experience?	X			
Perception – Speed				
22. Does the design of the road environment encourage people to exceed the speed limit? (e.g. wide roads; divided; few trees or other objects)	X			· Multi-lane one-way · Wide lanes · Str-ight roads
23. Do the speeds on advisory signs seem realistic and consistent?		X		
Working Memory				
24. Do warnings require immediate response?				
25. Are drivers frequently reminded of control information which varies along the road (e.g. speed limits)?	X			
26. Are traffic signs and signals separated in time?		X		

27. Is there too much information on traffic signs? (more than 7+/- items of information)		X		
Information Needs				
28. Are drivers are alerted in advance to presence of intersections?		X		
29. Are traffic signs and signals conspicuous? (in terms of size, brightness, bold, contrast, simple background)	X			
30. Are traffic signs and signals legible (able to be read)?		X		Graffiti & dented
31. Are traffic signs and signals comprehensible (i.e. understandable)?	X			
32. Are traffic signs and signals credible in their context (perceived to be appropriate)?	X			
33. Do the colour, size and shape of traffic signals and signs appear to conform with national codes, guidelines and standards?	X			
34. Are important messages adequately displayed (e.g. speed limit repeater signs)?		X		Harris St, tiny speed limit sign
35. Is advance direction signing consistent and prominent?	X			
36. Are all necessary regulatory, warning and direction signs in place? i.e. all that are needed by the road user to keep them safe?		X		No pedestrian warning
Human Vulnerabilities				
37. Fatigue: Have engineering treatments been implemented to mitigate the effects of fatigue?		X		Basic design, super long sightlines Risk compensation problem
38. Distraction: Are their sources of distraction at and near the location that could divert a driver's attention away from critical traffic signs, signals and delineators?	X			Lots of businesses & pedestrian stuff Flag advertisements
39. Hysteresis: Are pedestrian crossings, bus stops, etc, placed immediately downstream of an intersection? (which is undesirable)		X		
Reaction Time				
40. Do any traffic signals, signs or delineation appear unusual?		X		
41. Do traffic signals, signs, or delineation appear too small for the approach speed?	X			Harris St 40km/h sign
42. Are traffic signals, signs, or delineation poorly maintained (e.g. making them harder to see)?	X			Graffiti on No right turn sign
43. Are traffic signals, signs, or delineation poorly located?	X			Harris St(S) speed Bus lane sign behind pole (Broadway, W)
44. Are familiar situations (e.g. unusual intersection layouts or other traffic management treatments) – or unexpected responses – avoided?	X			

45. Are the number of alternative courses of action the driver has to take been kept to a minimum ? (e.g. "No Entry")		X		Restrictions on turning
Delineation - Pavement Markers				
46. Are the messages conveyed by pavement markings clear and simply understood?		X		Worn out
47. Are vehicle paths through intersections delineated satisfactorily?		X		Along Broadway
48. Are all lanes properly marked (including any arrows)?	X			
Behavioural adaptation				
49. Are there any features of the road and traffic environment likely to induce behavioural adaptation that compromises safety?	X			Excessive speed

Appendix 2: Site Observations



Intersection notes

Thursday, 20 October 2022 12:17 pm

Volumes

Pedestrian

Intersection 1: 376/15min
Intersection 2: 663/15min
} ~4200/hr (4156)

Car

- 7578 vehicles/15min (4655/703) → 7032 v/hr → (x1.25 = Average Vehicle Occupancy*) → 3800 people/hr (3790)

Δ = 400 more pedestrians
^ Inaccurate ped measurements due to sheer numbers
^ Volumes checked @ mid-day on a typical Wednesday

Misc

- ~6 honks / hr (car beep)
  - 1 vehicle going the wrong way on Harris st (s)
  - Most due to risky lane changes
    -> Harris st, right turn lane
  - Inattentive drivers another cause
- A lot of drivers not following speed limits along broadway for sure
- The return of the beg button caused massive pile-ups of pedestrians
  -> Especially w/ the observed volumes, might need to remove it again

Overall, very hostile pedestrian experience

* Observations re: vehicle occupancy seem to follow data
  -> Didn't actually test as it's real hard
  -> Uber makes it even more difficult
- Clear / overcast conditions
- Queing across intersection along Harris St
  -> Blocking westbound traffic for a bit

~4 UE bikes / minute
-> More during night time probably

Road conditions

Harris St

- Slight incline/hill through Harris
  -> contributes to speeding?
- Can be slightly confusing / convoluted going along Harris st
- Decently wide lanes
- ~20m wide (google maps)

Broadway

- No turns allowed, can be confusing
- Lines faded
- No follow-through lines
- Very wide lanes for the set speed
- Very long pedestrian crossings

~30m wide

Phase timing

Harris:

- Pedestrian green: 7sec
- Total light (w/ all red): 1:00
- Green: 53
- Yellow: 3.6
- All red: 3.1
- Red arrow (right turn): 10
- Yellow arrow (flash): 3.1
- Crossing time: 19

Broadway:

- Pedestrian green: 11s
- Total: 40
- Green: 32
- Yellow: 3.4
- All red: 3.5
- Crossing: 13

Appendix 3: Google Maps Street view

Appendix 4: Additional Images of the Broadway Harris St intersection

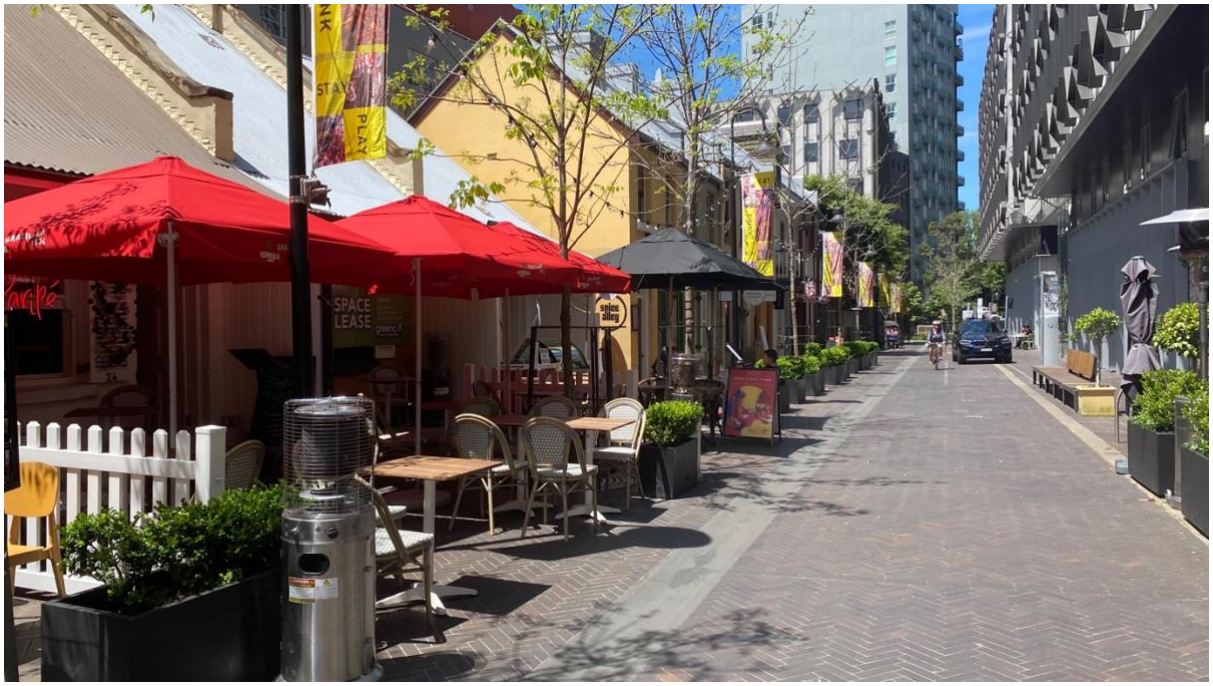
Pedestrian-oriented food & drink establishments along Broadway

UTS building 90m upstream of Broadway

View of Central Park Mall from intersection

Comically small speed limit sign

Wide lanes that do not reflect the posted 40km/h speed limit



Spice Alley & Kensington St located within the vicinity the area. A highly pedestrianised food alley

References

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