

# Abstract

## Greenshields' Legacy – Urban Streets

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July 8, 2008  
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While Greenshields is well known for his development of The Fundamental Diagram in Traffic Flow Theory, it is less known that he also made fundamental contributions to the study of traffic behavior at signalized intersections. This was done while he was associated with the famed Yale Bureau of Highway Traffic at Yale University in New Haven, Connecticut in the mid-1940s and culminated in a seminal report entitled “Traffic Performance at Urban Street Intersections” (1).

Greenshields developed instrumentation for the study of traffic behavior at intersections. He then used this instrumentation to study the time-space relationships of vehicle movements at intersections. “It is the total time required to pass a given number of vehicles through the intersection that is of primary interest to the traffic engineer. In analytical categories, this time depends on the integration of individual patterns of reaction time, acceleration, speed and spacing.” He went on to determine the famed “Greenshields Numbers” which measure the time required by successive vehicles to cross a signalized intersection when starting from a standing queue. This led to the determination of signal controlled approach capacity.

Greenshields also studied behavior patterns at unsignalized intersections: “In the absence of a signal to control his crossing, the driver selects the gaps in opposing traffic that he considers large enough to be safe. The rapidity with which the driver makes up his mind and the rate at which he accelerates once he has decided are factors to be considered.” Whence, the well-known method of Gap Acceptance.

Greenshields was also a pioneer in the application of probability theory to traffic problems. Among the typical problems he analyzed are: Traffic Delay Caused by Drawbridge, Accident Exposure due to Obscured Vision, Size of Temporary Storage Space at Parking Lot Unnecessary Stops at Stop Sign, and Optimum Signal Timing (1).

Another concept that he proposed was “the quality of flow index” Q. This index may be defined as a number expressing the desirable ratio of the flow factors of time, change of speed, change of direction and distance. Thus Q is a rate per unit distance. The quality of traffic flow may be expressed by the equation

$$Q = T \times S \times D / L$$

Where Q = quality, T = time, S = change of speed, D = change of direction, and L = distance. The smaller the Q, the better the travel.

Reference:

(1) TRAFFIC PERFORMANCE AT URBAN STREET INTERSECTIONS. Bruce D. Greenshields, Donald Schapiro and Elroy L. Ericksen. Technical Report No. 1. Yale Bureau of Highway Traffic. Yale University, New Haven, Conn. 1947.