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Signalling inequity – How traffic signals distribute time to favour the car and delay the pedestrian.

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Traffic signals are a source of great inequality in the urban realm, giving priority to motor vehicles over pedestrians. Cities and states say (http://www.cityofsydney.nsw.gov.au/vision/better-infrastructure/streets-and-public-places) they want to encourage walking and biking for many reasons: it is space efficient, it has less environmental impact, it is healthier, it is safer for other travelers, and, since, it reduces the numbers of cars on the road, even motorists should be in favour of other people walking. To help achieve that, road management agencies should take the lead in reprioritising traffic signals by redistributing intersection delay from pedestrians to cars.

While planners tend to focus on the long-term decisions, like infrastructure and land development, it is the shortest of short-term decisions, how many seconds of green light each movement gets at an intersection, that shapes daily perception of the feasibility of walking or driving to a destination at a given time, and thus the choice of route, destination, and mode of travel. Traffic signal timing involves math, so it has been historically delegated to the engineers, but it also involves values and priorities, and so is the proper subject of public policy.

Since the early twentieth century dawn of what Peter Norton calls 'Motordom' in his book '*Fighting Traffic (https://mitpress.mit.edu/books/fighting-traffic)*', street space has steadily been regulated and enclosed, limiting the rights and privileges of pedestrians while promoting those of drivers as a class, in the name of safety and efficiency. But we should ask safety and efficiency for whom? Prior to traffic signals, pedestrians could and did cross the street whenever and wherever they wanted, before the term 'jaywalking' was invented and street crossing was regulated. The introduction of signals prioritised the movement of motor vehicles at the expense of pedestrians, whose effective walking speed through the city necessarily slowed. The consequences of making it easier to drive and harder to walk on people's choice of mode is pretty straight-forward, and consistent with the rise of the automobile in the 20th century.

Phases

Pedestrians take longer to cross streets than cars because they move slower. As a result, the 'don't walk' signal flashes before the light turns red for cars. But at many intersections it is worse than that. In Sydney, the traffic signal policy is set at many intersections to give less green time to pedestrians on a phase (from the time the light turns green to when it turns red, or from 'walk' to 'don't walk') than to automobiles, to give autos a protected left turn without having to yield pedestrians. This guarantees the average pedestrian arriving randomly at the intersection waits longer than a random car.

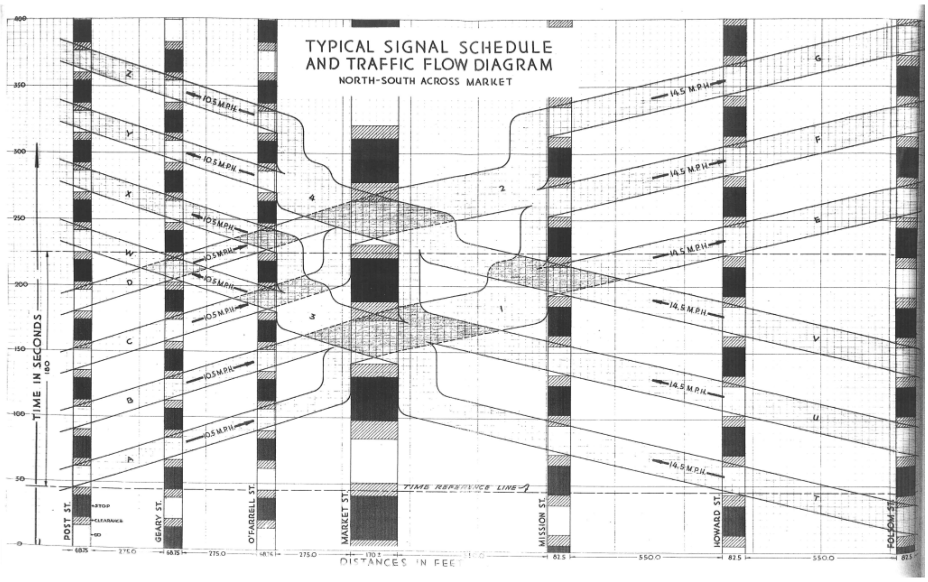
Cycle length

The cycle length (time from the start of the green light to the start of the next green) tends to be longer at busier intersections (and busier times of day) as a longer cycle length reduces the number of phases per hour, and thus reduces the amount of lost time associated each phase, when the intersection is not being effectively used by any approach. Lost time can never be reclaimed, so one understands why engineers might want longer cycle lengths if the objective were moving cars.

However long cycle lengths particularly disadvantage pedestrians, who stand out in the open exposed to the elements and the tailpipe emissions of cars, motorcycles, trucks, and buses. Even more significantly, people systematically misperceive travel delay, so waiting at a traffic light feels even longer than it actually is (http://www.cmnzl.co.nz/assets/sm/4465/61/paper139-Vallyon.pdf).

Coordination

First introduced in 1922 in New York City, traffic signal coordination aims to ensure vehicles arrive at the traffic signal when it is green, so they don't have to stop. By correctly timing traffic signals in sequence, platoons of vehicles move together through a 'green wave'. So let's say the wave is set for a speed of 40 km/h. Then as long as a car accelerates from the first signal to 40 km/h, and maintains that speed, it should then hit the following lights on their green phase as well.



Typical Signal Schedule and Traffic Flow Diagram, North-South across Market Street, San Francisco (1929). Green wave set to 10.5 MPH (about 17 km/h).

While this is relatively easy to maintain on a single road, it is more difficult on a network, especially a complex, asymmetric network. It also works against the idea of actuation, as interruptions to the pattern (extending or contracting phases) change the window in which cars can successfully hit a green light at a given speed. Of course, just because cars can make a green wave at a speed of 40 km/h doesn't mean pedestrians will make a green wave unless they travel at exactly a divisor of 40 km/h (e.g. at exactly 5 km/h between intersections). This means that pedestrians will more likely wait at red lights at intersections timed for cars.

Actuation / Beg Buttons

While some signals are 'fixed time' which eases coordination at the expense of adapting to conditions, modern signals are 'actuated', that is, they respond by adjusting the phasing, and perhaps the cycle time, in response to the presence of vehicles. For vehicles, there is either a camera which detects their presence, or more commonly, a sensor in the road, often a magnetic loop. In either case, this is automatic for the car, and can detect cars upstream of the signal. This allows the signal to stay green longer for a phase if it detects a vehicle approaching, or turn red sooner when there are no vehicles. In contrast, for pedestrians, they are required to push a button to get a walk signal. If they arrive a second too late, they have to wait the entire cycle to get a walk signal. If there are many pedestrians, they don't get a longer walk signal. Pushing the 'beg button' (so nicknamed as the pedestrian must request the signal) twice does not make it come faster or stay green longer. Ten, or a hundred, pedestrians do not make the 'walk' light come faster either. The beg button is often positioned out of the way, requiring the pedestrian to walk longer than would otherwise be required. A few seconds here, a few seconds there, add up.

There is a reason that traffic engineers don't automatically allocate pedestrian phases. Suppose the car only warrants a six second phase but a pedestrian requires 18 seconds to cross the street at a 1 meter/second walking speed. Giving an automatic pedestrian phase will delay cars, even if the pedestrian is not there. And there is no sin worse than delaying a car. But it also guarantees a pedestrian who arrives just after the window to push the actuator passes will wait a full cycle.

The role of signal policy

It turns out that one of the world's most widely deployed traffic signal control systems, the Sydney Coordinated Adaptive Tra tem (https://en.wikipedia.org/wiki/Sydney_Coordinated_Adaptive_Traffic_System) (SCATS), w developed here in Australia. Just as Australia led in traffic control to more smoothly move cars, it should lead in pedestrian-oriented traffic control. There are a number of steps that those concerned about pedestrians should insist on. To start:

- Pedestrians, like vehicles, should be counted automatically (https://edition.cnn.com/2014/09/17/world/europe/scoot-pedestrian-technology/index.html) at controlled intersections.
- Pedestrian time must be considered (and prioritised) in the traffic signal timing algorithms so that their weight is equal to or higher than the weight of a passenger car.
- Pedestrians should get the maximum feasible amount of green time on a phase, rather than the minimum, so that pedestrians arriving on the phase have a chance to take advantage of it, and slower moving pedestrians are not intimidated by cars.
- Pedestrians should get a 'leading interval' so they can step into the street on a 'walk' signal before cars start to move on a green light, increasing their visibility to drivers.
- Pedestrian phases should be automatic, even if no actuator is pushed. Instead, the actuator should make the pedestrian phase come sooner.
- Many more intersections should have an all-pedestrian phase (what is referred to as a 'Barnes Dance') in addition to existing phases so pedestrians can make diagonal intersection crossings without having to wait twice.

There are numerous other steps as well that can improve the life of the pedestrian, and thus increase their number. Certainly we can demand more patience from drivers as well. The advent of the autonomous vehicles over the next few decades is unlikely, by itself, to eliminate the need for traffic control in cities. There will be places where the number of cars and people are such that they cannot efficiently organize themselves, and where other traffic controls, like stop signs or roundabouts, cannot be effectively implemented. But autonomous vehicles should help get more throughput out of intersections, losing less time than human drivers, and behaving far more safely.

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