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## Improved Traffic Control at Complex Work Zones

Establishing and maintaining safe and effective traffic control through large, complex work zones on high-speed roadways in Texas is extremely challenging.

Complex work zones commonly include multiple work activity areas and require a large number of temporary signs, barriers, channelizing devices, and markings to guide motorists safely and efficiently through the zone.

Little guidance exists as to how best to coordinate and integrate all of the devices required for each of these activity areas into an effective overall work zone traffic control plan. Researchers at the Texas Transportation Institute (TTI) and at the Center for Transportation



*Motorists must process guidance information from numerous sources when traveling through complex work zones*

problems that exist at these locations. Researchers then employed test subject drivers to drive through a sample of complex work zones. This process was used to identify specific work zone features and driving situations that create motorist confusion and anxiety about the proper travel path through the work zone. In many cases,

Research (CTR) have developed recommendations to help establish and maintain complex work zones to reduce motorist confusion and make it easier to maneuver through the activity areas.

### *What We Did . . .*

Researchers studied complex work zones in Austin, Dallas, Hillsboro, Houston, and San Antonio to identify the common types of driver behavioral

subject comments and behaviors allowed researchers to identify the likely underlying causes of the confusion and anxiety within these zones.

With an improved understanding of the features and conditions that contribute to driving difficulties in these complex work zones, researchers next focused on determining why these features and conditions occur and on what can be done to eliminate

them. Researchers conducted a series of interviews with the Texas Department of Transportation (TxDOT) field personnel who are or have recently been responsible for the implementation and maintenance of traffic control within complex work zones. Researchers also examined available training materials to help field personnel assess the effectiveness of a newly installed traffic control plan at a complex work zone to determine if it provides adequate path-finding information to motorists. Both the interviews and the training reviews pointed to specific areas that need improvement regarding the implementation and ongoing inspection of traffic control within complex work zones.

One of the key problem areas identified in the research was the large amount of traffic control devices and other information that motorists are required to process while traversing

complex work zones. Researchers hypothesized that certain driver physiological measures (e.g., heart rate) may correlate to areas of extremely high or low driver workload and could possibly be used to assess work zone complexity in an objective manner. Therefore, researchers conducted additional subject driver testing to compare driver physiological measures to vehicle and situational characteristics within a small sample of complex work zones as a possible means of assessing driver anxiety and workload through these zones (see Figure 1).

### What We Found . . .

Motorist path-finding capabilities through complex work zones depend heavily upon satisfying principles of positive guidance. One of the key facets of positive guidance is the acknowledgment that humans have a limited capacity for detecting, processing, and remembering

information as part of their driving activities. Positive guidance concepts have been fairly well integrated into the planning and design phases of work zone traffic control plan development. However, researchers found that this integration has not been formally extended into the implementation and monitoring aspects of work zone traffic control in the field. Researchers concluded that this lack of integration was due in large part to lack of a formalized process for applying these positive guidance principles during systematic field reviews of the overall traffic control system at complex work zones.

Researchers developed a simple but systematic review process to guide field personnel in checking work zone traffic control setups for common positive guidance deficiencies. The process assesses four common areas of positive guidance deficiencies:

- Hazard visibility - anything in the work zone environment that could ultimately be involved in, or contribute to, a crash;
- Driver expectancy - features and conditions that can surprise, mislead, or confuse the motorist;
- Information loading - locations where too much or too little information is being presented to motorists as they travel the roadway segment; and
- Information needs - where the presence and location of advance warning information is inappropriate for the specific hazards and expectancy violations for which it is intended.



Figure 1. Examining Driver Physiology as a Means of Assessing Work Zone Complexity.



Information loading assessment is particularly problematic for field personnel, as it should consider both the type and location of temporary traffic control devices in the work zone as well as the relationship of these devices to the existing permanent information system. Figure 2 illustrates how both temporary and permanent signing at a work zone location can influence a driver's information loading process.

The messages displayed on portable changeable message signs (PCMSs) in complex work zones were found to be another key area where the limits of information loading within the work zone were often exceeded. Researchers found several instances of messages that were too long, that were not formatted properly, or that presented words or phrases that were confusing to the motorist. In addition to the messages themselves, researchers found that improper PCMS placement too close to or too far away from the feature or condition it was intended to warn about created motorist confusion and anxiety.

### The Researchers Recommend...

Based on the results of the project, the following recommendations have been made to TxDOT.

- Messages displayed on portable and permanent changeable message signs are common sources of motorist confusion and anxiety in complex work zones. The researchers recommend that basic guidelines governing message design and sign operation

developed in this project from prior research be incorporated into the TxDOT Traffic Control Plan Standard Sheets.

- TxDOT should issue instructions to the districts and area offices to perform explicit field reviews of the overall driving environment using positive guidance principles in all complex work zones. These reviews should occur at the initiation of major construction

projects and each time major changes in traffic control sequencing occur. The process developed in this research should be used to guide the review.

- TxDOT should also incorporate the recommended review process developed from this research into the Texas Engineering Extension Service (TEEX) work zone traffic control training courses.

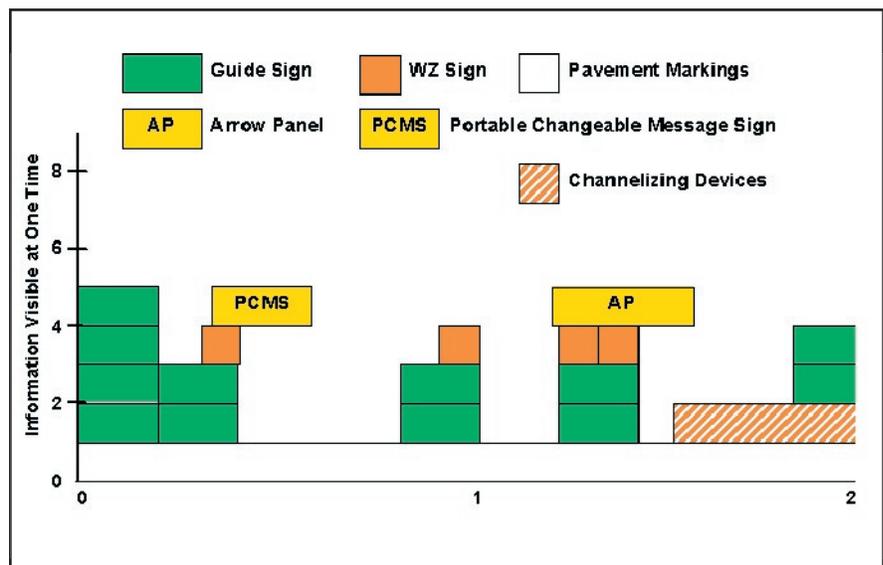
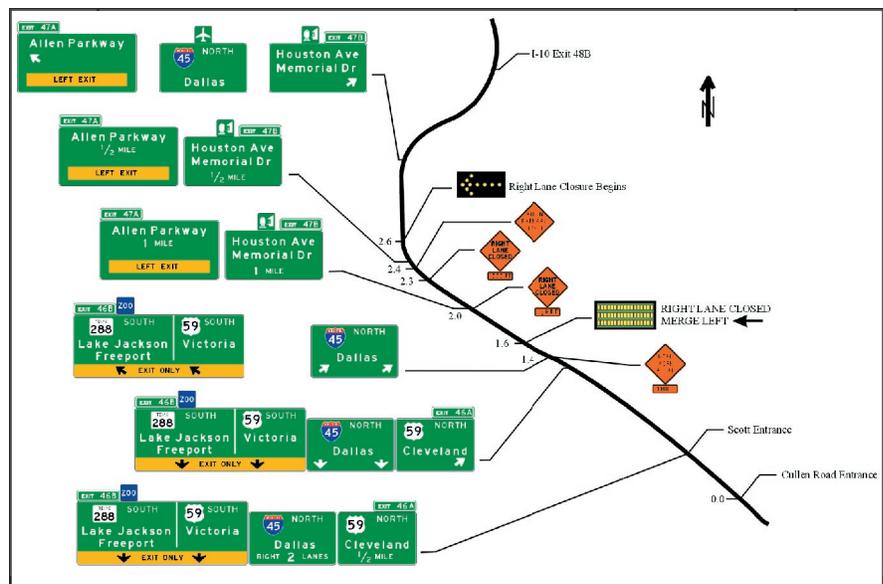


Figure 2. Example of Information Load at a Complex Work Zone.



## *For More Details . . .*

The research results, recommendations, and operating guidelines are documented in:

Report 4021-2, *Improving Traffic Control Effectiveness in Complex Work Zones*

Report 4021-3, *Complex Work Zone Safety* (prepared by the Center for Transportation Research)

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## *TxDOT Implementation Status*

### *July 2003*

This research project involved the investigation of improved traffic control at complex work zones. Three products were required for this project:

1. recommended changes to TxDOT Work Zone Traffic Control Plan Standard Sheets,
2. recommended changes to wording in the Texas MUTCD, and
3. guidelines to assist traffic control plan designers and evaluators in developing a functional work zone traffic control system, including proposed changes to special provisions or general notes.

The products have been incorporated into the TxDOT Work Zone Traffic Control Plan Standard Sheets and work zone field review forms. It was determined that there is no need at this time to change the wording to the Texas MUTCD. The products that were developed in this research project can be implemented for use in complex work zones where conditions warrant.

For more information, contact Mr. Wade Odell, P.E., RTI Research Engineer, at (512) 302-2363 or email [wodell@dot.state.tx.us](mailto:wodell@dot.state.tx.us).

***YOUR INVOLVEMENT IS WELCOME!***

## *Disclaimer*

This research was sponsored by the Texas Department of Transportation (TxDOT) in cooperation with the Federal Highway Administration (FHWA). The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of TxDOT or FHWA. This report is not intended to constitute a standard, specification, or regulation, nor is it intended for construction, bidding, or permit purposes. The engineer in charge of the research was Dr. Gerald L. Ullman, P.E. #66876.