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Evaluation of the Autoflagger in Virginia

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16. Abstract

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The AutoFlagger was successfully deployed by two VDOT area headquarters. Various AFADs have been used by several state departments of transportation effectively.

The Federal Highway Administration's interim approval of AFADs requires maintenance of an inventory of locations where the AFADs are used. VDOT field offices should purchase AFADs when they have determined that such a device will effectively aid them in doing more with less staff and/or improving the safety of flaggers. They should also evaluate their effectiveness, including the supplemental signing, and send the evaluation results to VDOT's Traffic Engineering Division. After reviewing this information, VDOT's Traffic Engineering Division should decide how VDOT will use AFADs.

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FINAL REPORT

EVALUATION OF THE AUTOFLAGGER IN VIRGINIA

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Virginia Transportation Research Council
(A partnership of the Virginia Department of Transportation
and the University of Virginia since 1948)

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ABSTRACT

The AutoFlagger consists of a stop/slow paddle and supplemental signs and lights mounted on a trailer that can be operated by remote control. The AutoFlagger is classified as an automated flagger assistance device (AFAD), which is a portable traffic control system that assists a flagger operation for short-term lane closures on two-lane highways. The primary benefit is to enhance the safety of flaggers by removing them from the roadway and moving traffic while also maintaining positive control of traffic approaching the work zone. Another important benefit is that under certain conditions, one flagger can control traffic, thereby allowing the second flagger to perform other duties. Two AutoFlagger units were purchased by the Virginia Department of Transportation (VDOT), and the deployment of the units was recorded and the comments by the users were described. Other AFAD systems used by other state departments of transportation were also reviewed.

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FINAL REPORT

EVALUATION OF THE AUTOFLAGGER IN VIRGINIA

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INTRODUCTION

The AutoFlagger is a traffic control device mounted on a trailer that includes the sign faces of a stop/slow paddle and supplemental signs and lights as shown in Figure 1.[1] The AutoFlagger, manufactured by Safety Technologies, is classified as an automated flagger assistance device (AFAD). AFADs are portable traffic control systems that assist a flagger operation for short-term lane closures on two-lane highways.[2] In a typical flagging operation, a flagger is located at each end of the lane closure and uses a stop/slow paddle to direct traffic while positioned in the travel lane. AFADs are used to remove flaggers from the traveled way in temporary traffic control (TTC) zones. A flagger can operate an AFAD by using a radio control unit or a cable directly attached to the AFAD.[2] In either case, the flagger can be positioned well away from the roadway and moving traffic. The primary benefit of this arrangement is to enhance the safety of flaggers while also maintaining positive control of traffic approaching the TTC zone.[2] The Federal Highway Administration (FHWA) has granted interim approval to states to use AFADs.[3]

The AutoFlagger is a large device consisting of 36-inch stop/slow signs on a trailer 8 ft wide by 13.9 ft long. The supplemental signs mounted below the stop/slow sign are WAIT ON

Figure 1. AutoFlagger. Source: http://www.AutoFlagger.com/AutoFlagger.htm. Reprinted with permission.

STOP (required) and GO ON SLOW (optional). Supplemental lights include a 12-inch red LED signal light with a strobe above the stop sign and two amber or yellow lights with strobes on each side of the slow sign. Other supplemental signs such as STOP HERE ON RED may also be used. An emergency horn can be activated to warn workers of a potential danger such as a motorist not complying with the stop sign. The wireless remote control system allows one operator to control both signs from a strategic location.

AutoFlagger Use in Minnesota

The Minnesota DOT (Mn/DOT) has used the AutoFlagger since 1996.[4] After reviewing the results of a motorist survey, comments from the flaggers who used the device, field review observations by traffic engineering staff, and driver behavior videos, Mn/DOT concluded that the AutoFlagger device provides a useful tool that when used correctly, can enhance the safety of flaggers in work zones on two-lane roadways.

The number of positive responses from motorists was much larger than expected for this unique type of traffic control device. The response from workers has been undeniably positive. Some of the comments were: "it is easy to set up and use," "clearly understandable," and "safe." The fact that the flaggers who tried this device were so overwhelmingly positive about its use bodes well with respect to its acceptance by other workers. Observations and videos of driver's behavior in Minnesota showed that only a very small number of people failed to understand immediately what the device represented and how to respond to it correctly. Understanding of this device should increase as the device is used more.

Thousands of hours of flagging have been logged by Mn/DOT using the AutoFlagger. Every Mn/DOT district has tried the device, and the weather conditions have varied from sunny and hot to cold and dark. During the time this device was used, no crashes occurred; driver compliance was at least as good as with flaggers; and most important, no flaggers were placed in dangerous traffic conditions.

In the future, Mn/DOT will consider using the AutoFlagger when all of the following conditions exist:

1. two-lane, two-way roadways closed to one lane of traffic

2. average daily traffic (ADT) less than 1,500 vehicles per day

3. distance of lane closure is 800 feet or less for one operator; engineering judgment is recommended for greater distances and multiple operators

4. operator(s) has unobstructed view of AutoFlagger and approaching traffic in both directions.

Because of this device's acceptance by drivers and workers, the proven field operation reliability, and safety benefits to the flagger(s), Minnesota intends to adopt the AutoFlagger in the Minnesota *Manual of Uniform Traffic Control Devices.*

Maintenance Operations Research (MOR) Program

VDOT's Asset Management Division and the Virginia Transportation Research Council (VTRC) collaborated in 2002 to establish the Maintenance Operations Research (MOR) Program. The purpose of the program is to promote innovation in the delivery of the maintenance program by making funds available for research, testing and development of equipment, materials, and procedures. This program is a tool that allows maintenance forces to pilot new technology that will potentially enhance VDOT operations. Once VDOT is convinced that a product merits testing, the product is tested to determine its benefits. The AutoFlagger was recommended for testing under the MOR program.

PURPOSE AND SCOPE

The purpose of this study was to evaluate the use of the AutoFlagger in Virginia. Although the study focused on the AutoFlagger, it was important to be familiar with other available AFADs. Therefore, a secondary purpose was to review other AFADs and document their effectiveness based on their use by others.

METHODS

The following tasks were performed to accomplish the study purpose.

1. *Literature review of AutoFlagger and other AFADs.* The search was conducted using computerized transportation literature databases, the Internet and the VDOT Research Library.

2. *Determine conditions for AutoFlagger use.* The conditions described for use by Mn/DOT were used in addition to the following: (1) the AutoFlagger was placed as far off the travel lane as possible, and did not extend into the open travel lane; (2) during the first days of operation, a flagger was present at the unit to observe and verify that the unit was functioning properly. As part of the MOR program and this research effort, VDOT's Asset Management Division purchased two units (a unit is defined as a pair of AutoFlaggers) and deployed them in the Chesterfield and Wytheville residencies. The units were housed and deployed in the Beach and Wytheville Area Headquarters (AHQs).

3. *Log of AutoFlagger deployment and events.* The person assigned the responsibility for the AutoFlagger compiled a monthly log of events that occurred during the deployment. The daily log entry included the time, date, type of work, and location of the AutoFlagger deployment. Any problems experienced with the system, any system maintenance performed, any incidents of driver confusion, any inquiries or comments made by drivers, observed conflicts, hazardous situations, and crashes were recorded. The flaggers and VDOT maintenance crews provided comments about the AutoFlagger. The intent was to capture the events associated with the AutoFlagger deployment without creating an undue burden for the flaggers. The AutoFlagger units were used during a 9-month period by two area headquarters. Monthly reports were sent by the area headquarters staff to VTRC staff. The form used to gather this information is shown in Figure 2.

4. *Data compilation and analysis.* The data collected in the monthly logs were compiled and analyzed to assess the performance of the AutoFlagger.

5. *Review of other AFADs.* Information on other AFADs was gathered and reviewed. A description and photograph of each AFAD were compared with the AutoFlagger.

RESULTS

Literature Review

The literature focused on the experience of other state DOTs that have used the AutoFlagger. The experience of Mn/DOT was presented in the Introduction. The Kansas DOT (KDOT) also has experience with the AutoFlagger.[5]

The AutoFlagger was included in the 2002 Midwest Smart Work Zone Deployment Initiative (MwSWZDI). The larger paddle plus the presence of the trailer made the AutoFlagger much more visible and conspicuous than a human flagger. An attempt was made to track when drivers began to slow for the flagger when STOP was showing and to record the speed of vehicles as they passed the trailer when SLOW was showing. The results are not yet available. KDOT had some problems with the transmitting range for the remote control. It is believed that the manufacturer resolved the problem. In the field, the appearance of the trailer and general operation lived up to expectations. The only disadvantage was the cost. KDOT has continued to be interested in the concept and has requested demonstrations of other products serving the same function but has made no purchase (as of 2005).

AutoFlagger Deployment in Virginia

Wytheville Area Headquarters

This AHQ deployed the AutoFlagger nine times during January and February 2006 in Grayson County. The total number of hours of deployment was 59, averaging 7.4 hours per

AUTOFLAGGER DATA COLLECTION FORM

Name, Residency, and Phone Number: _____
Month and Year: _____

Date	Number of Hours	Route	Location (estimate ADT)	Activity	DESCRIBE the experience, especially any incidents, problems, equipment malfunctions

Send the completed form to:
Ben.Cottrell@VDOT.Virginia.gov
Ben Cottrell
Virginia Transportation Research Council
530 Edgemont Road
Charlottesville, VA 22903-2454
(434) 293-1932 FAX (434) 293-1990

Figure 2. AutoFlagger Data Collection Form

deployment on secondary and frontage roads. The estimated ADT on these roads ranged from 100 to 1,600 vehicles per day. The types of projects included bridge repair, tree cutting, pipe installation, and shoulder operations. Work crews were successful in using the AutoFlagger where there were no or narrow shoulders by placing it in the travel lane and using a 50-ft taper of cones in front of the device. With advance signing for flagging operations and good sight distance, this setup was useful and effective. More deployments did not occur because this AHQ limits maintenance operations to mowing during mowing season (early spring to late fall); there were also several construction projects to accomplish with a small staff.

The first deployment of the AutoFlagger by the Wytheville AHQ was free of problems. During the second deployment, three motorists drove by the AutoFlagger. During the third deployment, two motorists drove by. In every instance, a nearby worker/flagger monitoring traffic stopped the violators. After the fourth deployment, during which one motorist drove by, the crew concluded that the WAIT ON STOP—GO ON SLOW sign (see Figure 1) was being misunderstood. Most motorists who drove by would stop and then proceed slowly past the STOP paddle and not wait for the SLOW sign, just as motorists do with a typical stop sign; i.e., motorists would not wait for the sign/paddle to change from STOP to SLOW. Another way to view this is that motorists who drove by would stop and then go on slowly without waiting for the paddle to change to SLOW.

In an attempt to remedy the problem of motorists driving by, for a period of time, workers chose to use WAIT ON STOP and covered up GO ON SLOW with an orange plastic trash bag. The next five deployments were made in this manner, and one motorist drove by. Mn/DOT devised the WAIT ON STOP/GO ON SLOW sign and found it helpful in their operations.[6] FHWA technical provisions for AFADs display two signs; the use of WAIT ON STOP is mandatory, and the use of GO ON SLOW is optional.[2]

In June 2006, VDOT displayed the AutoFlagger at a safety day sponsored by the Town of Wytheville. In later deployments, the GO ON SLOW sign was not covered and it worked well—no motorists drove by. The AutoFlagger was deployed four times after 8 hours each time in August 2006 for pavement patching on secondary roads. No motorists drove by during the 32 hours of operations. AHQ staff speculated that the earlier confusion was due more to the novelty of the AutoFlagger than to the sign message itself. The AutoFlagger was deployed a total 13 times for 91 hours. This AHQ plans to continue using the AutoFlagger and is pleased to be able to free up a flagger to perform other duties. This is especially important and valuable because of the small staff in this work unit.

Beach Area Headquarters

This AHQ deployed the AutoFlagger on two occasions in December 2005 on Route 60 in Powhatan County (ADT about 5,300). The total hours of the two deployments were 16, or 8 hours per day. The unit was used with the assistance of flaggers who watched to make sure that the operation was safe. The AutoFlagger was placed on the shoulder.

The AHQ supervisor commented that the warning horn needed to be much louder. He tried it to see if his crew could hear it in the work area. Without any traffic or equipment

operating, the crew barely heard the horn. He believed that if there was any noise being generated by traffic or equipment that the work crew would not have heard the horn at all. The supervisor also thought that the flashing lights could be a little bigger or brighter to be more visible. The unit was not used more frequently in this AHQ because candidate sites with wide shoulders to accommodate the unit on the shoulder were not available. The AHQ staff was more comfortable using the AutoFlagger where it would be mostly off the road. In the supervisor's opinion, the unit would be placed in the road only where there was a long straight section allowing very good sight distance to the AutoFlagger.

Other AFAD Systems

Two types of AFAD systems exist: stop/slow paddles and signal displays. A signal system and a system that offers both options are described here. The systems vary in their costs, features, and available options. In some cases, current cost estimates for the system were not available. This is a sampling of the types of units available and does not include all available AFADs.

Signal: RC Flagman

The Ohio, Missouri, Wisconsin, and Alaska DOTs have used the RC (for remote controlled) Flagman manufactured by R.C. Flagman, Inc.[7] The unit uses a 12-in LED red signal head for the stop mode along with a gate arm that is lowered to stop traffic (see Figure 3).[8] The slow mode is indicated by a 12-in LED flashing yellow signal and a raised gate arm. The RC Flagman was approved for use in Canada in 1994. Experimentation was conducted using (1) an RC Flagman at both ends of the TTC zone, and (2) one flagger at one end and one RC Flagman at the other end of the TTC zone. No vehicular crashes or incidents involving injury to the flagger were recorded at any of the experimentation sites. The reports from all states were

Figure 3. RC Flagman. Used with permission of R.C. Flagman Inc., Welland, Ontario, Canada.

positive. The Ohio DOT concluded that comments from the traveling public were very favorable and comments from the flaggers and supervisors using the units were generally favorable on the performance and use including quick setup and removal, ease of use, and a cost-effective way to provide for a one-lane closure. The Missouri DOT (MoDOT) found a benefit/cost ratio ranging from 1.15 to 2.5 for 1 year. The Wisconsin DOT concluded that it is critical for the operator of the remote flagger to have approaching traffic in view while operating the device and to follow proper procedures in determining the appropriate time to stop and release traffic. Adding a flag to the end of the gate arm helps improve the conspicuity of the arm. The estimated cost is $14,000.[9]

Signal or Paddle: IntelliStrobe

IntelliStrobe Safety Systems of Springfield, Illinois, offers an AFAD system with various options, including a signal-based or paddle-based system mounted on a base and four legs or on a trailer as shown in Figure 4.[10] This system has been effectively used by MoDOT and KDOT.[11] MoDOT staff who have tested other AFADs noted the unique standard features of the LED lights and the automatic safety (intrusion) alarm.[12] The alarm consists of a pair of pneumatic hoses that extend across the lanes of traffic at each unit. If either device is in the "stop" mode and a motorist violates that end of the zone by crossing the hoses, a 128-decibel safety alarm immediately goes off at that unit and the opposite unit turns to "stop." Although both signal- and paddle-based systems are offered, about 98 percent of the units sold are signal based. The gate arm is standard on all signal systems. The estimated cost of this typical system (two signal units with base and four legs and a wireless transmitter, W1-AG) is $15,000. The portable transport trailer is a popular option.

Figure 4. IntelliStrobe Paddle and Signal Systems. Source: http://flaggersafety.com. Reprinted with permission.

DISCUSSION

Limitations

In Task 2, it was stated that the AutoFlagger would be placed as far off the travel lane as possible and would not extend into the open travel lane. This condition severely limited the roads that would be eligible for use of the AutoFlagger. Most two-lane roads do not have shoulders wide enough to accommodate the device. The intent was to begin using the AutoFlagger in a conservative manner by initially complying with this constraint. Once experience was gained, it was expected that the guidelines would be revised and this restriction removed. The Wytheville AHQ staff exercised careful judgment and chose to use the AutoFlagger on roads where it was in the travel lane. In contrast, the Beach AHQ staff chose to follow the guidelines. In June, the Beach AHQ staff was encouraged to consider roads where the AutoFlagger would be partly in the travel lane. The AutoFlagger was viewed as a fixed object being placed in the roadway. Other AHQs in the residency were given the opportunity to use the AutoFlagger but declined. According to the staff there, one characteristic of the area served by this AHQ that limited the use of the AutoFlagger is the higher traffic volumes in the growing suburban area of Chesterfield County. The AutoFlagger has not been deployed in such a manner to date because the staff felt neither comfortable nor safe using it under these conditions.

Comparison of AFAD Systems

All systems with documented results have proven to be effective. The AutoFlagger's advantage is its larger size. The two other paddle-based AFADs are much smaller units using 24-inch signs on the paddles. These signs are 50 percent smaller than the AutoFlagger signs. The 36-inch paddle mounted on an 8-ft-wide orange trailer that is usually supplemented with a taper of cones provides the AutoFlagger a large physical presence and target value for visibility. The size of the device also helps it to command respect and attention from the motorists. The size also contributes to its durability through its sturdy construction. The AutoFlagger has a 5-year warranty whereas the other devices have a 1-year warranty. Its size also tends to be the AutoFlagger's major disadvantage because it results in a higher cost. As noted by the Chesterfield staff, its size makes it a fixed object in the travel lane in most deployments. However, this can be overcome by properly placing the unit in the travel lane and using a taper of channelizing devices. The AutoFlagger is now available on a 6-ft-wide trailer. This option reduces its size but maintains the paddle size and durability. It is a matter of perspective and prioritizing what is valued to determine if its size is more of an advantage or disadvantage.

Based on the literature and VDOT's experience, the paddle- and signal-based AFADs appear to be effective. Both are based on well-established, familiar traffic control devices. There may be some concern regarding whether the supplemental signing for the paddle is clear and not confusing to motorists. Specifically, the Wytheville AHQ's experience suggests that the GO ON SLOW sign may cause confusion. The finding is inconclusive but raises a flag that the signing should be examined and reviewed with future deployments. The use of a gate arm as described in the RC Flagman and IntelliStrobe system should be helpful in informing motorists

to remain stopped and not drive by the stop sign. This option is available on most AFADs including the AutoFlagger. AFADs are a valid tool that state DOTS can deploy to assist in flagging operations.

CONCLUSIONS

- The AutoFlagger was successfully deployed by two VDOT area headquarters.
- The AutoFlagger was most successful under conditions where the staff were motivated to use it based on the need for more staff and safer conditions.
- Various AFADs have been effectively used by several state DOTs.

RECOMMENDATIONS

1. *VDOT field offices should purchase AFADs when they have determined that such devices will effectively aid them in doing more with less staff and/or improving the safety of flaggers.*
2. *Users should evaluate the effectiveness of the AFAD during deployment and provide VDOT's Traffic Engineering Division the results.* The evaluation should include a log of the deployments similar to that shown in Figure 2. It may also include a comparison of different AFADs and should include an assessment of supplemental signing used. FHWA interim approval of AFADs also requires the recordation of locations where the AFADs are used.
3. *Once this information is reviewed by VDOT's Traffic Engineering Division, they should make definitive decisions as to how VDOT can further deploy AFADs.*

COSTS AND BENEFITS ASSESSMENT

There are two primary benefits to using the AutoFlagger: flaggers can be positioned away from the roadway and moving traffic, and if sight distance permits, one flagger can control both AutoFlagger units.

The savings incurred by using one flagger rather than two can be estimated. The AutoFlagger costs $25,000 for one unit. A typical hourly rate for a flagger is $15.33 according to the Wytheville AHQ. To recoup the cost of the AutoFlagger, 1,631 hours (or 204 days, assuming 8 hours per day or 0.86 year, assuming 1,900 hours per year) of flagging will be needed. This annual estimate assumes that the worker spends 100 percent of the time as a flagger. In practice, crews perform various activities and not all require flagging. Assuming that the AutoFlagger is used 25 and 50 percent of the time yields 3.4 and 1.7 years, respectively, to recoup the cost. The more frequently the AutoFlagger is used, the quicker the return on the

investment. Other AFADs are smaller and less expensive, with costs ranging from about $14,000 to $15,000. Accordingly, the cost of these systems would be recouped in a shorter time period.

A potential disadvantage of using AFADs is that from time to time flaggers provide warnings, instructions, or answers to motorists' questions. The flagger controlling the AFAD can still perform this function except that he or she may be more difficult to find since the flagger position would be away from the travel lane and flagging device.

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