Relation of Traffic Signals to Intersection Accidents

CASE HISTORIES FROM MICHIGAN SIGNALIZATION EXPERIENCE

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● THE unprecedented expansion of vehicular volumes since the war is putting the existing highway structure to a tremendous test and is revealing glaring deficiencies created by enforced neglect during the war years. The public is clamoring for relief and its demands can be met only by the construction of new facilities and by improving the operation of the old.

The traffic engineer has the responsibility for operating traffic on the plant as it exists. Regardless of the inadequacies, he must keep traffic moving as efficiently and safely as possible. In view of the importance and difficulty of his job, he not only must analyze his problems thoroughly but must examine the tools of his trade continuously and critically. This paper presents early results of some investigations in Michigan of one class of these tools — traffic control signals.

The conditions demanding rural traffic regulation and protection are, for the most part, concentrated in and about intersections. A recent study of accident experience on a heavily traveled suburban trunkline in Michigan revealed that 70 percent of all the accidents occurred on the 30 percent of the route in intersection areas. This study had particular reference to the influence of roadside features in accident causation, but since roadside establishments cluster about practically every important intersection, the results are entirely characteristic.

It appears, then, that the requirements for the operation of traffic between intersections are understood and are not too hard to provide. But where traffic streams intersect, the problems of efficient, safe movement are multiplied. The difficulties inherent in this situation have long been recognized, and certain standard methods of intersection traffic regulations and protection have been developed and used.

Where traffic volumes are low, stop signs halt entering traffic for a convenient opportunity to cross or turn onto the main highway. Where both traffic streams are extremely heavy, grade separations permit uninterrputed movement on and interchange between both routes. But the real problems arise at intersections with volumes too large for stop signs to be effective, and yet not large enough to warrant a costly separation structure.

These intermediate locations constitute a twilight zone in which opinions as to proper traffic-engineering procedures jostle as violently as the vehicles themselves and sometimes quite as unreasonably. Stop-and-go signals and flashers are the accepted means of traffic control at these intersections. The basic cause of the conflicts of opinion is a widespread confusion, and even ignorance, regarding the function and proper use of the first of these signals.

The signal salesman of the past offered the stop-go signal as a panacea for all traffic ills, and since safety was a condition sought by his customer, he labelled it a safety device. The public generally still holds to this belief.

As a matter of fact, the stop-go signal is nothing more than a regulator valve. Properly applied and operated, it can produce orderly flow in two intersecting traffic streams, and traffic safety is an important by-product of traffic order. But order, and not safety, is the functional purpose of signalization; neither orderly movement or its byproduct, safe movement, will be obtained unless the signal is applied to the right conditions in the right way.

Some years ago the Michigan State Highway Department began to suspect that signal installations do not necessarily end accidents. It appeared that what they really do is to alter traffic behavior and, for that reason, produce a different accident pat-

Figure 1.

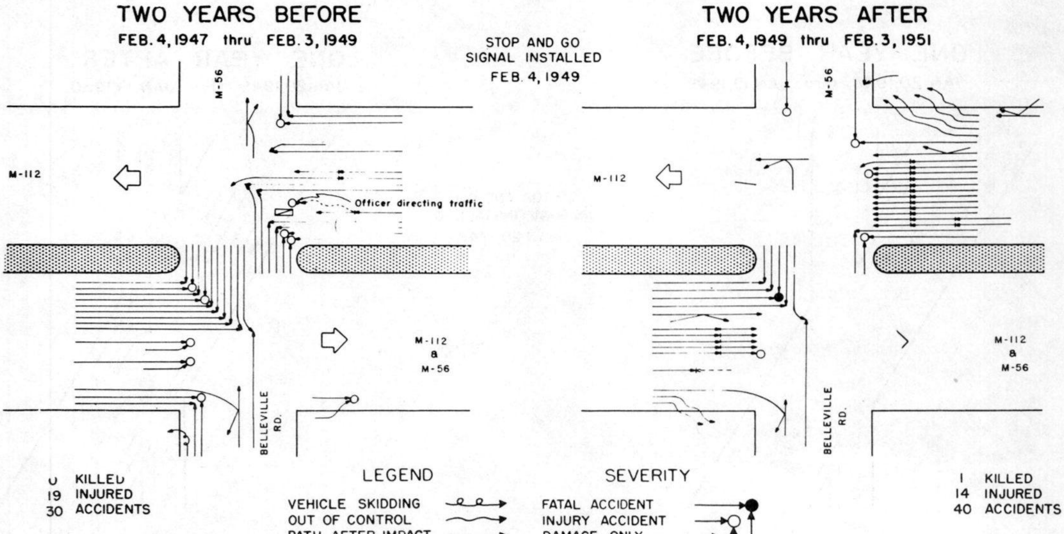

Figure 2.

tern. It was noted, moreover, that often accidents actually increased after signalization. In view of these experiences, it was deemed necessary to conduct aprobing study of the whys and wherefores of accidents as pertaining to traffic signals.

With this thought in mind, a Traffic Analysis Section has recently been established in the Planning and Traffic Division. In addition to its function of determining needs for various types of traffic control and design, the new section also evaluates the efficiency and safety of such controls after placement. Although its work is only started, certain facts have already revealed themselves.

In the first place, it has become apparent that composite or mass grouping of accident data from many locations means little or nothing when applied to traffic-signal problems, because each location has individual conditions and characteristics which are basically important to an understanding and solution of its particular traffic problem. It was finally decided to isolate each case and diagnose each new signal installation by a before-and-after study of its accident experience. Michigan clusively from rural or suburban areas, because the conditions for which signals are used and under which they operate are radically different on congested city

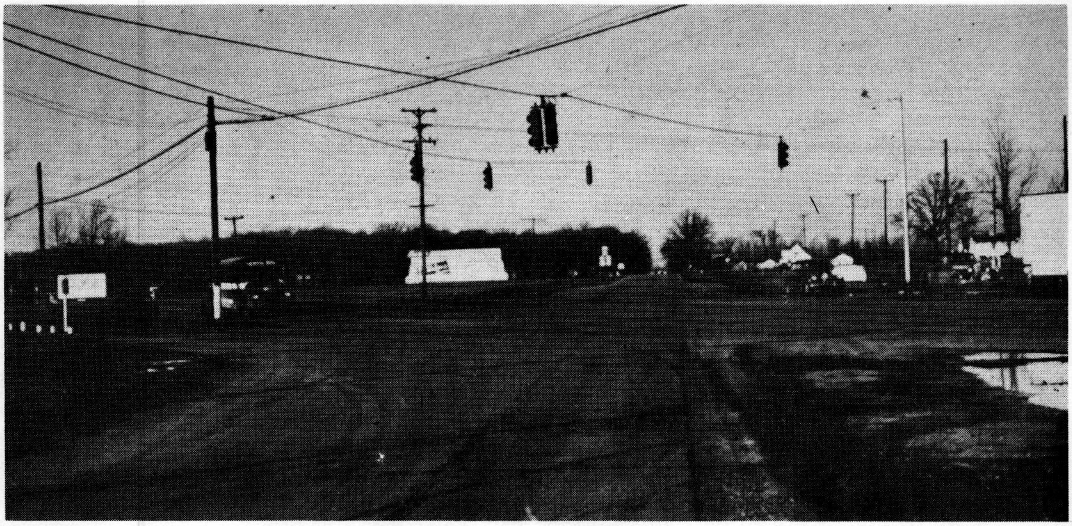

Figure 3.

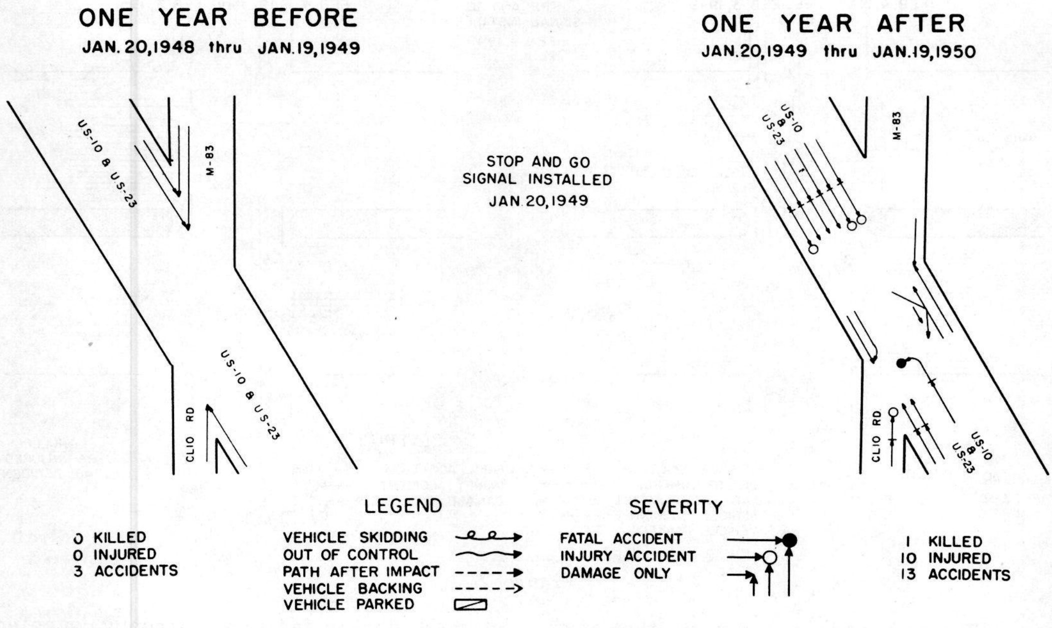

Figure 4.

hopes, by this process, to establish a trend which may be used in the future to predict accident potential and to gain information helpful in determining the type of signal installation most conducive to safety.

The examples below are drawn exarteries from those that exist on isolated trunkline intersections in relatively open country. For one thing, signal control is a part of the process of movement through a crowded city district and drivers are conditioned to it. But usually the signal at a rural intersection is an exceptional feature of the rural trunkline and, as such, is often dangerously inconsistent with the driver's expectation of an unobstructed roadway for high-speed travel.

The remainder of this discourse will be centered on pictures and charts of carefully selected intersections. They were selected to prove that stop-go signals are not cure-alls. They are not presented as damning evidence against all such signals but as contributions to a record which, it is hoped, will grow in usefulness as it becomes more complete. The figures include a view and a before-and-after collision idagram of each intersection.

The first case (Fig. 1) is the intersection of M 112 with M 56, commonly known as Belleville Road. M 112 is the Detroit Industrial Expressway, but in this particular area it has lost its expressway characteristics and has intersections at grade, even though it remains a divided highway with controlled access.

The figure shows M 112 to be a four-lane divided highway with the medial divider having a width of 32 ft. at this point. Belleville Road is a well-developed asphalt-surfaced road. There are dual signal heads for both directions of M 112. Belleville Road has one signal head for both the near slab and far slab of M 112 in both directions. Signal head visibility is, therefore, better than average and not a contributing factor for the accident pattern to be discussed.

The volume of traffic on Belleville Road, plus a large number of angle collisions, indicated the need of a stop-and-go traffic signal installation. Consequently this project was completed on February 4, 1949. The accident study conducted over a 2-yr. period before and after the installation shows 30 accidents before and 40 accidents after the installation (see Fig. 2). Angle collisions were reduced from 16 to 8, while rear-end collisions were increased from 2 to 17. There are over twice as many rear-end collisions between westbound vehicles on M 112 as eastbound. An explanation is that motorists are coming out of the expressway section from this direction and are acclimated to high vehicle speeds and no cross traffic. Their time-speed sense apparently fails them when faced with the necessity of stopping for a red signal.

Another interesting fact to be noted is that most of the angle collisions in both the before and after periods occurred when vehicles from Belleville Road collided with vehicles on the far slab of M 112. This same condition has been observed at other locations, and we are running some observation and accident studies at certain selected intersections to determine a method of correcting this condition with signalization. We are providing a delayed far-side green, which means that a motorist can enter a divided highway and have a better than average chance of crossing both slabs, since the near signal will go red first, followed a short time thereafter by the far signal. We are doing this under the assumption that some drivers, when crossing a divided highway, will attempt to negotiate the entire crossing rather than store in the medial area in case the green interval expires.

Since we have only conducted tests on this particular operation for a short period, before-and-after accident experience is not available, but operational-wise the plans seem to be obtaining good results.

Figure 3 shows a view of US 10 and US 23 at the intersection of Clio Road, which is located in a rural area north of Flint. The view was taken looking north from Clio Road. The highway has dual signal heads, while Clio Road has single heads. The trunkline is a four-lane undivided highway, while Clio Road is a two-lane concrete pavement. Clio Road north of this location is also state trunkline highway M 83 which serves a prosperous agricultural area.

Vehicle volumes on US10, US23 were very high, while the Clio Road volumes were above signal requirements. The collision diagram shows 3 accidents before and 13 accidents after installation (see Fig. 4). The vehicle speeds are high throughout this area, which accounts for the increase in rear-end collisions.

Maple Road runs west from Birmingham and intersects US24 in a rural area although there is intersection development (Fig. 5). Maple Road carries considerable traffic. The view shows US24 as a four-lane highway, during the time covered in the accident study, US24 was a two-lane highway carrying near capacity vehicle volumes for such a roadway.

The collision diagram (Fig. 6) shows an increase in accidents from 7 to 13 after the installation of the traffic signal. Vehicle speeds are high on US24, which again accounts for the increase in rear-end collisions. The accident study will enter a

Figure 5.

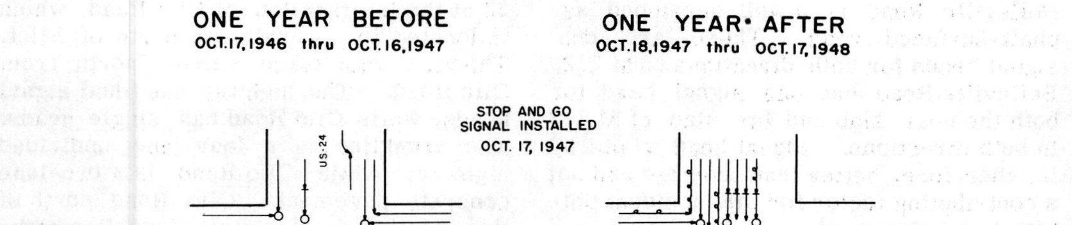

Figure 6.

third stage at this location, since we shall now be able to record the effects of the changing of the physical surface of US24 from a two-lane to a four-lane pavement.

Figure 7 shows the intersection of M59 with Milford Road. A small village named Highland lies to the south of this intersection on Milford Road. A number of angle collisions were occurring due to the suddenness with which motorists found themselves upon M59. It is a two-lane concrete pavement with moderate vehicle volumes traveling at a high average speed.

The collision diagram (Fig. 8) shows that positive results were gained by the installation of a flasher, since accidents were reduced from 12 to 6, while injuries were cut from four to zero in the 2-yr. periods before and after installation.

The intersection of US223 with US223

(Business Route) southeast of Adrian (Fig. 9) makes an interesting intersection to study, since it operates from a traffic standpoint like a T intersection, even though it has four approaching legs physically. US223 splits into a business route going north into Adrian, while the bypass route continues west from the intersection.

The collision diagram (Fig. 10) shows an identical pattern in both the before and the after patterns. The number of accidents was constant at eight, while the injuries were reduced from seven to one.

Figure 7.

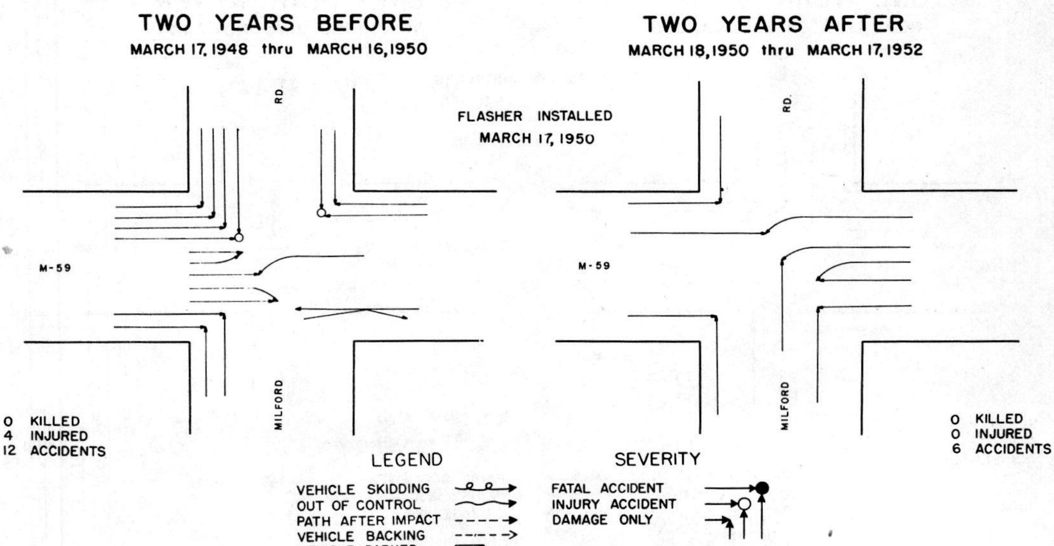

Figure 8.

SUMMARY

From the examples shown of accident experience before and after installations of stop-go and flasher signals, it might be concluded that we should either abandon the stop-go installations or else improve our installation methods. It might be concluded that flasher signals should be substituted for present equipment at the existing stop-go locations. But the problem is not that simple, and is not to be solved by any easy answers.

To begin with, abandoning use of the stop-go signal under existing conditions would leave a wide and dangerous gap in the traffic engineer's array of control devices. Also, we believe that Michigan standards of signal installation are fully in line with the best accepted modern practice. And finally, the flasher signal itself has its own limitations. But there are still other factors to be considered:

All of these selected intersections have traffic-volume characteristics which place them in that intermediate range referred to earlier in this paper; traffic is too heavy for stop signs but does not quite warrant a separation of grades. However, there is a wide variation of volumes represented by these 13 selected intersections, ranging all the way from 1,100 to more than 14,000 vehicles per day on the main highway. The four flasher-equipped locations had average traffic of 3,800 vehicles, or only half the average of 7,600 vehicles per day for the nine stop-go intersections. Performance of the two types of controls is not directly comparable under these widely differing conditions.

Figure 9.

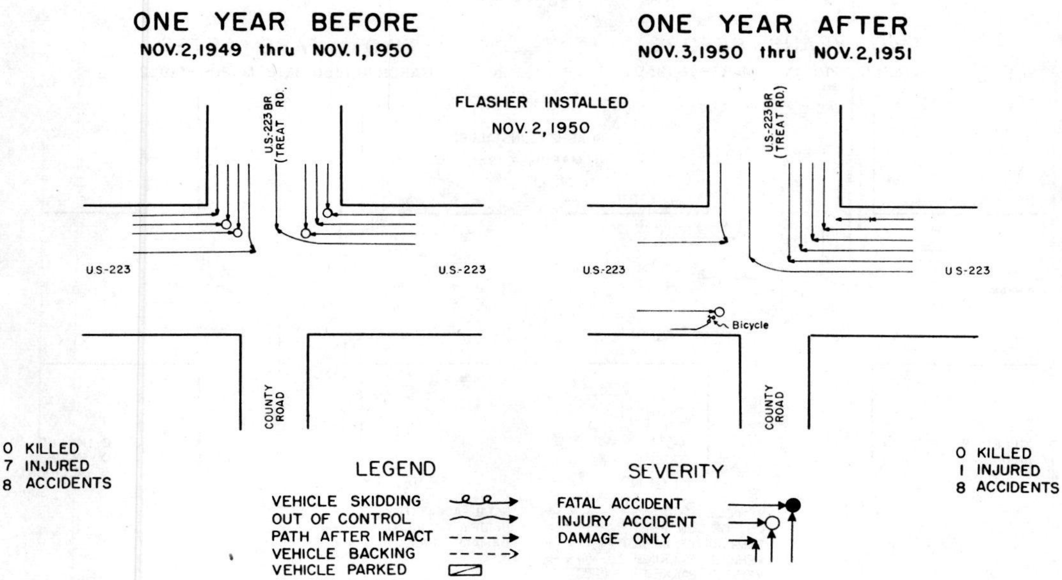

Figure 10.

The stop-go intersections were selected

to demonstrate that the stop-go signal is not a cure-all. They are only a few out of the 150 or 160 rural and suburban intersections in Michigan where similar control equipment is installed. While our analyses have not proceeded far enough to reveal the full performance record of these other locations, it is safe to say that a considerable number of them are operating with a fair degree of safety.

However, while the intersections shown may not be completely representative of Michigan's total experience with rural stop-go signals, they are thoroughly representative of the weakness of these devices in handling certain difficult conditions which are inherent in rural trunkline traffic operation. They clearly cannot be installed whenever and wherever public pressure dictates. They plainly show that we are playing with life and death when we place signals at locations to which they do not apply.

The figures reveal some of the conditions which render the operation of stop-go signals ineffective and dangerous. They suggest the probability that in some cases volumes are crowding the limit for this kind of control, and they show that most of the intersections are exposed to the hazards created by roadside mercantile development. But the most-important unfavorable condition indicated by the collision diagrams is that these are isolated controls and that they intrude unexpectedly into the high-speed characteristics of rural trunkline traffic. This latter fact is the message spelled out by the huge increases in rear-end and turning collisions at several of these intersections.

This latter effect can be expected in some degree whenever a stop-go signal is installed in an isolated location on a high-speed rural trunkline. It is apparent, at least, that the present signal installed according to the best currently approved methods, cannot be depended upon to command the attention of approaching drivers to a degree that assures consistent safety.

But even if the shortcomings of the stop-go signal were more glaring than is indicated by available experience, it does not mean that its use can be abandoned. Traffic must be regulated and protected at the many important rural intersections in this intermediate range. Flashers are unequal to the task of assigning use when volumes on the intersecting routes are in the upper brackets. It is totally unrealistic to dream that grades will be separated at any but the heaviest traveled of these locations—and at these not quickly.

It seems that the most practically constructive course is to focus some rather critical attention on this device whose operations we are analyzing. It is a highly standardized mechanism which has not been changed or improved in any basic way for at least 25 yr. Methods and procedures for using the stop-go signal have been developed and improved, and these also have become highly standardized.

Is it not possible that this standardization process has brought us to a dead end in the field of intersection control? It seems likely that what we are finding is that the same form of this device is not equally applicable to traffic conditions in both urban and rural areas. Do not all of the special conditions of rural trunkline traffic operation—higher speeds, isolated location, and intersections cluttered with roadside developments—point plainly to the need for signals specially designed for this service? It is even conceivable that further investigation, study and experiment might yield improvements in installation and operation methods.

These are some of the directions in which we believe our analyses of rural traffic signal operation are leading. With the alarming concentration of accidents at rural intersections, it is vital that highway and traffic engineers learn all they can about the conditions affecting intersection traffic design, operation and control.

Certain points have been soundly established. The stop-go signal, in spite of public confidence in its powers, is not primarily a safety device, it is not fool-proof, and it is not a cure-all. These findings indicate that to install one of these devices just because the public demands it, is like giving a child a loaded pistol just because he is crying for it.

Our investigations in this field will continue. The author strongly urges that other agencies undertake studies paralleling those reported in this paper. In the future we can unite our information and increase our understanding of these important phases of the traffic and safety problem.