Midwest States
Smart Work Zone Deployment Initiative

Evaluation Plan

Year 3

DRAFT III

March 1, 2001

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INTRODUCTION

In 1999, the states of Iowa, Kansas, Missouri, and Nebraska created the Midwest States Smart Work Zone Deployment Initiative (MwSWZDI), a pooled-fund study to develop better ways of controlling traffic through work zones, which improve the safety and efficiency of traffic operations and highway work. During the first two years of MwSWZDI, a total of 23 technologies were deployed and evaluated in the four states. The results of the technology evaluations during the first year were presented at the Midwest Smart Work Zone Conference - *New Approaches, New Solutions*, which was held in Omaha on January 26-27, 2000. In addition, they were documented in a technical report titled *MwSWZDI Technology Evaluations – Year One*, which can be downloaded from the Mid-America Transportation Center (MATC) website (www.matc.unl.edu). The technical report documenting the results of the second year technology evaluations is in preparation and will be available from the MATC website in June, 2001.

The four states have agreed to continue the MwSWZDI, and they have been joined by the state of Wisconsin. The five states have selected 18 deployments of 15 technologies for evaluation in the third year. These deployments are listed in Table 1.

Universities in the participating states will conduct the evaluations. The universities that will be involved in the evaluations in the third year are:

- Iowa State University,
- University of Kansas,
- University of Missouri-Columbia,
- University of Nebraska-Lincoln,
- University of Wisconsin-Milwaukee, and
- Marquette University.

MATC will coordinate the overall evaluation process and compile the results of the evaluations into a final report.

The descriptions and budgets of the technology evaluations are presented in this plan. Evaluations will begin in March 2001. All evaluations will be completed by May 31, 2002.

TABLE 1 Technology Evaluations.

Deployment	Technology	State
1	Fluorescent Yellow-Green Background for Work Zone Signs	Iowa
2	Radar Speed Display	Kansas
3	Reflectorized Sleeves for Barrel Delineators	Kansas
4	Removable Orange Rumble Strips	Kansas
5	Mobile Highway Advisory Radio (HAR)	Kansas
6	Wizard CB Alert System	Kansas
7	Fluorescent Yellow-Green Background for Work Zone Signs	Kansas
8	Rumbler (Preformed Rumble Strips)	Kansas
9	Q-Cam	Missouri
10	Brown Traffic Real-Time CMS Control & Iteris Wireless Detection	Missouri
11	SafetyCor High Profile Sign Stand System	Missouri
12	Hollow-Core Sign Substrate	Missouri
13	Rumbler (Preformed Rumble Strips)	Missouri
14	Speed Advisory System	Nebraska
15	Travel Time Prediction System (TIPS)	Wisconsin
16	Rumbler (Preformed Rumble Strips)	Wisconsin
17	Mobile/Stationary Speed Boards	Wisconsin
18	Vehicle Mounted Rollup Warning Sign	Wisconsin

EVALUATIONS

IOWA

One technology will be evaluated in Iowa. It is the Fluorescent Yellow-Green Background for Work Zone Signs.

Fluorescent Yellow-Green Background for Work Zone Signs

Description

The Iowa DOT has created a 6-inch fluorescent yellow-green background for work zone signs that are mounted on the back of Iowa DOT vehicles during moving work zone operations (see Figure1). Moving work zones have fewer traffic control devices than fixed work zones and provide no buffer space for vehicles that encroach on a work zone. As shown in Figure 2, the background appears to be providing a highly visible contrast between the orange Iowa DOT vehicles and the orange work zone signs.

FIGURE 1 Fluorescent yellow-green background.

FIGURE 2 Work zone signs with and without the background.

Evaluation Methodology

Figure 3 shows a moving work zone on a multilane roadway. This is a situation where the moving work area is led and followed by two maintenance vehicles. Another orange truck augmented with orange "Right Lane Closed" sign follows the two maintenance vehicles on the shoulder.

The objective of this evaluation is to study the impact of the fluorescent yellow-green background on enhancing the visibility of the work zone sign. There will be two parts to the evaluation:

1. Performance measurement of traffic when the background is added.
2. Driver reaction.

It would be difficult to conduct an on-site study of upstream traffic behavior of a moving work zone. In this evaluation, a stationary Iowa DOT truck, augmented with a lane closure sign, will be placed on the shoulder at the road crest to depict a moving work zone on the down side of the vertical curve. Being invisible to the approaching vehicles, the "imaginary" moving work zone will cause drivers to merge to the open lane. Some cones will be placed on the shoulder over the crest of the hill to simulate a real work zone rather than having a totally "imaginary" work zone. A video detection trailer with two video cameras will be placed upstream of the stationary truck to record the speed of approaching vehicles and the lane occupancy before and after background placement. If the sign has an impact on traffic, approach speed should decrease and vehicles should merge to the open lane sooner.

Data should be collected for a minimum of ten days before and after the background installation. The location of the stationary truck will be changed daily before local drivers figure out about the "imaginary" work zone. To fairly evaluate the effectiveness of the fluorescent yellow-green background, the "before" and "after" condition data will be collected at the same location following the installation of the background. For example, a scheduled six-hour data collection period at a location will consists of three hours "before" and three hours "after" the background is placed.

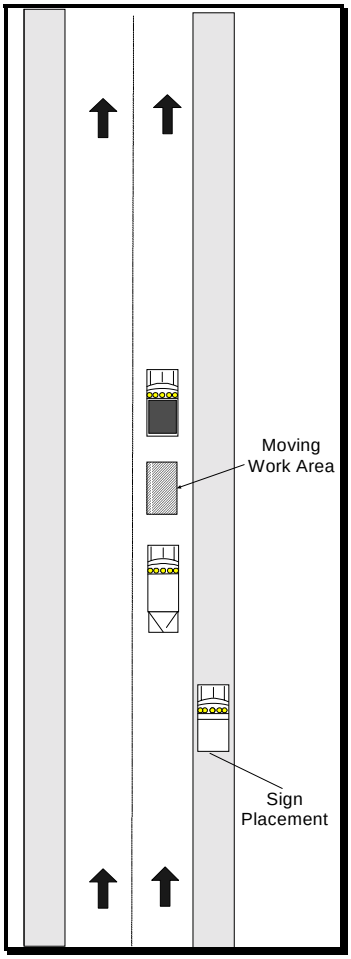

FIGURE 3 Moving work zone.

A brief survey will also be conducted to assess the drivers' opinion on the visibility of the new sign. The survey will be performed at the first service station or rest stop downstream of the work zone. It is assumed that one interviewer can conduct 30 interviews in one day. It will, therefore, require five days to obtain 150 interviews.

Measure of Effectiveness

- Reduction in approach speed
- Earlier lane change
- Sign visibility

Evaluation Parameters

- Speed distribution parameters
- Lane distribution of traffic versus volume
- Results of interviews with drivers

KANSAS

Seven technologies will be evaluated in Kansas. They are:

- Radar Speed Display;
- Reflectorized Sleeves for Barrel Delineators;
- Removable Orange Rumble Strips;
- Mobile Highway Advisory Radio (HAR);
- Wizard CB Alert System;
- Fluorescent Yellow-Green Background for Work Zone Signs
- Rumbler (Preformed Rumble Strips)

Radar Speed Display

Description

A speed trailer will be used which displays vehicle speeds. The device is capable of observing three speed thresholds. First, a speed may be set at which a strobe flash is activated simultaneous with the displayed speed changing to flash mode. A second threshold can be set at which an alarm is sounded toward the construction site to warn workers of an incoming vehicle traveling at a reckless speed. The third threshold is the upper limit of the speed displayed, discouraging drivers from "competing" to register higher speeds.

Study Site

(To Be Determined)

Performance Measures

The objectives of this application and the associated performance measures are as follows.

Objectives	Performance Measures
Reduce speeds in work zones	1. Speed
Reduce speed variance in work zones	2. Speed distribution

Experimental Design

Study type: Before/after

Data to be Collected

Vehicle Speeds

Collection method: Laser speed gun
Sample size: 2 hrs daytime and 2 hours nighttime, before installation, each of the following days after installation—[1, 2, 4, 7, 14, 21]. All observations should be on week days in order to capture repeat traffic.
Analysis technique: Comparison of 85th percentile, mean, standard deviation, and percent speeding.

Work Plan

The testing and evaluation of the technology application will consist of the following tasks.

Task	Responsibility
1. Obtain trailers	KDOT, SML
2. Collect before data	KU
3. Setup trailer	SML, KU, KDOT
4. Collect after data	KU
5. Analyze data	KU
6. Write report	KU

Schedule

Task	April				May				June				July				August				September				October			
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6	January-March																											

Reflectorized Sleeves for Barrel Delineators

Description

The drum sleeves slip over and wrap around a traditional drum. The color scheme is retroreflective material with 6” bands of green, orange, white and green working from the bottom to the top.

Study Site

(To Be Determined)

The location of the skirts will be within the construction zone at the gore area of various exit ramps. One exit will be designated as the test exit.

Performance Measures

The objectives of this application and the associated performance measures are as follows.

Objectives	Performance Measures
Make the exit ramp locations more distinguishable to the driver	1. Subjective conspicuity 2. Speed characteristics of exiting vehicles 3. Local survey
Improve traffic flow within work zone	4. Speed characteristics of mainline traffic
Reduce potential rear end accidents	5. Visual Study of driver behavior 6. Speed characteristics of exiting vehicles (prior to exit)
	7. Maintenance requirements

Experimental Design

Study type: Before/after

Data to be Collected

Conspicuity

Collection method: Drive section with subjects and mark distance at which exit could be identified.
Sample size: 10 subjects before and 10 after.
Analysis technique: Comparison of recognition distances between before group and after group.

Speed characteristics (mainline and exiting traffic)

Collection method: Pneumatic tubes at three locations, 500 ft upstream of the exit, immediately prior to the exit, and 50 feet down the ramp.
Sample size: 1 week before, 1 week after.
Analysis technique: Comparison of 85^{th} percentile, mean, standard deviations. Analysis will be performed separately for mainline traffic and for exiting traffic.

Local Survey

Collection method: mail out survey
Sample size: 150 mailed
Analysis technique: summary of qualitative comparisons.

Visual study of driver behavior

Collection method: video traffic and review braking patterns of exiting traffic
Sample size: 1 hour on 2 consecutive days before installation, repeat after installation
Analysis technique: comparison of distance prior to exit at which brakes are first applied (exiting vehicles only).

Durability

Collection method: review maintenance records and review existing drum sleeves at the end of the project
Sample size: 50-100 drum sleeves
Analysis technique: check percentage of replacement and retroreflective condition of each drum sleeve

Maintenance Requirements

Collection method: project crew will review daily with the rest of the traffic control
Sample size: NA
Analysis technique: review field records and interview inspector and contractor personnel.

Work Plan

The testing and evaluation of the technology application will consist of the following tasks.

Task	Responsibility
1. Purchase/receive drum skirts	KDOT (Mike McKenna)
2. Designate locations to install	KDOT (tech comm)
3. Finalize data collection plans	KU, KDOT (tech comm)
4. Install evaluation equipment	KU, KDOT (traffic ctrl)
5. Install drum sleeves	Contractor
6. Review project daily	Inspector
7. Periodic night reviews	KU, KDOT
8. Collect data, including interviews	KU, KDOT
9. Analyze Data	KU
10. Write Report	KU

Schedule

Task	April				May				June				July				August				September				October			
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10	January-March																											

Removable Orange Rumble Strips

Description

Advance Traffic Markings will provide enough “orange rumble strip” (ORS) @ $1 per foot to install rumble strips in advance of a signal operation for a one lane bridge project. ORS is a 250 mils thick self-adhesive plastic strip, which is orange in color. The ORS will be applied in a double thickness. The product is marketed to be placed across the roadway in order to cause noise and minor vibration of the vehicle when the vehicle traverses the strips. The noise and vibration therefore heightens the drivers’ attention to the roadway conditions.

Study Site

(To Be Determined)

Performance Measures

The objectives of this application and the associated performance measures are as follows.

Objectives	Performance Measures
Provide advance warning to drivers and provide a practical process for field application	1. Speed 2. Noise and vibration in the vehicle
Reduce erratic maneuvers to circumvent rumble strips	3. Drivers crossing the edge line or centerline (as a percent of volume)
Perform for life of project	4. Durability and removability
Install and remove easily	5. Man-hours required for installation and removal

Experimental Design

Study type: site comparison

Data to be Collected

Vehicle Speed Profiles

Collection method: pneumatic ATRs, treated and control approach, 500 ft upstream (for baseline), and within the pattern.
Sample size: 48 hrs, 2 weeks following installation.
Analysis technique: comparison of means, modes, speed variations, and speed profiles.

Vehicles Crossing Edge Line or Center Line to Circumvent Strips

Collection method: pneumatic ATR placed within the pattern.
Sample size: 48 hrs, 2 weeks following installation.
Analysis technique: post-process with custom utility, compare percentages between sites.

Cabin Noise and Vibration

Collection method: sound meter and kinetic sensor.
Sample size: 3 different vehicle types (e.g., compact, full size, and truck).
Analysis technique: comparison with asphalt rumble strips.

Durability and Removability

Collection method: testimonials of construction inspector
Sample size: N/A
Analysis technique: summary.

Installation and Removal Time

Collection method: observation.
Sample size: NA
Analysis technique: comparison with asphalt rumble strips.

Work Plan

The testing and evaluation of the technology will consist of the following tasks.

Task	Responsibility
1. Obtain product	KDOT, KU
2. Contact area for traffic control and set date	KDOT
3. Install ATRs	KDOT, KU
4. Monitor equipment	KDOT, KU
5. Remove ATRs	KDOT, KU
6. Remove strips	KDOT, KU
7. Generate profiles	KU
8. Analyze data	KU
9. Generate report	KU

Schedule

Task	April				May				June				July				August				September				October			
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Mobile Highway Advisory Radio (HAR)

Description

Portable HAR will be used in conjunction with signing to advise drivers of striping activity ahead, warning drivers not to cross the centerline to pass the striping truck, and informing drivers that the truck will pull over every 15 minutes to allow traffic to flow. Signs will mark the start and end of the section being striped, and advise drivers of the AM frequency over which the advisory message can be heard.

Study Site

District 6 in Southwest Kansas

To be used on a rural two-lane roadway during striping operations with a moving striping train. A portable HAR unit will be deployed at the beginning of the work area and another at the end of the work area to provide broadcasts to vehicles approaching from both directions. Static signage will be used to inform drivers to tune to the HAR for information. These will be placed at both ends of the work area.

Performance Measures

The objectives of this application and the associated performance measures are as follows.

Objectives	Performance Measures
Reduce the number of vehicles crossing centerline in paint area	1. Percent of vehicles passing paint truck
Inform drivers of expected delays	2. Percent of drivers who tune to radio message 3. Percent of vehicles passing paint truck 4. Percent of drivers who complain about delays (via survey)
Reduce claims to KDOT for paint damage to vehicles	5. Number of claims for paint damage compared to other striping crews

Experimental Design

Study type: Before and after

Data to be Collected

Percent of vehicles passing paint truck

Collection method: video train from ahead

Sample size: 4 hours baseline, 4 hours with HAR, same time of day on consecutive week days.

Analysis technique: comparison of baseline conditions, and additional signage with HAR.

Percent of drivers who tune to radio message

Collection method: poll drivers in queue

Sample size: NA

Analysis technique: summary

Percent of drivers who complain about delay

Collection method: survey downstream from train

Sample size: 4 hours baseline, 4 hours with HAR, same time of day on consecutive week days

Analysis technique: comparison of subjective delay ratings

Number of drivers who claim paint damage

Collection method: Track claims for 30 days following paint operation.

Sample size: NA

Analysis technique: Compare damage claims with claims received by other striping crews or in past years.

Work Plan

The testing and evaluation of the technology application will consist of the following tasks.

Task	Responsibility
1. Procure Equipment	KDOT District 6
2. Apply for FCC License	Ed Geer, KDOT
3. Make Static Signs	KDOT District 6
4. Finalize Data Collection Plan	KU, KDOT
5. Develop driver survey	KU, KDOT
6. Determine Test Schedule	KU, KDOT
7. Determine Test Locations	KDOT District 6
8. Perform Striping and Collect Data	KU, KDOT
9. Analyze Data	KU
10. Write Report	KU

Schedule

Task	April				May				June				July				August				September				October			
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Wizard CB Alert System

Description

The Wizard CB Alert System may be either vehicle mounted or self-contained as a trailer mounted unit that involves the use of a CB radio transmitter with a recorded message, alerting CB users approaching a work zone of the road and traffic conditions ahead. This evaluation will be of the vehicle-mounted version.

Study Site

US-50, in Chase County is a 2-lane conventional highway of Portland cement concrete pavement construction. The project involves concrete pavement patching and the replacement of cracked concrete panels through the use of flaggers with or without pilot cars and also temporary traffic signals. This section of roadway has moderate traffic volumes with a high percentage of large commercial traffic with a posted speed limit of 65 mph.

Performance Measures

The objectives of this application and the associated performance measures are as follows.

Objectives	Performance Measures
Provide advance warning of approach to a flagger or temporary traffic signal	1. Percent of truckers who received the message prior to seeing the first work zone sign 2. Percent of truckers who said it helped improve their awareness of the approaching work zone. 3. Number of trucks locking brakes to stop for queue of traffic 4. Before and after speeds measurements at the first construction warning sign and at the ONE LANE ROAD AHEAD sign
Assess performance characteristics of the Wizard CB Alert	5. Maximum distance the message can be heard under various weather conditions and with various CB radio receivers
Assess ease of operations and acceptance by State and Contractor personnel	6. Time to install initially 7. Time to change message 8. Survey of users for subjective comments

Experimental Design

Study type: Before and after

Data to be Collected

Percentage of truckers hearing the message prior to seeing work zone signs

Collection method: survey of truckers stopped in queue of traffic
Sample size: 100 truckers at each work zone location
Analysis technique: Overall percentage of survey respondents who heard the message prior to seeing the first sign

Percentage of truckers who thought the message was useful

Collection method: survey of truckers stopped in queue of traffic
Sample size: 100 truckers at each work zone location
Analysis technique: Overall percentage of survey respondents who believe the message was effective

Number of trucks locking brakes to stop for queue of traffic

Collection method: Observation by flagger
Sample size: 20 construction days prior and 20 constructions days after activation of the Wizard CB Alert
Analysis technique: compare number before versus number after

Compare Before and After Speeds

Collection method: laser speed measuring device
Sample size: 100 trucks prior and 100 trucks after
Analysis technique: comparison of 85^{th} percentile, average and pace speeds of trucks before and after

Broadcast range of device

Collection method: observation
Sample size: 5 different types of CB radios under clear, partly cloudy and overcast conditions, and at various work sites where terrain can also be considered
Analysis technique: measurement of maximum range under each condition with each radio

Work Plan

The testing and evaluation of the technology application will consist of the following tasks.

Task	Responsibility
1. Discuss with vendor and field office	KDOT/Vendor
2. Determine vehicle(s) to mount device(s) in	KDOT/Contractor
3. Ship device(s)	Vendor
4. Install device(s)	KDOT/Contractor
5. Determine appropriate message(s)	KDOT/Vendor/Cont.
6. Prepare survey questions	KU/KDOT
7. Survey truckers	KU
8. Observe stopping patterns	KU/Contractor
9. Collect speed data	KU/KDOT
10. Analyze data	KU
11. Write report	KU

Schedule

Task	April				May				June				July				August				September				October			
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Fluorescent Yellow-Green Background for Work Zone Signs

Description

Fluorescent background for truck-mounted warning signs. The intended purpose is to increase the conspicuity of orange signs mounted on orange trucks by providing a background color that produces more contrast with the sign than the vehicle's color.

Study Site

KU Visual Cognition Laboratory

Performance Measures

The objectives of this application and the associated performance measures are as follows.

Objectives	Performance Measures
Increase the conspicuity of truck-mounted signs	1. Changedetection latency

Experimental Design

Study type: Comparison of standard mount signs with signs mounted on a fluorescent yellow-green background.

Data to be Collected

Change Detection Latency

Collection method: computed-based system

Sample size: 60 participants in three groups based on age. The youngest group will range in age from 18 to 25 years of age. The middle-aged group will range in age from 45 to 55 years of age. The oldest group will range in age from 65 to 85 years of age.

Analysis technique: comparison of change detection times

Procedure

Participants will be tested individually. Screening for visual acuity and attentional ability (i.e., useful field of view) will be conducted first. The participant will then seated in front of a monitor, using a chin rest to discourage head movement. Participants will be verbally informed that they will be viewing sets of pictures with a change made to an object between each set. As soon as they detect the change, participants are to push the left mouse button and verbalize the change to the experimenter, who records their accuracy. Two practice trials will be completed first, followed by blocks of trials. The order of the blocks will be counterbalanced across participants, and the order of the trials within each block will be randomized without replacement.

The participant presses the space bar to begin each trial. The picture sets are displayed using the flicker paradigm of Rensink et al. (Rensink, R.A., O'Regan, J.K., & Clark, J.J. (1997). To see or not to see: The need for attention to perceive changes in scenes. Psychological Science, 8(5), 368-373). Each picture (A) is displayed for 240 milliseconds, followed by a blank screen presented for 80 milliseconds. This pairing is repeated, then the changed picture (A') is presented alternating with blank screen, and this pairing is repeated. Thus the pictures are presented in this fashion: A, (blank), A, (blank), A', (blank), A', (blank). This sequence is

repeated for 60 seconds or until the observer responds. After completion of all trials, participants will be debriefed and compensated accordingly.

Work Plan

The testing and evaluation of the technology application will consist of the following tasks.

Task	Responsibility
1. Generate images for study	KU
2. Identify participants	KU
3. Pre-test participants' visual and attentional ability	KU
4. Administer tests	KU
5. Analyze data	KU
6. Generate report	KU

Schedule

Task	April				May				June				July				August				September				October			
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Rumbler (Performed Rumble Strips)

Description

Rumbler preformed rumble strips will be used with temporary traffic signals for a bridge expansion joint replacement project. Swarco Industries will provide enough of their *Rumbler* rumble strips to install one set of three groups of strips, as per KDOT standard rumble strip pattern. Along one of the approaches to the work zone, the preformed rumble strips will be installed in place of the furthest upstream set of (asphalt) rumble strips. The second set of rumble strips will be asphalt. The other approach to the work zone will consist of normal asphalt strips.

Strips will be laid out to approximate the standard KDOT pattern. The product is marketed to be placed across the roadway in order to cause noise and minor vibration of the vehicle when the vehicle traverses the strips. The noise and vibration therefore heightens the drivers' attention to the roadway conditions. Rumbler strips are available in nonreflective black, and reflective white or yellow. Black will be used.

Study Site

K-92, Jefferson County

The rumble strips will be used for a bridge expansion joint replacement project located on K-92 over Perry Reservoir, approximately four miles east of junction K-4 and K-92.

Performance Measures

The objectives of this application and the associated performance measures are as follows.

Objectives	Performance Measures
Provide advance warning to the driver	1. Speed 2. Noise and vibration in the vehicle
Reduce erratic maneuvers to circumvent rumble strips	3. Drivers crossing the edge line or centerline as a percent of volume)
Perform for the life of the project	4. Durability and removability
Install and remove easily	5. Man-hours required for installation and removal

Experimental Design

Study type: site comparison

Data to be Collected

Vehicle Speed Profiles

Collection method: pneumatic ATRs, treated and control approach, before strips, after strips, 1500 ft upstream (for baseline), and within the pattern

Sample size: 48 hrs, 2 weeks before installation

Analysis technique: comparison of means, modes, speed variations, and speed profiles

Vehicles Crossing Edge Line or Center Line to Circumvent Strips

Collection method: pneumatic ATR placed within the pattern

Sample size: 48 hrs, 2 weeks following installation

Analysis technique: post-process with custom utility, compare percentages between sites.

Cabin Noise and Vibration

Collection method: sound meter and kinetic sensor

Sample size: 3 different vehicle types (e.g., compact, full size, and truck)

Analysis technique: comparison with asphalt rumble strips

Installation and Removal Time

Collection method: observation

Sample size: NA

Analysis technique: comparison with asphalt rumble strips

Work Plan

The testing and evaluation of the technology application will consist of the following tasks.

Task	Responsibility
1. Obtain materials (strips and adhesives) and identify installation equipment (e.g., tamper cart, adhesive applicators, sweeper)	KDOT, Swarco
2. Install strips	KDOT, KU, Swarco
3. Install ATRs	KDOT, KU
4. Monitor equipment	KDOT, KU
5. Remove ATRs	KDOT, KU
6. Remove strips	KDOT, KU
7. Generate profiles	KU
8. Analyze data	KU
9. Generate report	KU

Schedule

Task	April				May				June				July				August				September				October			
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MISSOURI

Five technologies will be evaluated in Missouri. They are: (1) Q-Cam, (2) Brown Traffic Real-Time CMS Control & Iteris Wireless Detection, (3) SafetyCor High Profile Sign Stand System, (4) Hollow-Core Sign Substrate, and (5) Rumbler (Preformed Rumble Strips).

Q-Cam

Description

The Q-cam is designed to transmit real-time images of a section of highway over the Internet. It is portable and intended to be used for verification of queues or incidents detected by another device.

Study Site

The devices will be evaluated during the 2001 construction season at a work zone in the St. Louis area. The site will be chosen such that drivers will have an alternate route recommended in cases of queuing prior to the work zone.

Performance Measures

The study will answer the question "How much useful information about traffic flow conditions can be gained from real-time images from the Internet?" The researchers will use the real-time images to study traffic flow conditions at the traffic diversion site. The performance measure and corresponding measure of effectiveness are shown below.

Performance Measure	Measure of Effectiveness
Useful traffic flow information is derived from the technology.	Usefulness of traffic flow information as judged by MoDOT personnel and researchers.

Experimental Design

The images provided by the Q-Cam will be compared to the records of when queues are detected by the wireless detection system.

Work Plan

Task	Responsibility
1. Coordination meetings.	MU, MoDOT, vendors
2. Install devices.	MoDOT, vendors
3. Collect data.	MU
4. Analyze data.	MU
5. Final report.	MU

Schedule

The schedule is tentative because the installation times for the devices have not been finalized.

	2001								2002		
Task	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**	**J**	**F**	**M**
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Brown Traffic Real-Time CMS Control & Iteris Wireless Detection

Description

The Brown Traffic Real-Time CMS Control enables changeable message signs (CMS) to be activated by a signal from the Iteris Wireless Detection, which indicates that congestion is present. The CMS can advise drivers to take an alternate route when congestion is present. The wireless detection for work zones monitors traffic conditions and sends a wireless signal to the Brown Real-Time CMS Control when a queue occurs.

Study Site

The devices will be evaluated during the 2001 construction season at a work-zone in the St. Louis area. The site will be chosen such that drivers will have an alternate route recommended in cases of queuing prior to the work zone.

Performance Measures

The study will answer the question "What percentage of the traffic is diverted?" The researchers will also examine the traffic flow rate on the main road, the travel time on the main road relative to the alternate route, and the adequacy of equipment communication. The performance measures and corresponding measures of effectiveness are shown below.

Performance Measure	Measure of Effectiveness
Traffic is diverted.	Percentage of traffic diverted.
Travel times on the main road decrease.	Travel times on main road and alternate route.
Wireless detection provides adequate information to CMS.	Adequacy of performance as judged by MoDOT personnel and researchers.

Experimental Design

Vehicle counts will be collected at a point upstream of the CMS on the main road after the exit point for the alternate route, and at a point close to the work zone. These counts will also be used to calculate the diversion and estimated traffic flow.

The researchers will drive several passes during congested conditions on both the main and alternate routes to compare the travel times. In addition, a series of "before" travel times on the main route will be obtained for comparison purposes.

Work Plan

Task	Responsibility
1. Coordination meetings.	MU, MoDOT, vendors
2. Install devices.	MoDOT, vendors
3. Collect data.	MU
4. Analyze data.	MU
5. Final report.	MU

Schedule

The schedule is tentative because the installation times for the devices have not been finalized.

Task	2001								2002		
	M	J	J	A	S	O	N	D	J	F	M
1											
2											
3											
4											
5											

SafetyCor High Profile Sign Stand System

Description

The SafetyCor High Profile Sign Stand System is a frame, approximately 7 feet tall, made of rectangular, hollow-core PVC. It is designed to be movable and lighter than traditional wood frames. In addition, it has been approved by the Federal Highway Administration as meeting NCHRP 350 requirements.

Study Site

The device will be tested at a work-zone on an Interstate or other 4-lane highway in central Missouri.

Performance Measures

The study will answer questions about the stability and durability of the device. The table below shows the performance measures and corresponding measures of effectiveness.

Objectives	Measure of Effectiveness
Assess stability of stand	Stability of stand under various weather conditions, with and without ballast (measured as distance from original position and number of times stand falls over)
Durability of stand	Condition of stand at end of study
Ease of use	Weight, maneuverability, and upkeep as judged by MoDOT personnel and researchers

Experimental Design

The sign stands will be deployed and compared over time to the standard wood stands that are often used on MoDOT construction projects.

Work Plan

The table below shows the work plan.

Task	Responsibility
1. Coordination meetings	MU, MoDOT, vendor
2. Install device	MoDOT, traffic control subcontractor
3. Collect data	MU
4. Analyze data	MU
5. Final report	MU

Schedule

The schedule is tentative because the installation time has not been finalized.

2001										
Task	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
1										
2										
3										
4										

Hollow-Core Sign Substrate

Description

The Hollow-core Sign Substrate is a lightweight sign that can be used in either a post-mounted or portable application.

Study Site

The device will be tested at a work-zone on an Interstate or other 4-lane highway in central Missouri.

Performance Measures

The study will answer questions about the ease of mounting, durability, and overall condition of the signs. The table below shows the performance measure and corresponding measure of effectiveness.

Objective	Measure of Effectiveness
Compare performance to standard aluminum sheet signs	Ease of mounting and durability as judged by MoDOT personnel and researchers

Experimental Design

The signs will be deployed side-by-side with and compared over time to the standard metal signs that are used on MoDOT construction projects.

Work Plan

Task	Responsibility
1. Coordination meetings	MU, MoDOT, vendors
2. Install device	MoDOT, traffic control subcontractor
3. Collect data	MU
4. Analyze data	MU
5. Final report	MU

Schedule

The schedule is tentative because the installation time has not been finalized.

2001										
Task	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
1										
2										
3										
4										
5										

Rumbler (Preformed Rumble Strips)

Description

The Rumbler is a preformed rumble strip system intended as a traffic calming, speed reduction and driver alert system. The manufacturer states that the system combines the following features:

- audible warning
- controlled vibratory warning
- visual daytime warning
- visual night-time warning

- visual reflective wet-night warning temporary or permanent applications (on asphalt or PCC surfaces)
- easy and quick installations without requiring specialized equipment
- flexible and conformable construction to reduce risk of breakage
- reflective and non-reflective versions (white, yellow and non-reflective black)

Study Site

The Rumbler evaluation will be made at a work zone in an Interstate or multi-lane highway in central Missouri.

Performance Measures

The study will answer questions relating to whether the devices provide advance warning of downstream traffic conditions, reduce vehicle speeds, reduce speed variability, and perform adequately for installation, durability, and removal.

Objective	Measure of Effectiveness
Provide advance warning.	Accidents related to device.
Reduce speed.	Mean speed and speed distribution parameters.
Provide audible and tactile sensation.	Volume of sound and impact of bumps.
Perform for life of project.	Ease of installation, durability, and removal.

Experimental Design

The manufacturer suggested arrangement of Rumbler system rumble strips (four sets of six rumble strips at 36 inch spacings) will be used in advance of a work-zone lane drop. The four sets of strips will be approximately 200, 400, 800, and 1600 meters in advance of the lane drop. Speed measurements will be taken in advance of and within the four sets of six rumble strips. These speed measurements will be taken both before and after installation of the strips. Enough data will be collected to obtain statistically significant results under congested and uncongested conditions.

The researchers and MoDOT personnel will drive the rumble strips in passenger vehicles and larger vehicles to subjectively evaluate the level of noise and physical sensation provided by the rumble strips.

Any accidents which occur within 2.0 miles upstream of the Rumbler system during the deployment will be noted and described. Should an accident be determined to be possibly related to the system, the deployment will be re-evaluated and may be terminated. The accident rate will be reported and compared to typical accident rates in this type of work zone. Any statistically significant results will be determined.

The personnel who install and remove will be observed and questioned to determine their judgment of ease of installation, durability and removal. The same questions will be asked of the researchers and responsible MoDOT personnel.

Work Plan

Task	Responsibility
1. Coordination meetings	MU, MoDOT, vendor
2. Install Rumbler	MoDOT, traffic control subcontractor, MU
3. Collect data	MoDOT and MU
4. Analyze data	MU
5. Final report	MU

Schedule

The schedule is tentative because the installation time has not been finalized.

Task	2001									2002		
	A	M	J	J	A	S	O	N	D	J	F	M
1												
2												
3												
4												
5												

NEBRASKA

One technology will be evaluated in Nebraska. It is the Speed Advisory System.

Speed Advisory System

Description

The Speed Advisory System is an enroute traveler information system whereby real-time speed advisory information is provided to drivers by means of portable changeable message signs (CMSs) strategically located in advance of diversion points upstream of a work zone. The objective of the Speed Advisory System is to advise drivers of the speed of traffic in advance of a work zone and thereby encourage them to divert to an alternate route when there is congestion in the work zone.

The Speed Advisory System is comprised of three primary components: (1) a video detection system; (2) two portable CMSs; and (3) a control system. The video detection system will be used to measure the speeds of traffic at two critical points in advance of a work zone. The average speeds measured at the two points will be displayed on the two portable CMSs

placed in advance of diversion points in advance of the work zone. The control system will be the itsworkzone™ software program, which will provide communications between the video detection system and the portable CMSs necessary to display the appropriate speed messages. The control system will also provide communications to the Nebraska Department of Roads (NDOR) District 2 office, which will enable the Speed Advisory System to be controlled and monitored by NDOR personnel. The control system will be able to alert the NDOR personnel when speeds drop below a selected threshold and enable them to display incident-related messages when necessary.

Objective

The objective of the evaluation is to assess: (1) the effectiveness of the Speed Advisory System in encouraging traffic diversion when there is congestion in the work zone and (2) its applicability as a traffic management tool.

Study Site

The Speed Advisory System will be deployed in advance of a work zone on northbound I-680 between Pacific Street and west Dodge Road in Omaha, Nebraska. The work zone involves the closing one of three lanes. The posted speed limit in advance of the work zone is 60 mph, and the posted speed in the work zone is 55 mph. The average daily traffic on this section of I-680 is about 88,000 vehicles per day, of which 4 percent are trucks.

The video detection system will measure speeds at two points between Pacific Street and West Center Road on northbound I-680. The two portable CMSs will be placed in advance of 72nd Street on westbound I-80 and L Street on northbound I-80.

Performance Measures

Objective	Measure of Effectiveness
To advise drivers of speeds in advance of work zone and encourage them to divert to alternate route when there is congestion in the work zone.	Changes in estimated traffic demand in advance of the work zone during periods of congestion before and after the implementation of the speed advisory messages.
	Percentage of drivers who notice the speed advisory messages.
	Percentage of drivers who understand the speed advisory messages.
	Percentage of drivers who believe the speed advisory messages are useful.
To facilitate traffic management during incidents and periods of congestion in the work zone.	Opinions of NDOR personnel regarding the usefulness of the system.
To measure traffic speeds accurately and dependably.	Differences between speeds measured by system and those measured independently.
To display appropriate speed advisory messages.	Differences between speed advisory messages and traffic speeds.
To provide dependable notification to NDOR of slow speed conditions.	Differences between occurrences of slow speed conditions and system communications to NDOR of slow speed conditions.

Experimental Design

Speed and volume data will be measured at the two locations in advance of the work zone where the video detection system cameras are installed. The data will be obtained during a one-week period before and a four-week period after the speed advisory messages are implemented. These data will be obtained from the video detection system logs. The speed and volume data will be used to estimate traffic densities from which traffic demand will be estimated. The demand flow rates during 5-minute intervals will be estimated. The demand flow rates will be compared to the speed advisory messages obtained from the control system logs. An analysis of covariance will be conducted to determine the effects of volume and speed advisory messages on estimated traffic demand.

Traffic at the two data collection locations will video taped at selected times during congested and uncongested traffic flow conditions. The video tapes will be analyzed to determine the traffic speeds and volumes. These data will be compared to the speeds and volumes measured by the video detection system to assess the accuracy and dependability of the video detection system. In addition, the speed advisory messages displayed and the system communications with the NDOR District 2 office will be monitored during these periods to determine the system's reliability in selecting appropriate speed advisory messages and notifying NDOR of traffic flow conditions below the selected speed threshold.

Drivers who commuter regularly along northbound and westbound I-80 will be surveyed to determine their experience with the system, obtain their opinions regarding its usefulness, and their suggestions for improving it. About 100 commuter surveys will be administered.

NDOR personnel who worked with the system will be interviewed. Problems they encountered with the system will be identified. Their opinions regarding the usefulness of the system and their suggestions for improving the system will be noted.

Work Plan

Task	Responsibility
1 – Install system.	Brown Traffic, National ITS, NDOR
2 – Design speed advisory messages and display criteria.	NDOR
3 – Implement speed advisory messages.	Brown Traffic, National ITS, NDOR
4 – Analyze system logs.	MATC
5 – Collect speed and volume data.	MATC
6 – Monitor system displays and communications.	MATC
7 – Analyze system performance data.	MATC
8 – Conduct commuter survey.	MATC
9 – Conduct NDOR personnel interviews.	MATC
10 – Report results.	MATC

Schedule

Task	June				July				Aug.				Sept.				Oct.				Nov.			
1 – Install system.		■																						
2 – Design speed advisory messages.			■																					
3 – Implement speed advisory messages.				■																				
4 – Analyze system logs.			■	■	■	■	■	■	■	■	■	■	■	■	■	■								
5 – Collect speed and volume data.					■	■	■	■																
6 – Monitor system displays & coms.					■	■	■	■																
7 – Analyze system performance data.									■	■	■	■	■	■	■	■								
8 – Conduct commuter survey.									■	■	■	■												
9 – Conduct NDOR personnel interviews.									■	■														
10 – Report results.																	■	■	■	■	■	■	■	■

WISCONSIN

Four technologies will be evaluated in Wisconsin. They are: (1) Travel Time Prediction System (TIPS), (2) Rumbler (Preformed Rumble Strips), (3) Mobile/Stationary Speed Boards, and (4) Vehicle Mounted Rollup Warning Sign.

Travel Time Prediction System (TIPS)

Description

The Travel Time Prediction System (TIPS) is a portable automated system for predicting and displaying travel time for motorists in advance of and through work zones, on a real-time basis. It collects real-time traffic flow data using roadside non-contact sensors (microwave radar sensors), processes the data in an on-site personal computer, computes estimated travel time between different points on the freeway and the end of the work zone, and displays this information on several portable, electronic changeable message signs (CMS) positioned at pre-determined locations along the freeway. Provision of real time travel time information allows motorists to make decisions about staying on the freeway or taking an alternate route.

According to the system developer, the system has a communications range of 20 miles, its sensors can detect traffic flow on each lane (up to eight lanes), and provides travel time predictions with an accuracy of +/- 3 min. Communications between system detectors, the on-site personal computer and the CMS are through radios using the 220MHz frequencies that have been allocated to FHWA; thus no FCC permission to use these frequencies is required. The system is powered by batteries charged through solar panels.

Objective

1. Provide reliable travel time information.
2. Reduce travel time: motorists are expected to use less congested alternate routes once expected travel times through a work zone become excessive. Use of alternate routes is expected to produce a reduction in mainline and corridor travel time.
3. Reduce mainline risk of rear-end collisions, since mainline traffic volumes are expected to be lower due to diverted traffic.

Evaluation Methodology

1. System reliability evaluation: comparison of actual and predicted travel time information; system down time (and causes of down time) during evaluation period; system ability to function during inclement weather.
2. Travel time evaluation: comparison of mainline and corridor motorist travel times before and after system installation.
3. Diversion evaluation: comparison of mainline volumes before and after TIPS operation.
4. Safety evaluation: comparison of mainline and corridor crash statistics before and after system installation, and comparison with similar work zone statistics.

Study Site

The system will be evaluated during spring/summer 2001 at the asphalt resurfacing project on southbound I-94, in Racine County, south of Milwaukee. The project will begin in March or April. The project is within system operating parameters: the available three southbound lanes (system capability is up to eight lanes) will be reduced to two lanes during the project (and one lane at night for short periods), and work zone length is 12-13 miles (within the system range of 20 miles).

Portable Changeable Message Signs (CMS) will be placed upstream of the construction zone, near the interchanges with Ryan Rd. and Rawson Ave. (approx. 2 miles and 5 miles in advance of the work zone, keeping the total TIPS deployment length to 17-18 miles, within system capabilities) where motorists would have the choice of remaining on I-94 or exiting to one of a few alternate routes available to motorists. Trailblazing signs will be in place for motorist guidance.

Congestion would be most severe on June through August weekdays from 3-6 pm. (especially on Thursdays & Fridays). It would be desirable to obtain actual travel time data for a period before system installation and a similar period after system installation. Data collection will not commence until drivers have been acclimated to the work zone.

Measures of Effectiveness

Ease of installation
Ease of removal
Maintenance requirements
Travel time prediction reliability

Equipment reliability (down times, ability to withstand storms, ability to maintain power in overcast conditions)
Diverted mainline trips
Motorist travel time (mainline and corridor travel time)
Crashes

Data to be Collected

1. Crash data for the construction zone and alternate routes during the construction period.
2. Crash data from the previous Kenosha County resurfacing project.
3. Travel time runs during the before and the after periods.
4. Pavement-embedded loop detector data (volume, speed, occupancy) during the before and the after periods.
5. Mainline, on and off ramp and alternate route traffic counts during the before and the after periods.
6. TIPS ease of installation/removal and maintenance records (malfunctions, down time etc.).
7. Lane closure schedules during the 2001 construction season.

Tasks

Task	Responsibility
1. Plan installation and testing	(U. of Cincinnati/WisDOT)
2. Travel time runs data collection/analysis	(UWM/MU)
3. Embedded loop detector data collection/analysis	(UWM/MU/WisDOT)
4. Crash data collection/analysis	(UWM/MU/WisDOT)
5. Diverted trips data collection (mainline, ramp and alternate route)	(WisDOT)
6. Diverted trips data analysis (mainline, ramp and alternate route)	(UWM/MU)
7. TIPS maintenance records	(WisDOT)
8. Lane closure schedules during 2001 construction season	(WisDOT)
9. Report writing	(UWM/MU)

Rumbler (Preformed Rumble Strips)

Description

Like any rumble strip, Rumbler gives an audible and tactile message to drivers when approaching a location where a stop may be required. Rumbler could be used ahead of a temporary signal or a flag operation.

Evaluation Methodology

Rumbler will be installed by the Wisconsin Department of Transportation ahead of a temporary signal on a 2-lane rural state trunk highway (STH 26) where it intersects a local road (CHT E in Dodge County). The test will be one month in length for a single direction of travel. After the test, the Rumbler will be removed.

Traffic will be observed for two periods of time, each consisting of 4 hours, when traffic is light. Light traffic conditions would give the driver the least amount of clues that a stop will soon be required. One period will be with the Rumbler, one period will be without the Rumbler. Data collection will consist of measurement of speeds of individual vehicles and observation of driver behavior approaching the intersection. . Speed statistics (such as the mean, standard deviation, t-statistic, 85^{th} percentile speed, percent above speed limit) will be computed. The exact location of the Rumbler and the point of speed data collection will be determined during project planning.

The Rumbler will also be evaluated for durability, ease of application and removal, and effectiveness at producing an audible or tactile message. The strength of the audible message will be measured with a sound level meter. The strength of the tactile message will be evaluated subjectively by the driver or by accelerometers. A comparison will be made to a new, conventional rumble strip

Measures of Effectiveness

Durability of Rumbler and Adhesive
Ease of Installation
Ease of Removal
Differences in Average Speeds between Rumbler and Signal
Noise Level within Vehicle
Crashes or Unusual Behaviors

Tasks

Task	Responsibility
1. Plan installation and test	(UWM/MU/WisDOT)
2. Perform "without" data collection	(UWM/MU)
3. Install Rumbler	(WisDOT)
4. Perform "with" data collection	(UWM/MU)
5. Remove Rumbler and interview crew	(UWM/MU/WisDOT)
6. Write report	(UWM/MU)

Mobile/Stationary Speed Boards

Description

The Mobile/Stationary Speed Boards is intended to be mounted on a construction truck that frequently passes through the work zone or remains stopped at a location near the work zone. The device has two displays, one giving the speed of the truck (ME) and the other giving the speed of a following vehicle (YOU).

Evaluation Methodology

The Mobile/Stationary Speed Boards will be mounted on a single truck for one work-week. It is intended that this truck be one that moves much of the time, such as applying pavement markings. Traffic will be observed for two periods of time, each consisting of 4 hours when traffic is light. Light traffic would allow drivers to select their own speed. One period will be when the truck with the device is active or parked near the workzone. Crews will be interviewed as to the ease of use and reliability of the device. The device would be evaluated subjectively for visibility. The second period will be when the device is not present. It is unlikely that there will be a convenient place to interview drivers who have passed through the work zone, thus the evaluation will concentrate on objective measures of vehicular speed. Speed statistics (such as the mean, standard deviation, t-statistic, 85^{th} percentile speed, percent above speed limit) will be computed. The location of the speed measurement point, relative to the speed boards, will be determined during project planning. The locations for the before and after tests will be chosen to be as similar as possible, standardizing important environmental conditions, such as number of lanes, lane width, lateral clearance, curves, and distractions.

Measures of Effectiveness

Ease of Installation and Removal
Reliability of the Device
Accuracy of the Device
Visibility of the Device
Average Speeds within Work Zone

Tasks

Task	Responsibility
1. Plan installation and test	(UWM/MU/WisDOT)
2. Perform "without" data collection	(UWM/MU)
3. Install Speed Boards	(WisDOT)
4. Perform "with" data collection	(UWM/MU)
5. Interview crew	(UWM/MU/WisDOT)
6. Write report	(UWM/MU)

Vehicle Mounted Rollup Warning Sign

Description

A rollup sign contains a standard message that work is in progress. The sign can be attached to a trailer hitch. It can be mounted on a vehicle performing pavement marking or another mobile maintenance operation.

Evaluation Methodology

The locations of the test is still to be determined. The sign will be used by four different crews, either at the same site or at different sites. Crews will be administered a questionnaire to obtain their opinions of the sign. The sign would be rated subjectively for visibility.

Measures of Effectiveness

Ease of Installation
Ease of Operation
Lack of Interference with Vehicle Operation
Durability
Perceptions of Safety
Perceptions of Visibility

Tasks

Task	Responsibility
1. Plan installation and tests	(UWM/MU/WisDOT)
2. Write questionnaire	(UWM/MU)
3. Perform tests	(WisDOT)
4. Administer questionnaire	(UWM/MU/WisDOT)
5. Write report	(UWM/MU)

BUDGET

The total pooled-fund budget for the evaluation plan is $549,312. This amount does not include the cost share of the state highway agencies and the technology providers. The itemized budget by technology evaluation is shown in Table 2.

The budget is summarized by technology deployment in Table 3.

The amount of the pooled-fund carryover from Year 2 is $134,419. Therefore, the additional pooled funds needed for Year 3 are $414,893 ($549,312 minus $134,419), or $82,978.60 per state.

TABLE 2 Itemized Pooled-Fund Budget.

Item	#1 Fluorescent YG Background (IA)	#2 Radar Speed Display (KS)	#3 Reflector Sleeves for Barrels (KS)	#4 Removable Orange Rumble Strips (KS)	#5 Mobile HAR (KS)
Personnel					
Salaries & Wages	13,323	3,008	2,632	3,094	3,502
Fringe Benefits	2,963	677	592	681	836
Subtotal	16,286	3,685	3,224	3,775	4,338
Other Direct Costs					
Materials & Supplies	800	49	1,174	124	49
Printing & Copying	200				
Postage	25				
Telephone & FAX	100				
Research Equipment	0				
Travel	1,952	234	886	1,190	1,168
Tech Installation	0				
Tech Maintenance	0				
Subtotal	3,077	283	2,060	1,314	1,217
Total Direct Cost	19,363	3,968	5,284	5,089	5,555
Indirect Cost	8,617	1,514	2,158	2,028	2,171
Total Cost	27,980	5,482	7,442	7,117	7,726

TABLE 2 Itemized Pooled-Fund Budget (continued).

Item	#6 Wizard CB Alert System (KS)	#7 Fluorescent Yellow-Grn Background (KS)	#8 Rumbler (KS)	#9 Q-Cam (MO)	#10 Brown Real-Time CMS Control (MO)
Personnel					
Salaries & Wages	2,052	12,496	4,520		40,383
Fringe Benefits	430	1,892	877		11,261
Subtotal	2,482	14,388	5,397		51,644
Other Direct Costs					
Materials & Supplies	449	41	116		200
Printing & Copying		0	0		
Postage		0	0		
Telephone & FAX		0	0		
Research Equipment		9,900	0		
Travel	410	1,565	627		932
Tech Installation		0	0		
Tech Maintenance		0	0		
Subtotal	859	11,506	743		1,132
Total Direct Cost	3,341	25,894	6,140		52,776
Indirect Cost	1,339	11,041	2,421		22,324
Total Cost	4,680	36,935	8,561	Included in #10	75,100

TABLE 2 Itemized Pooled-Fund Budget (continued).

Item	#11 SafetyCor High Profile Sign Stand (MO)	#12 Hollow-Core Sign Substrate (MO)	#13 Rumbler (MO)	#14 Speed Advisory System (NE)
Personnel				
Salaries & Wages	3,570	3,570	14,520	27,321
Fringe Benefits	745	745	3,563	6,284
Subtotal	4,315	4,315	18,083	33,605
Other Direct Costs				
Materials & Supplies	100	100	100	250
Printing & Copying	0	0	0	500
Postage	0	0	0	0
Telephone & FAX	0	0	0	0
Research Equipment	0	0	0	0
Travel	200	200	120	512
Tech Installation	0	0	0	15,000
Tech Maintenance	0	0	0	
Subtotal	300	300	220	16,262
Total Direct Cost	4,615	4,615	18,303	49,867
Indirect Cost	2,077	2,077	8,236	3,361
Total Cost	6,692	6,692	26,539	53,228

TABLE 2 Itemized Pooled-Fund Budget (continued).

Item	#15 TIPS (WI)	#16 Rumbler (WI)	#17 Speed Boards (WI)	#18 Rollup Warning Sign (WI)	MATC
Personnel					
Salaries & Wages	27,915	3,085	3,085	2,285	33,640
Fringe Benefits	5,885	699	699	591	7,737
Subtotal	33,800	3,784	3,784	2,876	41,377
Other Direct Costs					
Materials & Supplies	150	100	100	50	1,500
Printing & Copying	200	100	100	50	3,000
Postage	0	0	0	0	500
Telephone & FAX	0	0	0	0	500
Research Equipment	0	0	0	0	0
Travel	200	100	100	70	2,500
Tech Installation	160,252	0	0	0	0
Tech Maintenance		0	0	0	0
Subtotal	160,802	300	300	170	8,000
Total Direct Cost	194,602	4,084	4,084	3,046	49,377
Indirect Cost	10,650	1,878	1,878	1,401	4,138
Total Cost	205,252	5,962	5,962	4,447	53,515

TABLE 3 Pooled-Fund Budget Summary.

Deploy-Ment	Technology	State	Cost
1	Fluorescent Yellow-Green Background for Work Zone Signs	IA	27,980
2	Radar Speed Display	KS	5,482
3	Reflectorized Sleeves for Barrel Delineators	KS	7,442
4	Removable Orange Rumble Strips	KS	7,117
5	Mobile Highway Advisory Radio (HAR)	KS	7,726
6	Wizard CB Alert System	KS	4,680
7	Fluorescent Yellow-Green Background for Work Zone Signs	KS	36,935
8	Rumbler (Preformed Rumble Strips)	KS	8,561
9	Q-Cam	MO	75,100
10	Brown Traffic Real-Time CMS Control & Iteris Wireless Detection	MO	
11	SafetyCor High Profile Sign Stand System	MO	6,692
12	Hollow-Core Sign Substrate	MO	6,692
13	Rumbler (Preformed Rumble Strips)	MO	26,539
14	Speed Advisory System	NE	53,228
15	Travel Time Prediction System (TIPS)	WI	205,252
16	Rumbler (Preformed Rumble Strips)	WI	5,962
17	Mobile/Stationary Speed Boards	WI	5,962
18	Vehicle Mounted Rollup Warning Sign	WI	4,447
	MATC		53,515
		Total Cost	**549,312**