SWZDI

Smart Work Zone Deployment Initiative

Pooled Fund Study

2008 REQUEST FOR PROPOSALS (RFP)

This RFP is for research that supports the purpose and goals of this pooled fund cooperative effort defined as:

"The goal of the SWZDI is to develop improved methods and products for addressing safety and mobility in work zones by evaluating new technologies and methods, thereby enhancing safety and efficiency of traffic operations and highway workers. The project is a public/private partnership between the sponsoring public transportation agencies in several Midwestern States, the FHWA, private technology providers and university transportation researchers."

Minimum Requirements:

Please review the list of problem statements beginning on page 4 and submit proposals for any of interest. To be considered for acceptance, all project proposals must meet the following minimum requirements:

- The proposed research must clearly address topic(s) described in the RFP and result in the submission of a final report to the Board of Directors that concisely describes the activities and results of the research.
- The proposing entity must be a college or university located in one of the states contributing to this pooled fund consortium.
- Funding provided by the pooled fund for individual projects does not have an established limit, however normally the maximum amount provided is $50,000. Total project cost, including other source contributions will be considered during evaluation.
- Principal investigators are encouraged to be innovative in financing project work; contributions from sources outside the pooled fund may enhance project selection.

- Project period generally should not exceed one year in duration, no-cost extensions will be considered when warranted.
- Funding provided by the pooled fund can be used to support the work of faculty, support staff, and one or more Graduate Students, but cannot be used to support scholarships or tuition.
- The Principal Investigator must be a faculty or staff supervisor employed by the proposing entity

Evaluation Schedule:

Final date for accepting electronic proposals by the Program Manager (close of business on):	March 31, 2008
Notifications regarding the dispositions of proposals will occur on or about:	May 2, 2008
Eligible award periods can begin on or after:	As soon as possible

The Board of Directors for the Smart Work Zone Deployment Initiative will make all funding decisions resulting from this RFP. Awards will be based on proposed research objectives, the total amount of funding requested, and funding available for distribution. Contributions from other sources will be considered.

Proposal Format

Proposals must be concisely stated, using single-spaced pages (standard letter sized paper, 1 inch margins, minimum of 11 point font), and must clearly include each of the following:

- Working title of the project (not to exceed 120 characters).
- Name, title and contact information for the Principal Investigator that will supervise the research, including university address, telephone and fax number, and e-mail address.
- The name of any graduate students that will contribute to the research.
- A one-paragraph description of the problem or opportunity that will be addressed by the research.
- A list of project objectives that includes a rationale for each objective, and a list of tasks that will be carried out to accomplish each objective.
- A graphic timeline that illustrates when each task and objective will be accomplished.
- An itemized budget that lists all project expenses by category, including (but not limited to) salaries and wages, fringe benefits, travel, supplies, university indirect charges, and other items as appropriate. Total project cost and amount requested from the pooled fund should be shown as well as any other source contribution.

Submission of Proposals:

All applicants must submit proposals electronically, in Microsoft Word format to the email address indicated below, with the caption “Smart Work Zone Deployment Initiative 2008 RFP” included in the subject line. **Electronic proposals must be received on or before March 31, 2008.** Additionally a single printed copy of the proposal must be received by the Program Manager at the address indicated below on or before April 14, 2008. The printed copy must include the original signatures of both the principal investigator and authorized contracting representative of the proposing university and signed letters of commitment from any sources that will provide contribution funding for the project.

Proposals are limited to eight pages including the researcher's relevant qualifications for conducting the work and the resources available through the researcher's institution. Resumes and other relevant materials maybe provided for additional information in appendices but the proposal shall be a stand alone document. The proposer should not expect the reviewers to read appendices to be able to evaluate the merit of a proposal.

email proposals to: tmcdonal@iastate.edu

Submit printed copies to:

Thomas J. McDonald, PE
Program Manager, SWZDI
Center for Transportation Research and Education
Iowa State University
2711 S. Loop Drive, #4700
Ames, IA 50010-8664
(515) 294-6384

We encourage applicants to contact Tom McDonald, Program Manager, with any questions regarding the Smart Work Zone Deployment Initiative or the process for submitting proposals.

Smart Work Zone Deployment Initiative

2008 Problem Statements

1. EVALUATION OF VARIABLE SPEED LIMIT SYSTEMS FOR WORK ZONES

Variable speed limit systems (VSLS) have been used by several states as a means to mitigate both recurring and non-recurring traffic congestion. However, there haven't been as many field implementations of these systems for work zone applications. Traffic safety at work zones can be improved by using VSLS to achieve consistent speeds upstream and within the work zones. The reduced speed variance would mean a reduction in the crash severity.

Prevailing speeds at the bottleneck location would be measured using detectors and displayed to the upstream drivers approaching the work zone. A field evaluation of such a system has been conducted at one of the I-494 work zones in the Twin Cites, Minnesota, for a three week period in 2006. Traffic data including speeds and volumes were archived and used to evaluate the performance of the system after the field implementation. Results showed a decrease in speed variance, increase in throughput, and an increase in speed limit compliance during the morning peak period.

The proposed study should include a thorough literature review of what different states across the country are doing in terms of using VSLS for work zone applications and conduct field experiments to identify all the potential benefits of VSLS deployment. This would be a good ensuing project to the speed limit projects currently being conducted by states within the pool fund.

2. SAFETY OF WORK ZONE DEVICES

Over the last 50 years, safety performance evaluations have been performed on most roadside features. In 1993, the most recent guidelines were published in the National Cooperative Highway Research Program (NCHRP) Report No. 350, *Recommended Procedures for the Safety Performance Evaluation of Highway Features*. The NCHRP Report No. 350 impact safety standards were the first guidelines to provide specific criteria for testing and evaluating the safety performance of work-zone devices. Using this document, evaluations of work-zone devices were conducted using small cars. NCHRP Report No. 350 states that pickup trucks may also be used if the primary concern regarding the impact behavior of the work-zone device is penetration of the test article into the occupant compartment.

From 1998 through 2007, a significant number of safety performance evaluations were performed on work-zone devices. The evaluations were conducted using only small cars, and not pickup trucks, even though the primary concern with most light-weight devices was penetration into the occupant compartment. All work-zone devices found along our nation’s highways and roadways and within our nation’s work-zones have been designed to only meet small car impact safety standards. In 2003, a series of bogie tests performed by UNL researchers revealed a propensity for prior FHWA-approved, temporary sign stands to impact the windshield region of a simulated pickup truck during high-speed collisions.

Recently, UNL researchers revised the evaluation guidelines to include crash testing of work-zone devices using both small cars and pickup trucks. These criteria are expected to be published in AASHTO’s “Manual for Assessing Safety Hardware (MASH) - 2008.” Therefore, a research study is required in order to determine whether typical work-zone devices will provide acceptable safety performance when impacted by a broader range in vehicle class.

3. REMOTE SENSING FOR CLOSED ROAD SECURITY

A recent study of traffic control and enforcement in closed road sections found that theft, vandalism, or tampering with signs in the work zone represents a significant element of risk for personal injury and damage to property or completed work. (See *Temporary Traffic Control and Enforcement of Traffic Laws in Closed Road Sections*: http://www.ctre.iastate.edu/smartwz/reports/2007-mcdonald-temp-traffic-control.pdf). Local supervision of the integrity of signage within work zones by traffic control contractors is haphazard. The ability of local law enforcement and transportation agencies to monitor work zone signage is limited by time and resource constraints. Contractor responsibilities (e.g., minimum response time, frequency of inspection) for replacing and maintaining signage are sometimes unspecified and difficult to enforce.

Remote sensing and surveillance technologies may help provide some level of risk mitigation for work zones. A combination of motion detectors, radio signal devices, GIS tracking, and/or video surveillance may provide an economically feasible means of notifying contractors when signage has been moved or stolen. These same technologies may help law enforcement agencies quickly recover stolen signs and identify offenders. The objectives of the study are to:

- review possible technologies for notification of sign theft, tampering, or vandalism
- identify how requirements for such technologies could be incorporated into contract specifications
- recommend guidelines for allocation of responsibilities for monitoring and response times.

4. BENEFIT-COST AND LIFE CYCLE ANALYSES FOR WORK ZONE DESIGN STRATEGIES

As the nation’s transportation infrastructure continues to age, maintenance and construction activities will continue to rise. As a result, highway construction work zones will face increasing congestion, user delays, and lower contractors’ productivity due to tighter spaces on work zones. Departments of transportation (DOTs) will be forced to consider alternative methods of highway designs in order to safely move traffic and improve work zone construction productivity. There are many innovative techniques available, including:

- Reserving addition right-of-way for future expansion or traffic diversions during work;
- Building wider bridges to accommodate future increases in capacity or providing space for land shifts during maintenance;
- Partial building of bridge structures to allow faster future increases in capacities (build foundations and abutment first and decks later);
- Using more costly but longer lasting materials; and
- Building “full depth” shoulders to accommodate lane shifts during future work.

The problem DOT engineers face is how to accurately compare the cost effectiveness, advantages, disadvantages, and appropriateness of various alternatives, so that they can implement the best alternative. Some of the options may not be effective but simply increase project costs, while others could achieve safer and user-friendly work zones.

There are available solutions, such as Benefit-Cost Analyses and/or Life Cycle Analyses, where the effectiveness of these design options could effectively be compared. These analysis methods could have the potential to allow the DOTs in the SWDZI states to make better decisions and to decide which design options they would want to adopt. With limited funding, DOTs will always want the best and yet cost effective solutions. The research team will investigate available tools and techniques and how to integrate them so that DOTs could make good decisions on which options to select. Additionally, several of the innovative techniques used by the SWZDI states will be analyzed to show the effectiveness of the techniques as well as prove the usefulness of the research approach.

5. SYNTHESIS AND EVALUATION OF PRACTICE FOR HEAD-TO-HEAD TRAFFIC CONTROL

Temporary traffic control strategies for major construction and rehabilitation work on multi-lane divided roadways often result in full closure of the work lanes with diversion of all traffic to the remaining open lanes in opposing, two way direction travel, commonly referred to as two lane, two way operations, (TLTWO). The Manual on Uniform Traffic Control Devices (MUTCD) describes temporary traffic control guidelines for this type of work in Section 6G.15 and Figures 6H.39, 6H.40, and 6H.41, but does not require the use of specific devices for separation of opposing traffic. Consequently, several options have been adopted by states to provide adequate safety for travel through these work zone areas. For example, some states may require portable concrete barriers while others use a combination of tubular channelizing devices and raised pavement markers to separate opposing lanes of traffic.

This study would conduct a review of common practice among states for use of temporary traffic control devices in lane separation of opposing direction traffic. Of special interest would be crossovers and transitions. Common use devices include vertical panels, tall cones, tubular markers, temporary curbing, and temporary traffic barriers. The synthesis would evaluate the safety effectiveness and operational aspects of these various devices and would include consideration of these factors as a minimum:

- work zone crash data
- public traveler opinion surveys and performance observations (avoidance distance, impacts and displacements, etc.)
- cost and ease of installation and maintenance
- relative worker and road user safety
- capacity impacts
- etc.

Sources of data might include but not be limited to project contracts, work zone traffic control plans, inspector diaries, surveys, and crash records.

Results of this study would provide a valuable resource for agencies in selecting the most effective and safe temporary traffic control devices for this potentially hazardous work zone application.

6. DEVELOPMENT OF INTERNAL TRAFFIC CONTROL PLANS (ITCP)

Over the past several years the FHWA, state DOTs, and industry have made large strides in protecting the work zone workers from the passing traffic. The recent Federal “Worker Visibility” rulemaking should help workers to be seen more readily. However comparatively little guidance has been produced or emphasized to protect workers from construction vehicles and/or equipment. Reports titled “Internal Traffic Control Plan and Worker Safety Planning Tool”, Graham, Jerry L. and Burch, Robert, TRR No. 1948 and “Building Safer Highway Work Zones: Measures to Prevent Worker Injuries From Vehicles and Equipment”, Pratt, Stephanie G., Fosbroke, David E., and Marsh, Suzanne M., Department of Health and Human Services provided information of criteria for producing internal traffic control plans (ITCP).

Within the Building Safer Highway Work Zones report, it is stated, “In 318 of the 465 vehicle and equipment-related fatalities within work zones, a worker on foot was struck by a vehicle. Victims of these events were as likely to be struck by a construction vehicle (154 fatalities) as by a passing traffic vehicle (152 fatalities). Incidents involving backing vehicles were prominent among the 154 worker-on-foot fatalities that occurred within the confines of the work zones (51%)”. This data was for the time period between 1992 and 1998.

The Internal Traffic Control Plan and Worker Safety Planning Tool report featured a typical paving crew ITCP with a legend and states that other common types of construction ITCPs should be developed. A reference guide of internal traffic control plans for common work zone operations would be very valuable for agencies in planning for worker safety. This guidance document should include expectations for DOT’s and industry workers and typical ITCP’s for many common work zone operations. State DOTs could then use these recommendations as a major reference for development of state specific guidelines.

For a successful conclusion, the investigating team will need to consult with DOT’s and industry for advice and insight in developing the generic internal traffic control plans.

7. DRIVER BEHAVIOR EFFECTS ON LANE CAPACITY

Lane capacity at work zone lane closures is really a variable related to speed and density, and not a fixed value. Most work zone managers like to think of work zone lane closure capacity as the maximum flow past the work zone taper, and what they would really like to measure is work zone maximum flow just prior to work zone queue discharge capacity. Queue discharge capacity is the maximum flow immediately after a queue forms, and is almost always less than the maximum flow before queuing.

Although flow is generally measured in aggregate numbers, passenger car equivalents per hour, there is really a tremendous average of individual behavior that goes into these aggregate numbers. For example, we know that on the average, the maximum flow at a Los Angles area lane closer will be greater than the average maximum capacity of lane closure in Council Bluffs, Iowa. On the average, individuals in Los Angles commonly drive faster at lower headways and at higher speeds than will the average individual in Council Bluffs, and the California DOT uses a higher maximum capacity for lane closures than does the Iowa DOT.

So long as every individual follows aggregate behavior, aggregate numbers are satisfactory. However, driver behavior varies, and behavior is a function of the individual driver. For example, all it takes is one aggressive driver to force her/his place in the head of the line, at the taper, to turn flow from free flow to a lower flow queue discharge rate. The maximum flow of a work zone with a lane closer is governed by the flow at the taper point, and if drivers line-up in single file ahead of the taper, the maximum flow can approach the maximum capacity of an open freeway lane as traffic flows smoothly through the taper. On the other hand, if merging and turbulence takes place near the taper, the flow entering the work zone taper is unstable and maximum flow at the taper is reduced.

As flow through the work zone is reduced, the relatively traffic safety of the work zone is reduced. Work zone queues are commonly hampered by rear-end collisions and sideswipe crashes, but because data are not kept relative to their distance upstream from a work zone, the number of crashes resulting from queues, traffic flow shock waves and sudden lane changes are unknown. Improved work zone flow will improve safety, and work zone flow rates are dependent on the behavior of individual drivers. Hence, by reinforcing and enforcing positive lane closure, merging behavior can both improve safety and improve the capacity of work zones.

The purpose of this project is to determine which driver behaviors result in the greatest reduction of capacity. It is believed that such aggressive behaviors as forcing late mergers, tailgating, queue jumping in the closed lane or on the shoulder, and other aggressive behaviors have the greatest impact on maximum flow rates, but also behaviors that create excessive headways or slow speeds can reduce taper maximum flow. The objective of this project will be to measure which behaviors are the most detrimental and develop strategies to modify the aberrant driver behavior.

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8. USING DRIVING SIMULATORS TO ASSESS DRIVERS' RESPONSE TO WORK ZONE INTERVENTIONS

The threats posed to both workers and drivers by road construction and maintenance zones are well documented. Innovations in work zone safety could reduce these numbers. However, implementing work zone safety interventions before they are validated can undermine rather than enhance safety. Understanding driver behavior in work zones is critical as many work zone accidents are caused by speeding, aggressive, and possibly distracted drivers. Work zone interventions that work well for the majority of the driving population may not be effective for these drivers. Driving simulators offer a safe, virtual environment that can be used to validate work zone interventions and investigate their effect on driver behavior before they are implemented on actual roadways.

The proposed study would examine driver behavior in response to a set of work zone interventions in a simulated driving environment. The driving simulator used should be capable of implementing a variety of work zone interventions. Examples of potential interventions might include various configurations of cones, barricades, work zone signage, changeable message signs, and radar-based speed signs. The simulator should also be able to manipulate environmental conditions such as the speed and density of other traffic in the work zone. Because driver response to work zone interventions is the central interest of this study, the simulator must be capable of collecting data that accurately captures driver behavior such as vehicle trajectory, lane position, headway distance, and brake and throttle positions. Since the differences between drivers (e.g., propensity to speed) might interact with the effectiveness of work zone improvements, the study must measure these differences and how they affect driver behavior.

9. EVALUATION OF THE EFFECTIVENESS OF 780 WR (WET REFLECTIVE REMOVABLE TAPE) FOR TEMPORARY PAVEMENT MARKINGS:

Work zones today are illuminated by a variety of devices and materials. Highly reflective sheeting on signs and other channelizing devices use the latest in optical technology to guide motorists in all weather conditions. Pavement markings, on the other hand, have not been able to benefit from these technologies. Attempts at making pavement markings reflective in the rain have generally focused on raising beads above the road surface or simply making them larger. The common denominator among these markings is the need for water to drain away from the beads. Although all pavement markings are reflective when new, most lose reflectivity under water. These pavement markings simply disappear on the road when drivers need them most.

3M Stamark Wet Reflective Removable Tape Series 780 is designed to provide the positive guidance drivers need to safely navigate today's work zone environment—day or night, in dry conditions or in the rain. Unlike standard removable or temporary pavement markings, Series 780 tape works in both dry and wet conditions for all-weather performance.

Interested researchers should contact Kyle Kovar, 3M Company Representative in Omaha, NE for more information prior to submitting a proposal.

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10. RAMP METERING FOR WORK ZONE MOBILITY AND SAFETY

Ramp metering has been employed successfully for many years to regulate traffic flow on high volume urban freeways, particularly during peak flow periods. However the potential benefits of this technology has not been highly utilized for regulation of traffic flow where lane restrictions are necessary for construction or maintenance work on these busy roadways.

Traffic Technologies, LLC has developed a ramp metering system designated JamLogic to regulate traffic flow from entrance ramps using portable traffic signals. Communication across the roadway ramp entrance to the work zone is maintained via radio. Real-time traffic sensors continuously monitor traffic volume and speed on the mainline roadway and communicate this data via radio frequency to the networked traffic signals. The signals can be programmed to respond to several types of traffic conditions, allowing traffic to be regulated when entering the work zone in the mainline roadway. Real-time, reliable communication and a responsive system potentially could be quite beneficial for mobility and safety in work areas.

A research project to evaluate to effectiveness of this system would be beneficial in improving both mobility and safety for traffic through lane restricted work areas on busy urban freeways.

Interested researchers should contact Traffic Technologies, LLC of Minneapolis, MN for more information prior to submitting a proposal.
Traffic Technologies
4754 Lyndale Avenue North
Minneapolis, MN 55430

11. SYNTHESIS OF PROJECT SCHEDULING AND COORDINATION PRACTICES AND TOOLS

Each day, every state has hundreds to thousands of work zones on its roadways. Many of these work zones are for DOT-managed maintenance and construction work. However a large number of short-term work zones are for utility work. Efforts to coordinate these work zone activities are often very limited due to lack of information and tools to use that information. State DOTs could benefit from learning about the practices and tools in use by other states for coordinating projects within the DOT and with other DOTs (across states and with local agencies), as well as with planners, utility companies, multi-modal transportation operators, emergency management professionals, and any other entities working in the right-of-way.

To date, tools/applications are more readily available and used to track and share information about road closures and lane closures as they occur (e.g., through State road closure websites). It would be helpful to identify tools and practices that could be used during planning to coordinate road work—particularly road closures and lane closures—across various projects and owners/entities. Coordinating scheduling, locations, and type of work across projects and considering the combined user impacts, costs, and economies of scale has the potential to reduce congestion impacts to traffic and freight and increase economic use of resources. Without such coordination, many work zones are implemented simultaneously without regard to the cumulative effects of mobility restrictions. Resources could be better utilized through coordinated efforts across agencies. For example, by identifying projects from all agencies planned/scheduled for a particular road, projects can be coordinated. If a utility upgrade project is planned to begin soon after the completion of a paving project at the same location, it could be rescheduled to occur immediately before the paving project to prevent the excavation and repaving of a newly paved road.

12. DEVELOPMENT OF A WORK ZONE TRAINING PROGRAM

The Federal Highway Administration published updates to the work zone regulations at 23 CFR 630 Subpart J in 2004, which is referred to as the Work Zone Safety and Mobility Rule (Rule). The Rule applies to all state and local governments that receive Federal-aid highway funding. State departments of transportation (DOTs) and local transportation agencies were required to comply with the provisions of the Rule by October 12, 2007. As a requirement, state DOTs and local agencies need to develop a work zone training program for appropriate project personnel relating to work zones. The project personnel include DOTs personnel, design consultants, and construction personnel. Personnel need to be trained in temporary traffic control design, set-up, maintenance, and evaluation of work zones commensurate with their level of responsibility. Because the work zone training covers diversified topics and trainees are located in different organizations, using the traditional training approach (gathering people in a central location and training them) would be time consuming and not cost effective. The challenge is how to develop an efficient and effective training program for work zones.

The objective of this research is to develop an interactive e-training program for work zones. The e-training program will be built based on the advanced computer science technologies and delivered via Internet. The use of e-training program provides several significant advantages. First, trainees will be able to select their convenient time to receive required training via Internet at their offices or at home. Thus, it saves travel time and cost. Second, the developed e-training program will have user interactive functions so that the program will constantly evaluate the training effectiveness and determine if additional training is needed or not. Third, the e-training program can be easily updated when the new knowledge is available. Thus, it can provide up-to-date training. Finally, it will help DOTs to manage training efforts using advanced technologies such as electronic signature (e.g., automatically identify who have received training and who haven’t).

13. SYNTHESIS AND EVALUATION OF VEHICLE MOUNTED ATTENUATOR MARKINGS FOR COLOR-VISION DEFICIENT DRIVERS

Color vision deficiencies affect approximately one in 40,000 live births. In the US, more than 8% males and between 0.4 and 2% females are color-vision deficient. Traffic safety data also suggests that the probability of color-vision deficient drivers to encounter an accident is about twice as high as among non-color-deficient drivers. Color vision deficiencies are a group of conditions that affects the perception of color and these conditions are divided into three major categories: red-green and blue-yellow color vision defects, and a complete absence of color vision.

Many common activities rely on signs and signals that are color coded. There are also ways to help compensate for people's inability to see or distinguish colors by the way signs and signals are arranged or by observing other people's action. The example of vertical and horizontal arrangement of traffic signals is available and in most cases do not pose a hazard. However, color-vision deficient drivers have difficulty distinguishing colors of a traffic signal under certain conditions. In bright sunlight, red light looks dim and fails to stand out against the background of sky, trees and buildings. At night, a green light looks white, and becomes nearly indistinguishable from the street light.

This research proposes synthesis of literature on color-vision deficient drivers and driver color-vision deficiencies in construction zones where vehicle mounted attenuators (VMA) are used. The design and the color pattern, and the color of the arrow sign is of concern. This study proposes studying the effects of different weather conditions especially poor visibility conditions, day and night time driving, driving speed, height of VMA sign on recognition time and distance for color-vision deficient drivers. The study would propose improved color and design pattern for color-vision deficient drivers. The study also proposes studying drivers with low and moderate vision loss such as older drivers.