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Subject: Bicycles and level of service for streets

Road capacity by transit mode

Currently streets are sized for motor vehicle traffic. It is assumed that if there is a trade-off between bicycle and motor vehicle lanes the addition of bicycle lanes will significantly reduce the level of service of the road. A simple analysis of the carrying capacity of a lane of traffic indicates that this assumption is incorrect.

The carrying capacity of a lane of traffic is the product of the average speed of the traffic and the density of the vehicles. For a free-flowing lane for cars we can take the speed to be the speed limit. The density of the traffic is determined by the length of the vehicles, and the spacing required between them for safe operation. We can assume that a car length is about 15 feet. Safe operation of a vehicle usually assumes a one second time between vehicles to allow the following vehicle time to react. At 25 mph this is a distance of 37 feet. This gives a density of 101 vehicles per mile, and a maximum free flowing safe carrying capacity of 2525 vehicles per hour.

For bicycle traffic we assume that if there is only one lane the average speed will be that of the slowest bicyclist. We assume that this speed is only 5 mph. The length of a bicycle is about 6 feet, so the safe spacing at 5 mph is 13.3 feet per vehicle, or 396 bicycles per mile. The maximum free flowing safe carrying capacity of a single lane is therefore 1980 vehicles per hour. If there is a second lane the bicyclists can have a fast lane and a slow lane. We assume 10 mph for the fast lane. This gives 255 bicycles per mile, for a safe carrying capacity of 2550 bicycles per hour.

A standard car lane is 12 feet wide. A bicycle lane can be 4 feet wide or even somewhat smaller, so there can be three bicycle lanes per car lane. Since a bicycle lane has about the same maximum carrying capacity as car lane, this means that the maximum capacity for transporting people by bicycle is equivalent to a car loading of about 3 people per car. This is considerably higher than the normal amount, and suggests that the substitution of bicycle traffic lanes for vehicular traffic lanes could actually increase the transport capacity of a road.

The maximum capacities calculated above are for free flowing traffic with no stops or turns. A stop light will reduce the average speed of vehicular traffic by the fraction of time that it is red, plus a penalty for the time required to accelerate to speed. Acceleration to cruising speed is similar for bicycles and cars, and red lights affect all vehicles equally (at least in theory). A 50% green light fraction will reduce the maximum carrying capacity of a lane for both cars and bicycles and cars to on the order of 1000 vehicles per hour. It should be noted that this is still a fairly large amount, especially when compared to the carrying capacity for a bus lane. A dedicated transit lane, such as is proposed for the Bus Rapid transit, is limited in capacity by the spacing between buses, and the frequency of stops. A heavily loaded bus with 40 people running every 5 minutes carries 480 passengers per hour. The inclusion of traffic control devices, does not appear to make any significant difference to the relative traffic carrying capacity of bicycle versus motor vehicle lanes.

Most car parking is on street, and has a significant potential for slowing traffic. Bicycles can be more easily parked off-street, and it thus appears that parking should less severely affect bicycle through-put than auto through-put.

Conclusion: substitution of bicycle lanes for auto lanes has the potential to actually increase the carrying capacity of existing roads, and reduce congestion.