Traffic Data Collection Using a Computerized Data Acquisition System

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Traffic characteristics such as headway, flow rate, speed, acceleration, wheelbase, and lane position have traditionally been collected using manual procedures, which are labor- and time-intensive and generally allow only one characteristic at a time to be collected. However, a computerized data acquisition system (CDAS) using tape switch sensors on the roadway will allow many traffic characteristics to be collected simultaneously. CDAS has three major advantages over a manual collection system: it requires fewer total person hours to collect the data, it offers improved measurement precision and accuracy, and it collects data continuously. An overview of a CDAS is presented, the methods used to extract the desired traffic characteristics from CDAS data are discussed, and insights and experiences obtained using a CDAS are offered.

Traffic characteristics such as headway, flow rate, speed, acceleration, wheelbase, and lane position have traditionally been collected using manual procedures. In this context, a manual procedure would include any study procedure wherein the data are collected in the field or extracted from videotape or film in a visual manner. Most of these procedures are labor- and time-intensive and generally allow only one characteristic at a time to be collected. However, a computerized data acquisition system (CDAS) using tape switch sensors on the roadway will allow many traffic characteristics to be collected simultaneously.

A CDAS has three major advantages over a manual collection system: (a) it requires fewer total person hours to collect the data, (b) it offers improved measurement precision and accuracy, and (c) it collects data continuously. Time requirements (in terms of total person hours) for data collection can vary significantly with the type of traffic characteristic being studied and the type of study procedure. For example, a manual study of driver headways will typically require two persons for each lane studied. In contrast, a CDAS-based study would require a study team of four to six persons to set up the study and one person to monitor the system after it has been set up, regardless of the number of lanes studied.

Time requirements for data reduction can also vary significantly with the type of study. In general, a CDAS automatically creates a computer file of the raw data, whereas with manual methods the data are recorded on field data sheets for later manual entry into a data base. Data from manual methods, however, generally are in the proper format for statistical analysis, whereas the CDAS data are often in a very basic form that requires some data reduction before any analysis.

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Measurement precision and accuracy are much better with a CDAS than with manual methods. Improved precision stems from the ability of the CDAS to measure event times to the thousandth of a second. Manual traffic studies that measure timed events have lower precision because they are limited by the reaction time of the human observer. Manual methods also have less accuracy because of the human inability to maintain an alert state during long-term field studies. As a result of these deficiencies, manual methods cannot accurately measure complex traffic characteristics such as acceleration and lane position.

This paper presents an overview of a CDAS, a discussion of the methods used to extract the desired traffic characteristics from CDAS data, and some insights and experiences obtained by the authors in using a CDAS. The CDAS system described in this paper has been used successfully by the authors on several projects since it was assembled 2 years ago. These projects have been directed toward measuring traffic characteristics at signalized intersections. As a result, much of the discussion is directed toward CDAS applications to intersections. However, it should be noted that most of the concepts in this paper can easily be extended to other locations (e.g, midblock arterial segments, tangent highway sections).

SYSTEM CHARACTERISTICS

The CDAS used by the University of Nebraska–Lincoln (UNL-CDAS) includes a portable computer, digital timer, tape switches, photocells, and a video camera. A schematic of this system is shown in Figure 1. The portable computer is used to monitor the tape switch and photocell sensors and to record the time of all monitored traffic events. Tape switch sensors are adhered to the road surface at specific locations and used to detect passing vehicles. Photocell sensors are placed over the light-emitting diodes (LEDs) on the load switches (inside the signal controller cabinet) and used to monitor the signal phase change times. The video camera has an in-picture time code capability that makes it an ideal backup data collection system and supplemental visual record of traffic events. In this regard, the videotape record can be used to validate the tape switch data reduction software programs.

Data Gathering and Recording Equipment

The UNL-CDAS uses a 12-MHz 80286 portable computer with a digital-timer board to monitor all system sensors and

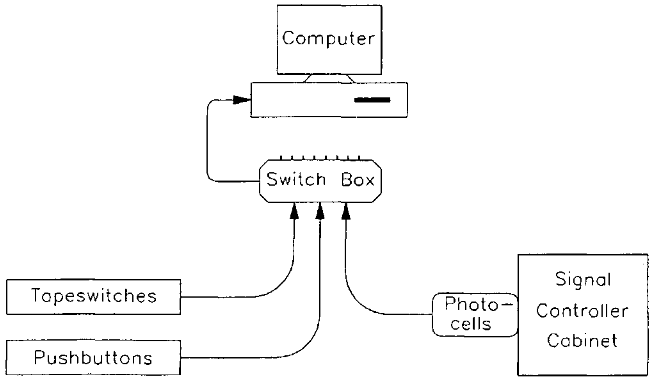

FIGURE 1 Schematic of a computerized data acquisition system.

record traffic event times. The digital-timer board has a 5-MHz clock and 16 digital I/O lines. With this board, the computer can monitor up to 16 sensors. To provide an interface between the computer/board and the sensor lead-in wires, a "switch" box was constructed to act as a terminal block and DC power source for the sensors. The box has a separate switch for each of the 16 sensor inputs to facilitate the mandatory status checks at the start of the data collection process.

Because the timer is a digital device, it produces output in the form of pulses denoting low (closed circuit) and high (open circuit) states. The computer continuously scans the sensors looking for a change in state. During data collection, the computer simultaneously checks the status of all 16 sensors every 0.002 sec. Once this "snapshot" of the switch status is taken, the status signal is decoded, and if a status change detected, the time and line/sensor ID number is recorded to the data file on disk. The computer then makes another status check and the cycle repeats. The scan interval of 0.002 sec results in an event measurement precision of ±0.001 sec, which is adequate for most traffic data needs. Moreover, this scan rate is fast enough to preclude the possibility of missing a switch closure.

Sensing Devices

Two types of sensing devices can be used with a CDAS: tape switch sensors and photocell sensors. Tape switches are used to detect the passage of vehicles at a point on the roadway. Experience with tape switches on urban roadway sections indicates that the life of a typical tape switch is about 70,000 axle hits. However, this lifetime can vary considerably on the basis of weather, pavement, and traffic conditions. Tape switch life appears to be reduced by higher temperatures, coarser pavement surface textures, and severely cracked pavement surfaces. Placement of tape switches on sections of roadway where traffic is accelerating or decelerating (e.g., intersection approaches) can also shorten the life of a tape switch. Tape switches can also experience premature failure because of faulty manufacture or when vehicles with flat tires drive over them. However, such situations are extremely rare.

Photocell sensors can also be monitored by a CDAS. An obvious photocell application would be at a signalized intersection wherein the starting time of the signal phase is needed for purposes of calculating the headway of the first queued vehicle. In this application, photocells can be used to monitor the LEDs on the load switches in the signal controller cabinet. Three LEDs are provided on each load switch, one LED for each signal indication the load switch serves (i.e., green, yellow, and red). In this manner, the status of the signal indications can be continuously monitored and any change (e.g., from red to green) recorded by the computer. This method of monitoring the signal indications prevents the circuitry of the controller from being disturbed in any way, which also has obvious liability benefits.

System Backup

The UNL-CDAS includes a high-resolution video camera to record the same traffic events as the tape switches. This video camera provides 400 lines of horizontal resolution and has an in-picture time coding capability with a measurement precision of ±0.017 sec. The videotape record is used for three reasons:

1. It provides a backup data source in the event of a failure in the tape switch system.
2. It can be used to validate the output of the tape switch data reduction program.
3. In the event of an unusual sequence of time records in the tape switch data, the video can be used to examine visually the sequence of events under question. Occasionally, a multiple-axle vehicle will produce an unexpected sequence of records, or a driver will change lanes without passing over all of the tape switches. In these cases, the data reduction program will flag the unusual sequence and the videotape record will be reviewed for possible explanation.

Types of Data Collected

A CDAS can be used to collect several types of traffic data. The common denominator among these data is that time is a fundamental component (e.g., headway). If two tape switches are located a known distance apart, then characteristics requiring distance and time can be calculated (e.g., speed, acceleration). However, a CDAS is not limited to these characteristics. Vehicle wheelbase and lane position can also be calculated from CDAS data by using the procedures described herein.

Vehicle Headway

Headway data can be collected by placing one tape switch parallel to the direction of travel (i.e., parallel to the vehicle axle) in one traffic lane. Headways are easily determined by computing the difference between the arrival times of the back axles of two successive vehicles. The back axle arrival times can also be used to calculate start-up lost time and saturation flow rate according to the procedures in the 1985 *Highway Capacity Manual* (*1*). If headways are being measured at a signalized intersection, then the load switch LED should be monitored with a photocell to record the start of the signal phase serving the lane under study.

Speed, Acceleration, and Wheelbase

Two parallel tape switches placed relatively close together in the traffic lane can be used to find speed, acceleration, and wheelbase. More specifically, two types of speed can be estimated: average speed and spot speed. Average speed can be found using the following equation:

$$v = \frac{D}{t} \tag{1}$$

where

v = average vehicle speed (m/sec),
D = distance between two parallel tape switches (m), and
t = time it takes one axle to travel across both tape switches (sec)

The calculation of average acceleration and spot speed is based on a procedure described by Evans and Rothery (*2*). This procedure is based on the assumption of a constant acceleration between two parallel tape switches, a distance D apart. The assumption of constant acceleration allows a vehicle's trajectory to be modeled by a second-order equation of distance x as a function of time t. In fact, this assumption allows two equations to be written, one for each axle of the vehicle. This relationship is shown in Figure 2 in terms of the vehicle's trajectory in space and time.

As shown in Figure 2, the trajectories of each axle are identical but separated by a distance equal to the vehicle wheelbase L_w. When a vehicle crosses the trap, it causes four event times to be recorded:

- t_1—the time that the front axle hits the first tape switch,
- t_2—the time that the front axle hits the second tape switch,
- t_3—the time that the rear axle hits the first tape switch, and
- t_4—the time that the rear axle hits the second tape switch.

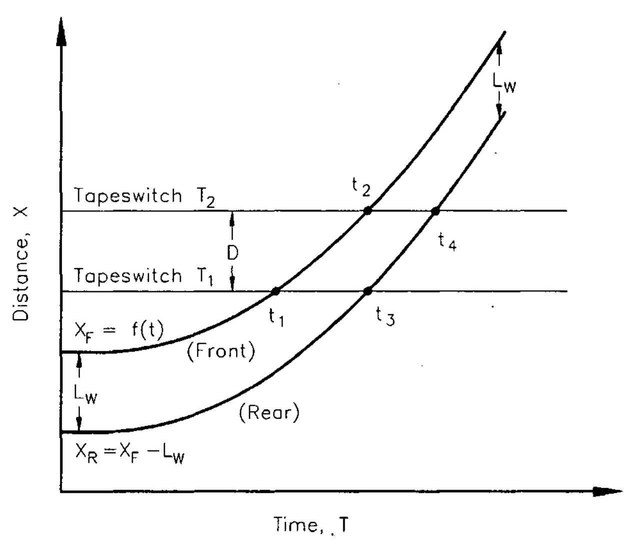

FIGURE 2 Time-space trajectory of vehicle as it traverses two parallel tape switches.

Transforming these event times by subtracting t_1 from each yields the relative travel time t_i' of the front and back axles between the two tape switches. As $x = 0$ when $t_1 = 0$ for the transformed data, the trajectory of the front and back axles can be described by the following second-order equation:

$$x = v_0 t + \frac{1}{2} a t^2 \tag{2}$$

where

x = distance traveled by vehicle in time t (m),
v_0 = velocity of vehicle at instant it hits first tape switch (m/sec),
t = time it takes to travel a distance x (sec), and
a = acceleration of vehicle (m/sec^2).

Examination of the time-space relationships in Figure 2 yields the following relationships for the transformed event times:

$x = D$ when $t = t_2'$
$x = L_w$ when $t = t_3'$
$x = D + L_w$ when $t = t_4'$

where

D = distance between two tape switches (m),
L_w = vehicle wheelbase (m),
T_1 = time when front axle hits first tape switch (sec),
t_2' = time when front axle hits second tape switch less t_1 (sec),
t_3' = time when back axle hits first tape switch less t_1 (sec), and
t_4' = time when back axle hits second tape switch less t_1 (sec).

Substituting these time-space relationships into Equation 2 yields three equations and three unknowns: a, v_0, and L_w. Solving these equations yields the following equations:

$$a = 2\left[\frac{D(t_2' - t_4' + t_3')}{t_2'(t_4' - t_3')(t_4' + t_3' - t_2')}\right] \tag{3}$$

$$v_0 = \frac{D}{t_2'} - \frac{1}{2} a t_2' \tag{4}$$

$$L_w = v_0 t_3' + \frac{1}{2} a (t_3')^2 \tag{5}$$

It should be noted that the equation for v_0, as published in Evans' paper (*2*), is in error; it is shown here in its correct form.

Lane Position

Lane position of vehicles is often a characteristic that is difficult to determine accurately using manual methods. How-

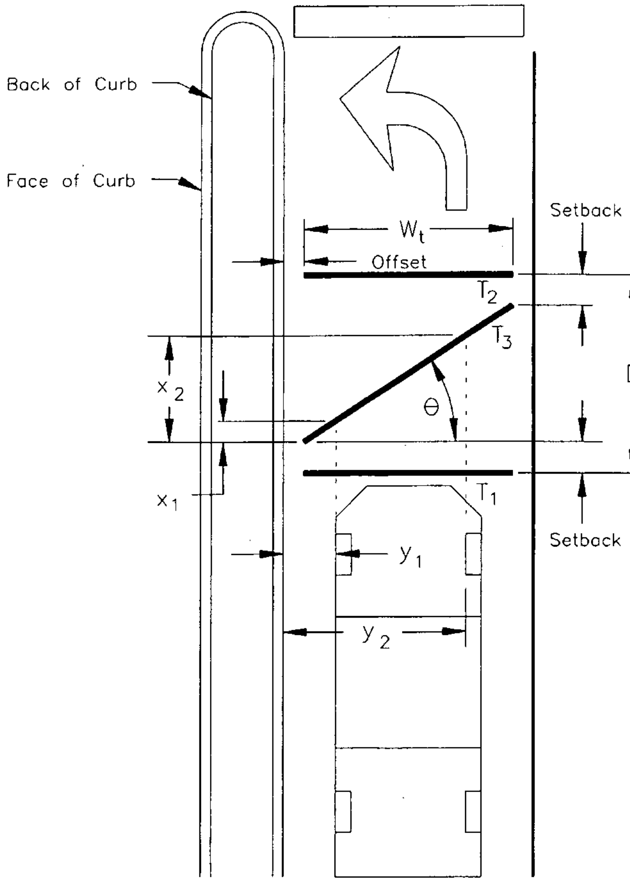

FIGURE 3 Layout of Z-shaped tape switch configuration for estimating lane position.

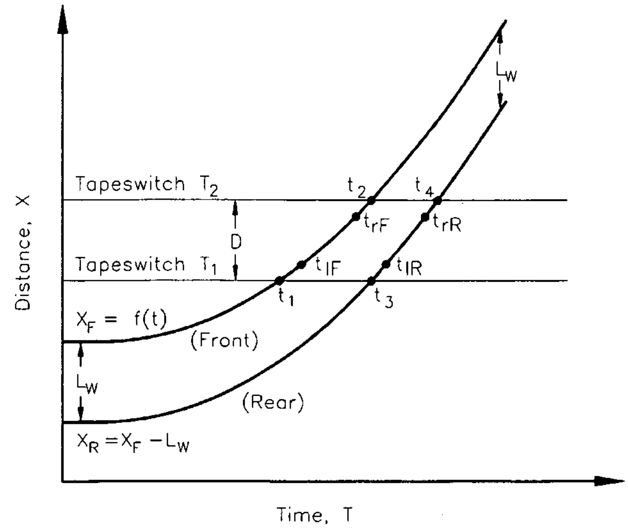

FIGURE 4 Time-space trajectory of vehicle as it traverses Z-configuration.

ever, three tape switches laid out in a Z-configuration can be used to determine lane position more easily and more accurately. Two switches in this configuration are laid parallel in the traffic lane, similarly to the layout for average speed measurement. A third switch is laid diagonally between these two switches. The layout of the Z-configuration is shown in Figure 3. In this particular figure the configuration is shown in a left-turn bay; however, it can also be installed in a through or right-turn lane.

Two assumptions are made in the application of the Z-configuration. The first assumption is that the vehicle has a constant rate of acceleration through the detection zone. This assumption is reasonable, provided that the detection zone is kept relatively short. The second assumption is that the vehicle travels on a relatively straight path through the detection zone. This assumption is reasonable so long as the Z-configuration is not located on a section of roadway where vehicles are executing sharp turning maneuvers.

The method of estimating lane position (i.e., lateral offset from the lane line or curb face) involves the following sequence of calculations. First, the two parallel tape switches are used to estimate the spot speed and average acceleration of the vehicle. Then these characteristics are used to calculate the travel distance, using Equation 2, that coincides with the measured travel time to the diagonal tape switch. Four distances can be estimated in this manner, one for each tire. Finally, using trigonometry, the lateral offset can be calculated from the four travel distances.

The vehicle trajectory through the Z-configuration is shown in Figure 4. This trajectory is identical to that in Figure 2; however, there are four additional event times recorded by the CDAS: t_{lF}, t_{lR}, t_{rF}, t_{rR}. These times coincide with arrival times of the front (F) and rear (R) tires on the left (l) and right (r) sides of the vehicle as it traverses the diagonal tape switch. Transforming these event times by subtracting the event time t_1 from each yields the relative travel time t_i' of the front and back axles through the trap. Having computed the average acceleration and the spot speed from Equations 3 and 4, the travel distance (x_1 + setback) from the first tape switch, T_1, to the point where the left side front tire hits the diagonal tape switch, T_3, can be calculated as

$$x_1 + \text{setback} = v_0 t_{lF}' + {}^1\!/_2\, a(t_{lF}')^2 \qquad (6)$$

where t_{lF}' is the left front tire travel time between T_1 and T_3 in seconds and setback is the distance between T_1 and the nearest end of T_3. The value of x_1 is calculated from the known value of setback (as determined from the Z-configuration's layout in the traffic lane).

The lateral offset distance from the face of curb to the point at which the driver's side front tire hits T_3 can be calculated as

$$y_1 = \frac{x_1}{\tan\theta} + \text{offset} \qquad (7)$$

with

$$\theta = \tan^{-1}\left(\frac{D - 2\ \text{setback}}{W_t}\right) \qquad (8)$$

where

y_1 = lateral offset distance to left front tire (m),
θ = angle between T_3 and a line parallel to T_1,
W_t = width of tape switch sensor (m), and
offset = lateral distance between face of curb and edge of tape switch trap (m).

In a similar manner, Equations 6, 7, and 8 can be used to calculate the lateral offset to each of the remaining three vehicle tires.

Once the lateral offsets to the tires have been calculated, the lateral offset to the vehicle centerline of each axle can be obtained by taking an average of these tire offsets. One problem with this approach is that the tire offsets must be corrected for the width of the tire contact patch. This can be estimated at about 15 cm (6 in) for most front axle tires. But the large number of trucks with dual tires on the rear axle makes estimation of the tire width (and rear axle lane position) more difficult. As a result, it is recommended that only the front tires be used in estimating the vehicle centerline offset. This offset distance (i.e., lane position) can be calculated as

$$L_p = \frac{y_1 + y_2 + P_w}{2} \tag{9}$$

where L_p is the distance in meters from the face of the curb to the centerline of the vehicle and P_w is the average width of a tire patch (0.15 m, 0.5 ft).

Phase Duration and Cycle Length

Information about the duration of various intervals in the signal cycle are sometimes a necessary part of the data collection effort. With a photocell sensor, the duration of the green, yellow, and red phase intervals as well as the cycle length can be measured accurately by the CDAS. As mentioned previously, the photocells would be placed on the LEDs on the load switches in the controller cabinet. The event times corresponding to a change in phase interval can then be used to calculate the duration of the desired interval by simple subtraction.

FIELD STUDY CONSIDERATIONS

Advance Preparation

Most of the preparation for the study is performed well before the study date. Plan sheets of the study sites are obtained and used to help in estimating the amount of wire and adhesive material needed for sensor installation. The plan sheet is also used to determine tape switch locations and the position of the signal controller cabinet. The CDAS data recording equipment are typically set up on the same corner as the signal controller cabinet to minimize the total length of lead-in wire. An example of a tape switch layout for determining the lane position of left-turn vehicles and headways of through vehicles is shown in Figure 5.

Special materials are needed to protect the tape switches from the harsh environment of the roadway. One of these materials is a 5.1-cm (2-in.) felt pad strip laid beneath the 1.6-cm (⅝-in.) tape switch. This pad protects the tape switch from irregularities in the pavement surface. Experience has also shown that a tape switch installed without a pad will slide back and forth with each passing vehicle. Under higher traffic demands, this will produce a sanding action that will eventually wear the bottom off of the switch and cause it to fail prematurely.

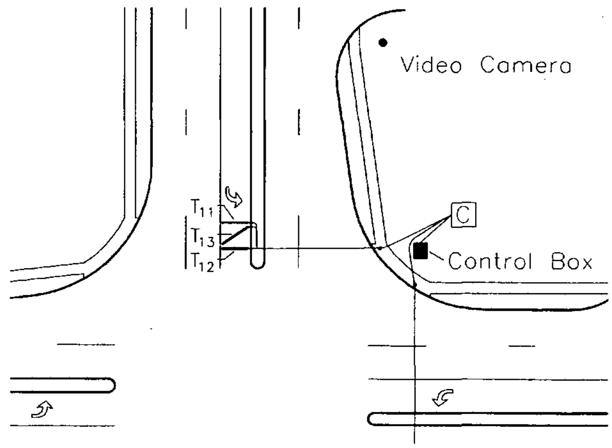

FIGURE 5 Intersection tape switch layout for lane position and headway estimation.

The tape switch and pad are adhered to the road surface with a 10-cm (4-in.) bituthene mat material. This material has been found to have excellent adhesive properties under a wide range of temperature conditions. Moreover, the fiberglass in the mat is able to withstand abrasion from frequent tire impacts and thereby protects the tape switch for long periods (generally much longer than the life of the tape switch).

Tape switch installation proceeds one lane at a time. This procedure has been found to yield the safest conditions for the installation crew. It also minimizes the impact on traffic by requiring only one lane to be closed at a time. To facilitate this approach, both the mat and pad are prepared in 3.7-m (12-ft) lengths.

The lead-ins used with the UNL-CDAS are four-conductor 20 AWG wire. Use of larger wire gauge is not recommended as it tends to incur a larger impact from the crossing vehicle tire. Moreover, in some instances, a tape switch and lead-in wire may share the same pad. In this situation, a larger wire may deflect the tire over the tape switch and result in an intermittent loss in data.

The width of the tape switch trap must be determined in advance and is dependent on the type of data to be collected. For a headway study, the tape switch should be centered in the traffic lane with about 0.30 m (1 ft) of clearance to the adjacent lanes. This approach will eliminate errant hits on the switch by vehicles that are effectively in the adjacent lanes (but that may wander momentarily out of those lanes). On the other hand, tape switches for a lane position study should be long enough to span the full width of the lane. As noted in the previous section, both the left and right side tires must be detected by the diagonal tape switch. Thus, without full lane coverage, it would be possible for vehicles traveling close to the edge of the lane to traverse the Z-configuration without the necessary four tires being detected. These extreme vehicles may be of particular interest to the study and cannot be missed.

The location of the tape switch on an intersection approach lane is dependent on the type of data to be collected. Since the equations for predicting lane position assume a straight-line travel path, it is important that the Z-configuration be placed in advance of the stop line. For speed or acceleration measurements, the trap can be placed in advance of or beyond the stop line as needed. For headway measurement, the tape switch should be placed just beyond the line behind which vehicles consistently stop (e.g., the crosswalk or stop line). In all cases, the tape switches must be perpendicular to the direction of traffic flow.

Z-Configuration Layout

The layout of the Z-configuration is dictated by several physical constraints, which include width of lane, proximity of Z-configuration to the stop line, and length of detection zone. An example Z-configuration layout is shown in Figure 5.

In general, the derivation of the speed, acceleration, and lane position equations is based on the assumption of constant acceleration between the two parallel tape switches. This assumption becomes less valid as the distance between the two parallel tape switches increases. Therefore, this distance should not be much larger than the wheelbase of a passenger car.

The effect of this distance on the angle between the diagonal tape switch and the first parallel tape switch should also be considered. For extremely short distances, the angle will be quite small and tend to magnify (via Equation 7) any error in the estimate of x_1. This error would then be reflected in the estimate of lane position. Therefore, the distance between the two parallel tape switches should not be much shorter than the wheelbase of a passenger car.

On the basis of these considerations, it was determined that the distance between the two parallel tape switches should be 3.0 m (10 ft). This distance represents a good compromise solution and does not appear to have any inherent problems. In fact, this distance is consistent with that used by Evans and Rothery (*2*).

The setback distance between the parallel tape switches and the near edge of the diagonal tape switch (Figure 3) was established as 0.46 m (1.5 ft) for somewhat more subjective reasons. The main goal was to avoid having the ends of two tape switches under a tire at the same time because it could cause the tire to vault over the second switch. Thus, it was determined that the setback distance should exceed the length of a tire contact patch.

Tape Switch Installation

The actual installation should begin at the point farthest from the curb (i.e., where tape switch is located) and proceed toward the curb. The tape switch or lead-in wire should be installed in one lane at a time to minimize the delay to motorists. In general, an experienced installation team will need about 1 min to install a tape switch or lead wire in a traffic lane. This time will increase in situations where multiple lead-ins are being "carried" to the curb. In this regard, each additional lead wire will add about 30 sec to the installation time in a traffic lane.

A tape switch installation crew usually has four to six members. This crew is composed of three or four installers and one or two flaggers. Three installers and a flagger are adequate for smaller studies; however, four installers and two flaggers are desirable for larger studies requiring multiple lead-in wires in a traffic lane. Two flaggers will maximize the conspicuity of the work area and provide positive driver guidance around the installation crew. These flaggers should be supplemented with one or two arrow-board trucks operated by local agency staff. These trucks can be brought into position sequentially in the appropriate lane (near or far side of the intersection) and used to provide advance warning of the closure of that particular lane.

If both a tape switch and wire are being installed under the same mat adhesive, the tape switch should be positioned nearest to the oncoming traffic. In other words, the wire lead-ins from other tape switches should be placed behind the tape switch on the pad. The reason for this arrangement is to ensure that the tape switch is the first point of vehicle-tire contact. If the wire leads are placed before the tape switch on the pad, the wire may deflect the tire over the tape switch and result in lost data. Precautions should be taken to make sure that multiple wire lead-ins are placed parallel to each other on the pad. If these wires are allowed to cross (or overlap) one another, there is a possibility that one wire will cut into the other wire under the weight of a crossing vehicle.

QUALITY CONTROL

Several measures are taken to ensure the quality of the collected data with the UNL-CDAS, including backup systems and formalized procedures for monitoring sensor performance. As mentioned previously, a video camera with an in-picture time-code capability is used as a backup data collection system. This camera is located such that all points of interest can be captured on the videotape image. When one video camera is not able to capture all desired events, a second video camera is used.

During data collection, the performance of the CDAS is monitored continuously via the computer display. This monitoring is essential to avoid losing large amounts of data due to equipment failure. The computer display provides a status report of each sensor and lead-in. Should a failure be detected, its time of occurrence is noted in a log book and steps are taken to correct it.

In addition to the continuous monitoring of the system status, a visual check of the tape switches and mat adhesive conditions is performed periodically. Occasionally, a piece of mat material will be damaged by a spinning or sliding tire and will require a mat overlay. In general, this check is performed at least once an hour during the study, although the frequency may be increased to every ½ hr if the temperature is warm or traffic demands are high.

COST

Although a CDAS requires the use of relatively expensive technology, it remains a practical and cost-effective method

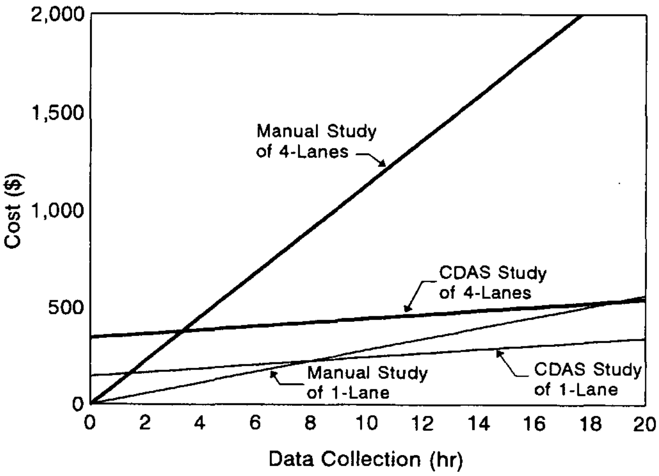

FIGURE 6 Cost comparison for CDAS and manual methods for headway study.

of collecting data. In fact, when compared with manual methods, a CDAS can save time and money. To illustrate this point, the costs of conducting one- and four-lane headway studies using both the CDAS and manual methods were done. The results of this comparison are shown in Figure 6.

The costs considered for this comparison included the startup costs (i.e., materials plus labor for installation) and ongoing costs (i.e., replacement materials and labor during study). The CDAS startup costs include the tape switches, mat, and pad as well as the setup time for a crew of five. The CDAS ongoing costs reflect the labor cost for one person to monitor the system. The manual method does not have any significant startup costs but does incur considerable ongoing labor costs (which vary with the size and duration of the study).

The trend shown in Figure 6 suggests that the manual method costs more than the CDAS method for studies of even nominal duration. The cost of the manual method is lower than CDAS only for studies of short duration. This trend stems from the higher initial costs of the CDAS equipment. As the duration of the study increases, the higher labor costs ($10/hr) of the manual method offset the higher initial costs of the CDAS method. For a one-lane headway study, the manual method has a lower cost for a study of fewer than 8 hr, but for a study of more than 8 hr, the CDAS method has the lower cost. For a four-lane headway study, the break-even point is reached at about 4 hr because of the higher on-going labor costs of the manual method.

VALIDATION

The UNL-CDAS was validated by comparing it with two other data collection techniques. The first technique used a verified videotape system with a built-in time coding capability. The second technique used a stopwatch to measure event times in a more traditional manner.

The videotape system represented the more accurate validation technique because it records to a precision of ±0.017 sec. Fifty headways were measured and compared using both the videotape system and UNL-CDAS. The average difference between the headways measured with the videotape system and those measured with the CDAS was 0.005 sec. This difference was not significantly different than 0 (at a 95 percent level of confidence).

The UNL-CDAS was also validated using a manual technique to measure headways. For this test, two observers collected headway data for a continuous period of 2 hr. Again, a comparison of the observed and CDAS headways indicated no significant differences.

During the second test, several interesting observations were made about the ability of the observers to collect data. As time progressed and the observers tired, they tended to underestimate vehicle headways. Moreover, the magnitude of this underestimate increased with time, as did the standard deviation of the error (i.e., the difference between the observed and CDAS headways). Given that a study of vehicle headways typically requires hundreds and perhaps thousands of observations for statistical significance, it appears that automated data collection systems offer the only realistic means of measuring headways (and other traffic characteristics) with any reasonable degree of accuracy.

CONCLUSION

A computerized data acquisition system using tape switch and photocell sensors can be an effective way of accurately collecting a variety of traffic characteristics. To conduct a successful computerized tape switch study requires a great deal of advance planning; however, the computerized study also offers a great deal of flexibility and can be an efficient means of obtaining a large amount of traffic data. Many types of driver characteristics such as startup lost time, clearance lost time, and lane position can be measured.

The computerized data acquisition system was validated and found to be accurate and precise in its measurement of timed events. The accuracy and precision of the computerized data acquisition system is its most important advantage over manual studies. As a result, small differences in driver behavior can be more easily detected and the statistical significance of these differences more easily established. Another advantage of a computerized data acquisition system is that it typically takes less time to collect and enter the data than manual methods.

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