New Traffic Signals
Their Effect on Street Utilization

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The average citizen appears to be convinced that the solution to any traffic problem, involving vehicular or pedestrian right-of-way, is a traffic signal. On the other hand, every city traffic engineer has probably stated that, a traffic signal at A street and B street will increase accidents and delays, if the location does not "meet the warrants," or if intuition tells him it should not be installed. He may or may not have factual data to support the statement.

Will the installation of a traffic signal increase or decrease accidents and/or delays? The answers depend on the intersection, the traffic pattern, the previous traffic control, and the traffic signal installed. Even the most superficial investigations will show that accidents and delays have decreased following some traffic signal installations, and have increased following others. The real problems are to identify the physical and traffic characteristics under which signals will produce improvements in accidents and delays, and those under which undesirable results will occur. Answers to these problems could shed real light on traffic signal warrants, and should also aid in improving design standards for traffic signal installations.

Accident record data are available for before and after studies of most traffic signal installations. Delay studies are much less common, and unless made in advance, there is no practical way to recreate before information. In any case, there are so many factors and variables beside the signal installation which affect the comparative results, that a rigorous statistical analysis of accident and delay studies at a large number of intersections is difficult.

It is possible, however, to study the effects of new signals on street utilization by means of group studies of intersections to determine if general patterns can be found. Also, case studies can be made at intersections where significant changes have occurred in either accident records, delays, or both. The remainder of this paper will consist of reports of two such group studies, followed by a number of case studies at individual intersections with which the author has had experience in Cincinnati.

While assembling and preparing data for this paper, the author learned of the report prepared by Paul C. Box for the Signal Committee, NJCUTD, "Assembly, Analysis and Application of Data on Warrants for Traffic Control Signals," which is an exhaustive study of pertinent data most of which are directly applicable to this paper. His report also includes a bibliography of 264 references. With that report as background, this presentation will be limited to the unpublished studies from Cincinnati.

ACCIDENTS AT INTERSECTIONS BEFORE AND AFTER SIGNALIZATION, 1950-1957

In 1959, a study was made by the Cincinnati Division of Traffic Engineering of accidents occurring before and after signalization at 152 intersections where traffic signals were installed during the years 1950 to 1958. The study was quite general in nature, being a comparison of the average number of accidents per year for the five years immediately preceding signalization, against the average number of accidents per year for the period from the installation date through 1959. The comparisons were made in three categories: (a) all accidents; (b) injury and fatal accidents; and (c) pedestrian injury accidents.

No attempt was made to evaluate changes in traffic volumes or patterns, to compare accident rates, nor to evaluate fulfillment of traffic signal warrants. It also was not practical to evaluate previous deficiencies which might have existed in the stop sign control, such as poor stop sign location, or visibility obstructions which could have been eliminated. Design adequacy of the signal installation also was not evaluated.

In general, the before traffic control at the intersections consisted of stop signs for the cross or side street, although there were a few (less than 10) four-way or all-way stops. The signals were installed according to standards of the time, using overhead, far side mountings, dual indications on major approaches, and pedestrian signals where required. At all intersections where progression problems existed, and/or where side street volumes were very low, coordinated semi-actuated controllers were installed. Most of the few isolated locations were actuated unless minimum volume warrants were met. Signals installed later in the study period were generally designed to higher standards than the earlier ones.

The study did not include locations where major physical reconstruction had taken place, but many of the signalization projects did include intersectional channelization. The results of the study were as follows:

All accidents after signalization:
- Yearly average increased at 102 intersections
- Yearly average decreased at 23 intersections
- No significant change at 27 intersections

All injury and fatal accidents after signalization:
- Yearly average increased at 58 intersections
- Yearly average decreased at 24 intersections
- No significant change at 46 intersections

Pedestrian injury or fatal accidents after signalization:
- Yearly average increased at 30 intersections
- Yearly average decreased at 32 intersections
- No significant change at 90 intersections

This study obviously showed no general advantage of traffic signal control as an accident prevention measure and, in fact, indicated that it was much more common for accidents to increase after signalization although there were some dramatic improvements at individual intersections. The picture was somewhat better with respect to accidents resulting in injury or death and pedestrian accidents, but still gave no support to signalization as a general safety measure.

The few locations identified as four-way or all-way stops before signalization showed no significant difference in pattern from the remainder of the group.

ACCIDENTS AT INTERSECTIONS BEFORE AND AFTER SIGNALIZATION, 1959-1964

In 1967, a study was made in Cincinnati of 32 intersections, comparing accidents in the calendar years immediately before and immediately after the year in which the signals were installed, as a starting point. The results of this initial comparison were as follows:

All accidents after signalization:
- One year total increased at 10 intersections
- One year total decreased at 22 intersections

All injury and fatal accidents after signalization:
- One year total increased at 7 intersections
- One year total decreased at 14 intersections
- No significant change at 11 intersections

Pedestrian injury and fatal accidents after signalization:
- One year total increased at 2 intersections
- One year total decreased at 6 intersections
- No significant change at 24 intersections

This study shows far more favorable results from signalization than did the earlier study, with respect to accident reduction. The reasons for this improvement are not

TABLE 1

SIGNALIZED INTERSECTIONS—BEFORE AND AFTER STUDY, APRIL 1967

Intersection	Total			Injury/Fatal Accidents			Approach Lanes		Warrant 1	Warrant 2	Warrant 3	Warrant 4	Warrant 5	Warrant 6
	Before (1 yr)	After (1 yr)	Change	Before	After	Change	Major Street	Minor Street	Volume	Interruption	Pedestrian Volume	Progressive Movement	Preventable Accident History	Combinations
Stanton and Taft	25	3	-22	2	0	-2	2	1	892/100	892/100[a]	/	OK	20[a]	
Burton, Greenwood and Reading	25	10	-15	5	3	-2	3-2	1	1671/81	1671/81[a]	1671/45	Poor	NA	
Harrison and Westwood	22	8	-14	2	0	-2	3-2	2	1221/344[a]	1221/344[a]	1221/64	OK	1	
Eastern and Kellogg	17	6	-11	0	0	—	2	2	1022/310[a]	1022/310[a]	1022/194	NA	7[a]	
Eastern and Linwood	10	3	- 7	2	0	-2	2	2	665/289[a]	665/289[a]		OK	1	
Eighth and Trenton	11	4	- 7	1	0	-1	2	1	490/94	490/94	490/86	Poor	3	
Race and Thirteenth	14	8	- 6	1	0	-1	2	1	391/237	391/237	391/174	OK	5[a]	
Clifton and Warner	8	4	- 4	0	0	—	2	1	444/113[b]	444/113	444/61	OK	5[a]	
Edwood, Faircrest and North Bend	6	2	- 4	0	0	—	2	1	957/106	957/106[a]		OK	2	
Grand and Warsaw	11	7	- 4	4	2	-2	2	1	439/101	439/101		OK	NA	
Kennedy and Woodford	9	5	- 4	0	1	+1	1	1	256/119	256/119	256/15	NA	NA	
Montgomery, Orchard and Robison	7	3	- 4	1	0	-1	2	1				OK	NA	
Overlook and Rapid Run	10	6	- 4	2	2	0	1	1	262/132	262/132		NA	5[a]	
Hamilton and Knowlton	6	3	- 3	1	0	-1	2	1	883/54	883/54	883/72	Poor	1	
Ludlow and Middleton	5	2	- 3	0	0	—	2	1	771/83	771/83[a]	771/20	OK	NA	
Argus and North Bend	7	5	- 2	0	0	—	2	1	957/136[b]	957/136[a]		OK	0	
Eastern and St. Andrews	4	2	- 2	1	0	-1	2	1				Yes[a]	1	
Evans and Gest	4	2	- 2	0	0	—	1	1	450/227[b]	450/227	/	NA	0	
Madison and Victory Parkway	25	23	- 2	1	3	+2	2	2	1139/510[a]	1139/510[a]	/	OK	NA	
North Bend and Savannah	6	4	- 2	0	1	+1	2	1				OK	3	
Banning, Belmont and North Bend	9	8	- 1	2	1	-1	2	2	792/196[a]	792/196[b]		OK	4	
Center Hill and North Bend	2	1	- 1	1	0	-1	2	2	666/69	666/69		OK	0	
Eastern and Hazen	1	2	+ 1	0	0	—	2	1				NA	0	
Glencross, Mitchell and Tower	1	2	+ 1	0	0	—	2	1	635/46	635/46		OK	0	
Eastern and Wenner	1	3	+ 2	1	0	-1	2	1				Yes[a]	0	
McHenry and Westwood Northern	4	6	+ 2	1	1	0	2	2	538/114	538/114		NA	0	
Highland and Ringgold	3	6	+ 3	0	2	+2	2	1				OK	0	
Linwood and Paxton	0	5	+ 5	0	1	+1	1	1	576/36	576/36		OK	0	
Froome, Gray and Winton	3	9	+ 6	1	0	-1	3	1	571/116[b]	571/116[b]	571/6	NA	0	—[a]
Herschel and Linwood	5	12	+ 7	0	1	+1	2	1	706/92	706/92		OK	4	
Baltimore and Westwood Northern	7	18	+11	0	2	+2	2	2	452/62	452/62		NA	2	
1961 MUTCD Warrants: One Lane									500/150	750/75	600/150		5	
Two Lanes									600/200	900/100	600/150		5	

[a] Warrant met.
[b] 80% of warrant.

TABLE 2

DELAY DATA EDWOOD AND NORTH BEND

Street	Approach Time	Volume		Avg. Delay Per Vehicle (sec.)		Total Delay (veh-hr)	
		1960	1967	1960	1967	1960	1967
SB Edwood	A. M.[a]	323	352	25.15	28.17	2.25	2.75
	P. M.[b]	167	172	20.06	35.2	0.93	1.73
NB Edwood	A. M.		29		20.7	0.20[c]	0.17
	P. M.		17		37.0	0.25[c]	0.18
Side Street total	A. M.					2.45	2.92
	P. M.					1.13	2.66
EB North Bend	A. M.				18.1[d]	0[c]	3.39
	P. M.				29.3[d]	0[c]	1.54
WB North Bend	A. M.				12.7[d]	0[c]	0.75
	P. M.				14.5[d]	0[c]	2.17
Main Street total	A. M.					2.45	4.14
	P. M.					1.13	3.71
Grand total	A. M.					2.45	4.89
	P. M.					1.13	3.71

[a]7:00 to 9:00 a.m.
[b]4:00 to 6:00 p.m.
[c]Estimated.
[d]Per delayed vehicle.

entirely clear, with possibilities being improved signal design standards, different application of warrants, and better geometric treatment in connection with signalization. In any case, further study of these intersections, the conditions leading toward their signalization, and the design problems involved seemed warranted.

All intersections were installed to current standards which are considerably higher than in the earlier study, and included all overhead vehicular signals and dual indications for all approaches with volumes greater than 3,000 veh/day. Every intersection in the group included pedestrian signals and all but one is traffic actuated. Two of the intersections were four-way stops before signalization.

Table 1 shows the intersections with an evaluation of preinstallation data versus the numerical and specific warrants for pretimed signals in Section 3-D of the 1961 Manual On Uniform Traffic Control Devices.

Although this evaluation is by no means conclusive, it does show a pattern of support for the present warrants with respect to the effect of signalization on accidents. Of the seven intersections having accident reductions of six or more after signalization, all but one met fully one or more of the standard warrants. Of the three intersections meeting the accident experience warrant, each showed a significant reduction in accidents.

Conversely, of the ten intersections showing an increase in accidents following signalization, only two met any semblance of warrants. One of these, Eastern and Wenner, was warranted only on a very marginal progressive movement basis. The other met, marginally, the 80 percent warrants for volume and interruption to continuous traffic.

The study gave very little support to the idea that unwarranted signals, per se, will increase accidents, since there were nine intersections meeting none of the standard warrants, where accidents did decrease to some degree after signalization. The study results, and investigation of the intersections involved, suggest that significant increases in accidents after signalization occurred at locations with serious design problems, or serious deficiencies in signal design, or both, and were largely independent of warranting conditions. Such design problems might well include severe approach grades, approach grades or alignment resulting in inability to provide adequate advance signal visibility, and unsatisfactory location for progressive signal timing.

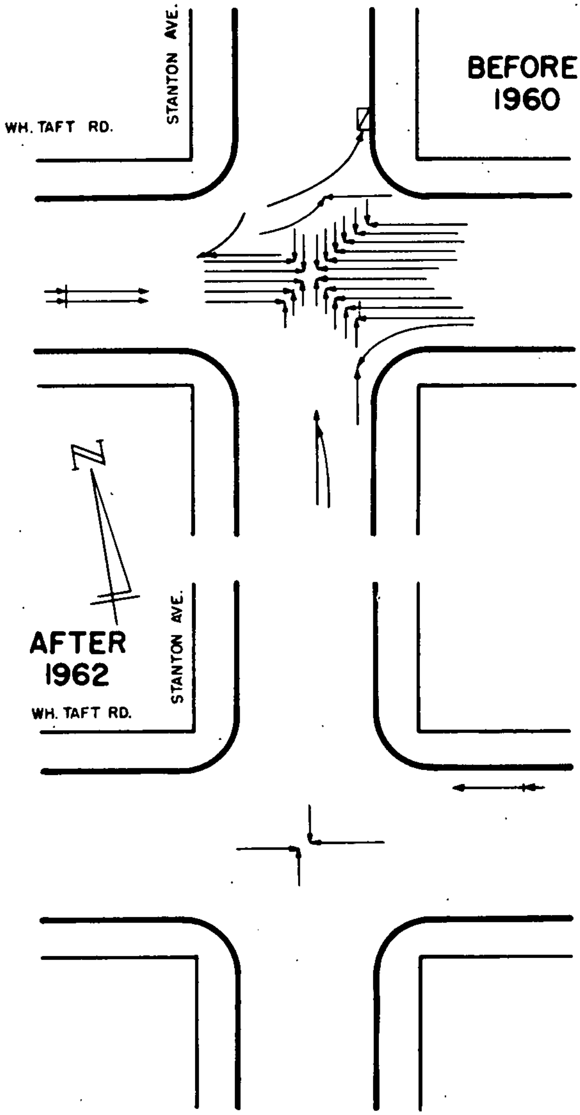

Figure 1.

CASE STUDY—ACCIDENTS AND DELAYS
BEFORE AND AFTER SIGNALIZATION, NORTH BEND AND EDWOOD

General Data

The intersection of North Bend and Edwood was signalized in 1962 from two-way stop control, following a long history of citizen requests. North Bend Road is a major cross-town arterial route, 4 lanes wide. Parking is prohibited during rush hours and is so light at other times that all four lanes are generally available and used. Edwood Avenue is a two-lane roadway, with one approach being a collector-type thoroughfare and the other approach a "no outlet" entrance to a small residential area. The

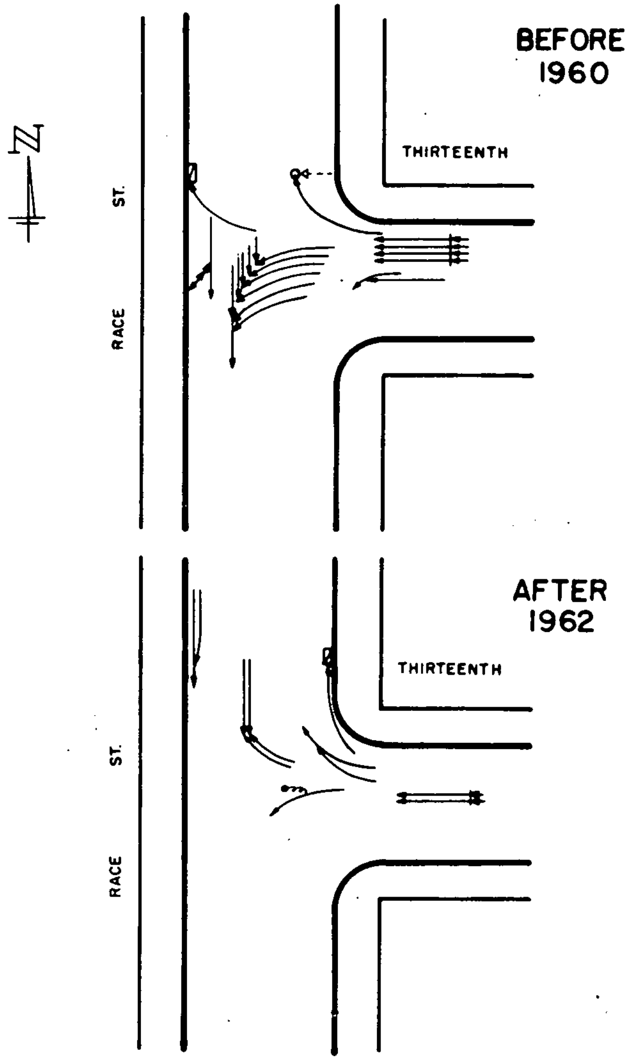

Figure 2.

intersection is level, nearly at a right angle, and visibility is excellent. At the time of signalization, the 1961 MUTCD interruption of continuous traffic warrant was just met, with eighth highest hour volumes of 957 vehicles from both directions on North Bend and 106 vehicles from the higher approach from Edwood.

The signal is semi-actuated and is the end signal of a coordinated system including six other signals. The cycle length is 60 sec, with the cross-street minimum 9 sec and maximum 17 sec.

Accidents

Reported accidents were 6 in 1961 (before signalization) and 17 in the 3-yr period from 1963-1965 (after signalization). There was some increase, as might be expected, in

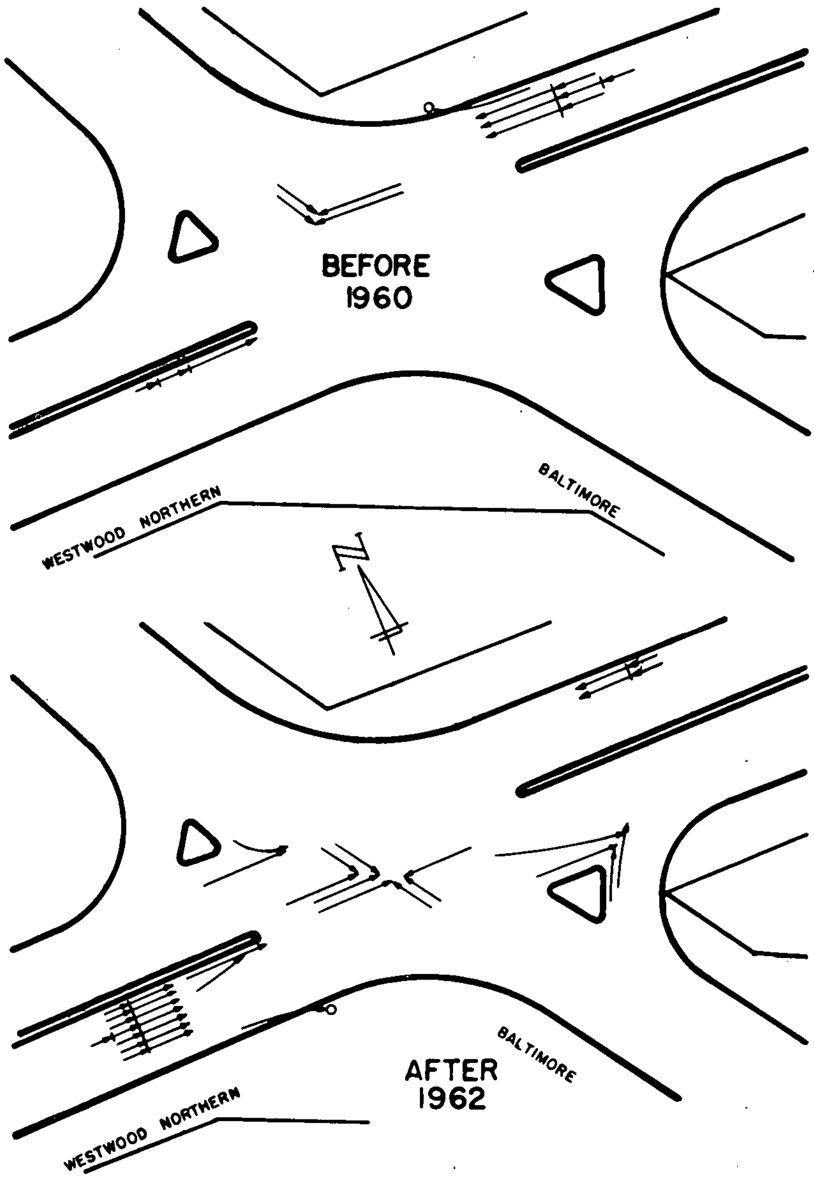

Figure 3.

rear-end and side-swipe accidents, and a decrease in certain miscellaneous types. There was one right-angle accident in 1961 (before) and two in the 1963-65 (after) period. There were no injuries or fatalities, and no pedestrians involved in any of the accidents before or after. It is concluded that signalization did not result in a significant change in accident experience at this intersection.

Delays

Delay studies for four peak hours were made on Edwood, in 1960, two years before signalization, and on all approaches in 1967, five years after signalization. The results cannot be compared directly because of significant volume increases on both streets, and the 1967 studies lacked an hourly separation, covering the two-hour periods of 7:00-9:00 a. m. and 4:00-6:00 p. m. Table 2 gives the results of the two studies.

Total delays were greater after signalization on every approach for which before data were available. The increase on the side street was minimum during the morning rush hour, when side street volumes were at a maximum. Delays on each major street approach varied directly with the volume, but delays on the westbound approach were substantially smaller than on the eastbound approach, apparently because of the progressive timing and platooning effect. It can be assumed that nearly all signalized delay on the major street is an increase over the two-way stop conditions, although there is some error in this due to left-turn delays, and friction from side street entry into minimum gaps. The results seem generally consistent with the work of Paul Box.

Results of this study support the conclusion that for an intersection just meeting the interruption warrant, delays will be substantially increased on all approaches by signalization. The increased delay on the minor street will be proportionately greater at lower volume levels, while the increase on the major street will be proportionately greater at peak volume levels.

Although delays at this intersection were substantially increased by signalization, there is a major difference in the apparent acceptability to the public of delays under signalized conditions, as compared to two-way stop conditions, particularly on the minor street. The knowledge that an opportunity to move within a reasonable time is provided seems to make a higher level of delay acceptable to the public under peak-volume conditions, although we have no actual evaluation of this factor.

CASE STUDIES—ACCIDENTS BEFORE AND AFTER SIGNALIZATION

Stanton Avenue and Taft Road

This is a right-angle cross intersection with four lanes on the major street, Taft Road, and two lanes on the minor street, Stanton Avenue. Taft Road is a major cross-town arterial, which legally and physically is two-way, but paired with a parallel street to form, for signal timing purposes, a one-way couplet. Signals on Taft are progressively timed for westbound traffic, and the signal installed at Stanton in 1961 was semi-actuated and coordinated in this westbound progression. Volumes on Taft show the effect of the signal system and are substantially heavier westbound. Stanton is a neighborhood collector street. The intersection met the interruption warrant when installed in 1961. Buildings and shrubbery limit visibility of approaching westbound traffic when entering from Stanton.

In 1960, there were 25 reported accidents, 18 of them right angles, of which 12 involved eastbound traffic on Taft. In 1962, after signalization, there were only three accidents, as shown in Figure 1. The 1963-65 average was 7. 3 per year. There were only three right-angle collisions in the four years after signalization.

Unexpectedly, however, a serious pedestrian accident problem developed after signalization, with seven such accidents in three years. Three involved failure of a turning driver to yield right-of-way, while four involved signal violations, two by drivers and two by pedestrians. There were no pedestrian accidents the year before signalization.

While the pedestrian problem is not readily explained, this intersection seems to be an example of one well adapted to signalization, meeting interruption and accident experience warrants, at which highly satisfactory accident reduction results were produced by signalization. The visibility restriction seems to have been an important factor in the unsatisfactory accident record under two-way stop control, and proved largely correctable by well-designed signals.

Race and Thirteenth Streets

Race and Thirteenth Streets is an example of an intersection meeting the accident experience warrant only, at which signalization produced good results in accident reduction.

The intersection is a level, T-type, with Race the north-south major and Thirteenth the minor street from the east. Race Street becomes one-way southbound starting at Thirteenth, and Thirteenth Street is one-way westbound. The intersection is on the fringe of downtown Cincinnati, and the signal installed in 1961 is pretimed, and coordinated on both approaches on the downtown signal system. Pedestrian volumes are very heavy, and were a major factor in the decision to signalize the intersection.

There were 14 accidents in 1960, as shown in Figure 2. After signalization, there were 8 accidents in 1962 and a total of 14, or 4.67 per year, for the next three years, a substantial improvement.

Baltimore Avenue and Westwood Northern Boulevard

Signalization of this isolated, oblique angle, cross intersection located on a hillside, was a catastrophe. Westwood Northern, the major thoroughfare, approaches the intersection from the west on a steep upgrade of 9 percent, cresting with a hump 100 ft west of the intersection. The east approach is on a curving 8 percent downgrade. Westwood Northern is a four-lane facility with a 2-ft wide raised median strip. Baltimore is 36 ft wide, generally two lanes, but on the signal approach is used for two approach lanes in each direction.

It was felt that the previous four-way stop control was inappropriate on a major thoroughfare, and two-way stop control was not practical because of the restricted visibility to the west. Therefore, although no standard warrants were met, a semi-actuated signal was installed in 1961.

In 1960, there were seven accidents (including two angle collisions), and no injuries. In the four years following signalization, there were 83 accidents, an average of 21 per year, including 10 injury accidents. There were eleven right-angle collisions, and a very large number of rear-end, side-swipe and turning movement accidents.

The approach grades and alignment at this intersection, coupled with high approach speeds, created difficult design problems, which obviously were not solved in the original signal installation. Deficiencies included inadequate approach visibility of the eastbound signal indications, inadequate yellow intervals for the prevailing speeds, poor signal visibility for southbound Baltimore. It may also be that a fully actuated operation would have reduced the frequency with which groups of vehicles on Westwood Northern are stopped, as compared with the semi-actuated operation. The one-year before-and-after accident diagram is shown in Figure 3.

It is hoped that corrective measures will bring the accident hazard at this location under control. It also emphasizes the importance, first, of careful signal design where operating problems are present, and second, of monitoring accident records carefully so that a situation such as this one does not go uncorrected for four years.

CONCLUSIONS

The foregoing studies are by no means conclusive. However, the author believes that data suggest the following points for consideration and discussion:

1. Signalization is not, per se, a reliable accident reduction measure.
2. Signalization is most likely to produce an accident reduction when standard warrants are met, and is most likely to produce a significant increase in accidents where signal control is unwarranted.
3. Notwithstanding, a well-designed traffic signal installation need not produce a significant increase in accidents even at locations where signalization is completely unwarranted, unless special design problems are present.
4. Where serious accident increases do occur following signalization, the problem can usually be traced to design problems and signal design deficiencies, unrelated to presently established warrants.

5. Restricted visibility of approaching traffic is an important factor in intersectional right-of-way control not directly covered in present warrants, and an important design factor in signalization regardless of warranting conditions.

6. Signalization will substantially increase intersectional delay at the volume levels provided in the 1961 MUTCD warrants.

7. A delay warrant for signalization appears to be desirable. However, it should take into account the varying acceptability to the public of different levels of delay under different traffic control conditions.

REFERENCES

1. Box, Paul C. Assembly, Analysis, and Application of Data on Warrants for Traffic Control Signals. Signal Committee, National Joint Committee on Uniform Traffic Control Devices, 1967. (Lists 264 references on this subject.)
2. Kuemmel, David A. A Study of Delay and Accident Characteristics of Four-Way Stop and Signalized Intersections in the City of Milwaukee. Unpublished thesis, University of Wisconsin, 1960.

Addenda

NEW HAVEN, CONN.

Flashing Signals Overnight

In 1962 New Haven installed a radio interconnected, pre-programmed, multi-dial multi-offset signal system. In programming the 24-hr 7-day operations, 8 of the 90 total CBD locations were set up for "overnight flash" from 1:00 a. m. to 6:00 a. m. weekdays, and 2:00 a. m. to 7:00 a. m. weekends. Two years later, routine accident record review revealed a tendency toward severe inter-angle accidents at 4 of the locations, during the overnight flash period. The number of accidents in nighttime operation was not alarming—averaging about 2 each location yearly over 24 months. However, the staff had immediate concern with the severity involved for downtown locations. Sight distance deficiency combined with prevalent motorist behavior in passing through flash locations was determined to be the cause. Four locations were programmed back to 24-hr fixed-time operation, and 4 were retained for overnight flash, according to the following criteria:

1. Motorist observance (in New Haven) of flash locations (red on minor, amber on major) is generally satisfactory during daytime, but markedly poor at night, especially during the midnight to 6:00 a. m. hours.

2. Where intersection sight-distance is deficient (as is generally true in downtown areas) observance is a vital necessity. The 4 locations experiencing severe accidents, in all cases, were deficient in sight distance.

3. Volume studies indicate most downtown intersections did not warrant fixed-time signal operation in the so-called overnight period. However, the considerations of item 2 are the primary guidance for establishing overnight flash.

4. Overnight flash is a motorist convenience and is desirable where conditions allow such operation. Some back-up device, possibly a "blank out" type stop sign, which could be activated during flash to supplement the red approach, may be necessary where motorist observance rates are unsatisfactory to permit use of flash alone. (It is interesting to note that the "old type" signal lens had STOP etched across the face of the lens.)

4:00 P. M. Signal

This is a factory location, with four pedestrian and vehicle surges daily. Traffic through the intersection is unidirectional other times. The signal is programmed to operate fixed time for the four periods, about 30 min each, weekdays only. The signal has favorable geometric relationships to other signal locations, and the factory population is steadily increasing. After fixed-time operation, the signal reverts to flashing operation. In effect, the programming plan provides signal control when volume conditions warrant such control, and flashing control is effected when volumes drop below warrants.

WASHINGTON, D. C.

The 1965 Accident Summary for Washington, D. C., indicates 163 locations with fifteen or more reported accidents. This figure increased to 190 locations in 1966. In 1965, 148 or 90 percent of these high accident locations were signalized intersections.

A summary of the work by Mike Flanakin in connection with the Bureau of Public Roads project of "Accident Experience as Related to Regular and Flashing Operation of Traffic Signals" follows. In addition, news releases which were used in connection with the conversion of a large group of signals from nighttime flashing to full 24-hr color operation are also included.

Accident Experience as Related to Regular and Flashing Operation of Traffic Signals

Results of an investigation in Washington, D. C., indicate that, under the studied conditions and from a traffic standpoint, regular signal operation is safer than flashing operation. A group of 162 traffic signals in the District of Columbia was changed from flashing operation in the early hours of the morning to full color operation. Accident experience at those locations, corresponding to the hours involved, was analyzed for periods of five months before and after the change. The same analysis was conducted with other groups of intersections where no change was made and compared with the first analysis. The purpose was to determine which overall trends compensate each other, and eliminate the effect of variables other than the change in signal operation.

The results showed that total accidents diminished significantly by about 40 percent at the locations where signals were changed from flashing to full colors and during the hours of the change. Those accidents represent approximately 2 percent of the total traffic accidents in Washington, D. C.

About 60 percent fewer angle collisions occurred after the change was made, while all personal injury accidents were down by more than 50 percent. Also, the severity of the accidents was less after the change was made.

Action of the Board of Commissioners

The Board of Commissioners, D. C., on March 21, 1967, approved a recommendation from the Director of Highways and Traffic that 79 existing traffic signals in the city be placed on full 24-hr color operation.

This recommendation was based on a recently completed two-year study that involved an analysis of nighttime accident experience in relationship to full color and flashing operation of traffic signals. Results of this study have indicated that certain types of signalized intersections, such as exceptionally wide streets, roadways with median strips, and locations where approach speeds are relatively high, lend themselves to 24-hr color operation, and that the conversion from flashing to full color will materially reduce the number and severity of nighttime accidents at certain signalized intersections.

Some of the main arterial streets included in this change-over from flashing operation between 1:00 and 6:00 a. m. to full color operation are Wisconsin Avenue, N. W., 16th Street, N. W., Constitution Avenue, N. E., and South Capitol Street. Each of these major traffic arteries carries in excess of 30, 000 veh/day.

The proposal approved by the Board had the prior endorsement of the Traffic Division of the Metropolitan Police Department and the Citizens' Traffic Board.

The Department of Highways and Traffic, D. C., estimated that approximately two months would be required to complete the proposed conversion, and when completed, 440 out of 1, 000 signalized intersections in the District of Columbia would be in full color operation.

BETHANY, OKLA.

Experience with flashing operations in small cities during the night hours has resulted in few accidents, as shown by the following data concerning four signalized intersections in Bethany, Okla. (population 20,000), on US 66.

Intersections 1 and 2 are in a small CBD-college area. The other two are ½ mile and 1½ miles west of the CBD in heavily developed residential areas. All flash amber on US 66 and red on cross streets from midnight until 6:00 a. m.

1. US 66 and College Avenue

Traffic volumes (24 hour) are approximately 3000 veh/day on College Avenue and 24, 000 veh/day on US 66.

Accident Experience (2 years):

Total reported accidents	19
Property damage accidents	15
Injury accidents	4
Accidents between midnight and 6:00 a. m.	0

2. US 66 and Asbury Avenue

Traffic volumes (24 hour) are approximately 2800 veh/day on Asbury Avenue and 23, 000 veh/day on US 66.

Accident Experience (2 years):

Total reported accidents	18
Property damage accidents	16
Injury accidents	2
Accidents between midnight and 6:00 a. m.	0

3. US 66 and Rockwell Avenue

Traffic volumes (24 hour) are approximately 8400 veh/day on Rockwell Avenue and 20, 000 veh/day on US 66.

Accident Experience (2 years):

Total reported accidents	28
Property damage accidents	19
Injury accidents	9
Accidents between midnight and 6:00 a. m.	3

4. US 66 and Council Road

Traffic volumes (24 hour) are approximately 4000 veh/day on Council Road and 16, 000 veh/day on US 66.

Accident Experience (2 years):

Total reported accidents	38
Property damage accidents	19
Injury accidents	14
Fatal accidents	1
Accidents between midnight and 6:00 a. m.	0