URBAN TRANSPORTATION IMPROVEMENTS THROUGH LOW-COST TRAFFIC ENGINEERING MEASURES

Vukan R. Vuchic and Michael J. Weston, University of Pennsylvania

ABRIDGMENT

•AN area in West Philadelphia that has serious and diversified traffic problems was selected as a class project in a graduate traffic engineering course at the University of Pennsylvania. The area was a part of a major Early Action Program planned by the Delaware Valley Regional Planning Commission (DVRPC). The suggested solutions are limited to improvement of existing facilities through regulation and minor redesigns, such as defined by the Traffic Operations Program for Increasing Capacity and Safety (TOPICS).

ANALYSIS OF STUDY AREA

The study area in West Philadelphia, primarily residential in character, is bounded by Baltimore and Woodland Avenues and 40th and 45th Streets. It is situated at the convergence of three important two-way arterials: Baltimore, Chester, and Woodland Avenues, representing the bottleneck of a triangular commuter corridor. Four heavily traveled double-track streetcar lines on the avenues proceed into the tunnel east of 40th Street between Baltimore and Woodland Avenues (known as the "portal"). They have near-side stops at each intersection. A common phenomenon in the area is the tendency for automobile flow along the avenues to be in platoons led by the streetcar.

Parking is allowed along most curbs. Traffic signals operate on a two-phase 60-sec cycle without coordination. Pedestrian crossings are often very long, and there are no signals for pedestrians.

For the study the following data were collected: intersection counts during the a.m. and p.m. peaks, streetcar and passenger counts, speed and delay studies, parking survey, and a physical survey. From these data, the major traffic problems in the area—congestion, low travel speeds, and inadequate safety for streetcars, automobiles, and pedestrians—were found to be caused by the following factors:

1. Streetcar-automobile conflict on Baltimore, Chester, and Woodland Avenues, where both modes use the single lane available for each direction;
2. No traffic signal progression and no signal override provision for the streetcars so that they often suffer double delay although they carry 72 percent of the total passenger volume through the area during the peak hours;
3. Congestion and backup across Baltimore Avenue and 40th Street, a weaving section where streetcars need 40 percent green time, because of the poorly designed streets and the portal area traffic; and
4. The presence of oblique, unsignalized intersections, difficult merges, and dangerous pedestrian crossings.

Planning, Evaluation of Alternatives, and Selection of Proposed Plan

The major planning objectives were to increase speeds of public transportation and automobile traffic in the area; increase capacity of the network, particularly at the most critical points; increase pedestrian convenience and safety; and reduce negative impact of traffic on the area.

Publication of this paper sponsored by Committee on Effectiveness of Operational Measures.

All these objectives had to be achieved without violating the overall project requirement that only low-cost improvements be considered.

Methods for achievement of the objectives include changing traffic flows by establishing one-way operation and closing some sections, changing streetcar line routings and providing tracks separated from other traffic at stops or whole street sections, introducing channelization and lane markings to improve flows through intersections, introducing modern traffic signals and other traffic control devices, and improving parking regulations and ensuring safe pedestrian movements.

Several alternative plans were considered and evaluated on the following set of quantitative and qualitative criteria: directness of automobile and streetcar movements, traffic flow conflicts, transit separation and priority, streetcar-automobile conflicts, pedestrian safety and convenience, level of service for automobile traffic, retention of curb parking, cost, and compatibility with extension of plan to adjacent areas. As a result, the comparative evaluation plan shown in Figure 1 was selected.

THE PROPOSED PLAN

The automobile volumes were reassigned to the revised network, and the obtained flows were used for capacity and signalization analysis. Generally, level of service A is obtained throughout the network. The new 45th Street weave is carrying only 70 percent of the traffic of the present 40th Street weave, yet it has three lanes, is not intersected by streetcars, and is over twice the length. Traffic can proceed on both Chester and Baltimore Avenues without being affected by the stopped streetcar because there are two lanes for one-way movement.

Intersection Design

Substantial revision of the intersections was made without any significant widening of streets. Through improved design it was possible to use only two-phase signals, so that traffic delays were kept to a minimum. Modal separation was a feature that was particularly stressed.

An example of the proposed intersection design is shown in Figure 2. At this intersection, automobiles and streetcars are completely separated by channelization and two-phase signal operation. Pedestrian crosswalks are shortened considerably, and a 14-sec phase is allowed at a pedestrian crossing on Baltimore Avenue east of 45th Street. Streetcars can also actuate this signal in order to enter the westward through-traffic lane after stopping at 45th Street. The existing traffic signal at the Baltimore Avenue-45th Street intersection is eliminated. Volume-capacity analysis for this intersection shows that, during a.m. and p.m. peak periods, the intersection will operate at level of service A on all approach legs. Forty-fifth Street, widened by 2 ft, has three 11-ft wide lanes with an exclusive streetcar lane protected by a raised curb. This street operates during peaks at level of service B.

Transit

The revised network requires relocation of 1,700 ft of track, practically eliminating the streetcar-automobile conflicts. Instead of the existing 27 stop locations, there would be only 15 although the average interstop distance is only increased from 605 to 725 ft. Only 3 stops remain in the single traffic lane on a street, compared to 23 at present.

Pedestrians

No crosswalk in the study area is longer than 44 ft compared to 80 ft at present, and for this a minimum crossing time of 19 sec including 11 sec for clearance has been allowed.

Traffic Regulation

The planning of efficient signalization presented one of the most interesting aspects of this project. Signal phasing and timing were developed with the objectives of providing

Figure 1. Street network for proposed plan.

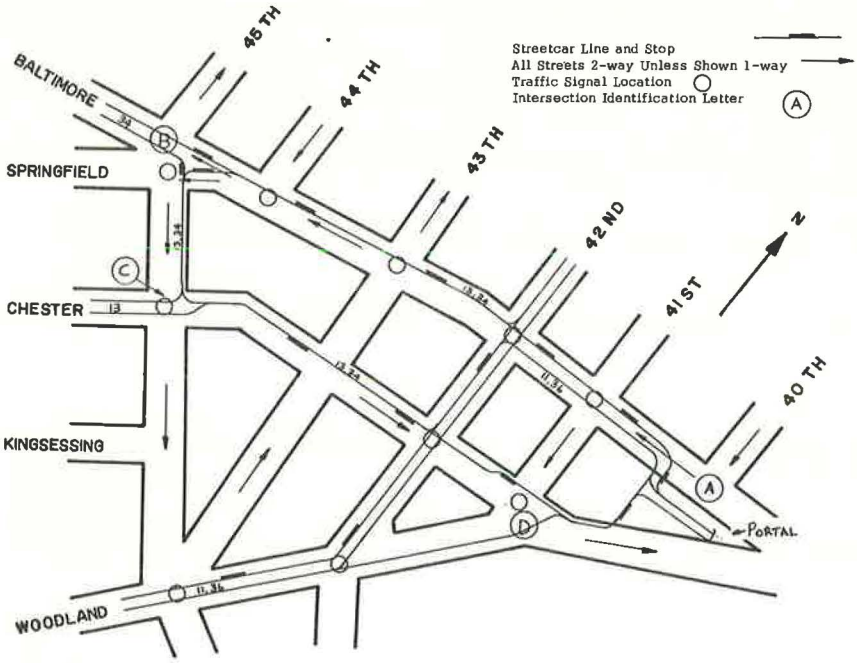
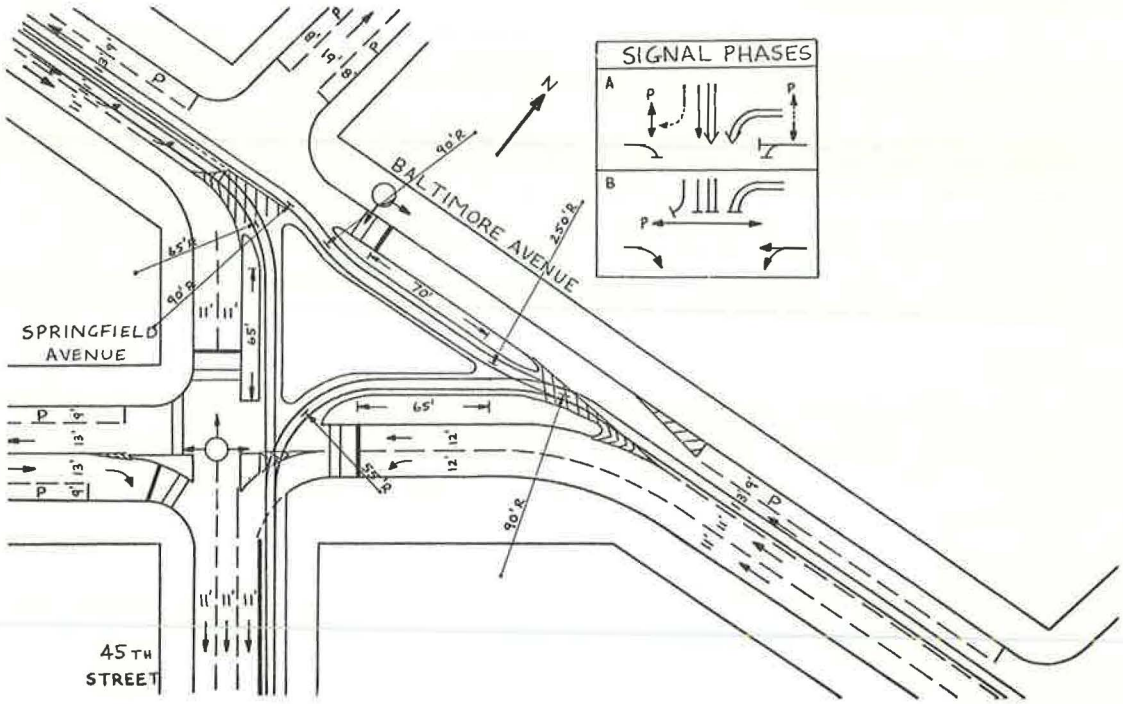


Figure 2. Proposed intersection design.



maximum possible separation of different modes and different movements, ensuring at least level of service B during the peak hours, providing progression for all major movements, and determining timings for minimum person delay, i.e., generally giving priority to transit vehicles.

A progression speed of 25 mph was chosen and wide through-bands were provided for all major flows. For transit priority, it is foreseen that signal preemption devices will be introduced for streetcars to call on the signals when they want to cross the intersection; the call can give them green from the beginning or end of the green time for the other phase.

User Benefits

Because of the limited scope of the study, no comprehensive evaluation of user benefits has been undertaken. However, some estimates have been made of its major component, travel-time savings. Without preempted signals, the average savings to streetcars are 33 percent and 26 percent of their total running time during a.m. and p.m. peaks respectively. Using preempted signals, which would cause slight increases in automobile travel times, these figures increase to 44 percent and 39 percent respectively. Automobile-time savings are even more impressive; they average 56 percent and 60 percent for a.m. and p.m. peaks respectively. These amounts are highly significant; peak-hour savings alone, without and with signal preemption, represent annual time savings of 78,500 and 101,000 person-hours respectively. This includes only the major through movements.

It is possible that the projected speed increases would not be fully realized because the improved conditions would attract higher traffic volumes. This could change the form of benefits: Somewhat smaller time savings and increased convenience would be experienced by a greater number of users. The total benefits would therefore probably still remain in the same range.

SUMMARY AND CONCLUSIONS

The area in West Philadelphia selected for this project represents a typical old-fashioned set of streets designed before motorized traffic. Almost no adjustment to accommodate motorized traffic had been made to these streets. Most streets are two-way without signal coordination. Complicated intersections are not channelized. Streetcar lines, representing the optimal mode because of heavy passenger volumes and tunnel operation from the area to City Hall, and automobile flows both are traffic problems.

The plan adopted on the basis of analysis of all important traffic aspects foresees a number of innovations such as improvement of network flow through one-way street operation, consolidation of streetcar lines to fewer but higher-type sections, separation of their stops to locations not conflicting with traffic, channelization of several intersections, and introduction of modern coordinated signals with transit priority feature. In summary, the proposed plan would virtually eliminate streetcar-automobile conflict, increasing reliability and safety of both; substantially reduce uncontrolled conflicts of automobile flows; result in an estimated speed increase of 50 percent for streetcars and 100 percent for automobiles; increase considerably network capacity in the area; provide for safe and convenient pedestrian movements; reduce the number of parking spaces by 14 percent (the only significant negative effect); and be conducive to extension into adjacent westward areas.

Because the plan is consistent with TOPICS, it involves a relatively low investment, is conducive to immediate implementation, and would be, according to rough estimates, highly cost-effective. Thus, this project clearly shows in general how badly underutilized urban streets can be improved to increase capacity, speed, and safety at a fraction of the cost that new facilities would require.

This plan is currently being considered by the various agencies planning the improvements in this corridor.

ACKNOWLEDGMENTS

The student team consisted of K. Balchunas, H. Evoy, M. Marcy, H. Park, J. Vitunic, and M. Weston (project leader). The cooperation of J. Boorse and J. O'Connell, city of Philadelphia; I. Pierce, DVRPC; F. Berdan, SEPTA; T. Harvey, Drexel University; and L. Gamel, Wilbur Smith and Associates is gratefully acknowledged.