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Canada

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## Guidelines for Safety Critical Warnings

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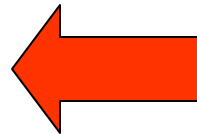
## Need for Warning HMI Standards

- Lack of specific standards for driver assistance system HMI
- New technology provides good opportunity to standardize
- Standard HMI will improve system performance with:
  - Better understanding and attention from drivers
  - Reduced confusion
  - More accurate and consistent expectations



## Integrated Safety Chain

1. Normal driving
2. Deviation from normal driving
3. Emerging situation
4. Critical situation
5. Crash unavoidable



(Tingvall, 2007)



## Safety Critical Warnings

A signal informing the driver of a hazardous situation, which if not corrected by an immediate action (0 to 3 seconds), will result in equipment damage and/or personal injury.

# A WARNING SYSTEM CAN BE NO BETTER THAN ITS INTERFACE



**HAZARD**

**WARNING  
SYSTEM**

**WARNING!**

**TIMELY &  
APPROPRIATE  
RESPONSE**

**WARNING  
FAILURE**

- No response
- Inappropriate responses
- Slow response

## WARNING FUNCTION

- Senses road traffic environment
- Filters & processes information for hazard
- Calculates severity & urgency
- Issues warning

## WARNING PERFORMANCE

- Sensor coverage
- Sensor reliability
- Sensor accuracy
- Warning decision logic
- Warning itself

## FAILURE DUE TO:

**Not noticed**  
**Confusion**  
**Misunderstood**  
**Ignored it...**



## Factors mediating warning effectiveness

- Conspicuity
- Comprehension
- Driver frustration and annoyance
- Expectancy
- Frequency of warnings
- Individual differences and condition
- Response options/ uncertainty
- Trust
- Willingness and/or ability to comply



## Warning design considerations

- Activation criteria – When? ..... Frequency
- Levels and priorities of warnings
- Presentation modality, information and location
- Response options



## Crash avoidance response options

1. Immediate hard braking.
2. Immediate steering manoeuvre.
3. Immediate termination of initiated or initiating action.
4. Seek awareness of situation and perform one of the above responses.
5. Immediate decision to retake control by the driver.





## Current Status and Scope

- Some good generic warning guidelines are available, but these need to be consolidated, promoted & applied.
- IHRA-ITS working group is developing warning guidelines to support the UN-ECE WP.29 ITS informal group.
- These guidelines are based on a consolidation of published guidelines, research and expert opinion.
- Scope - safety critical warnings.
- These guidelines are intended for people who design and evaluate high-level warning systems for vehicles.

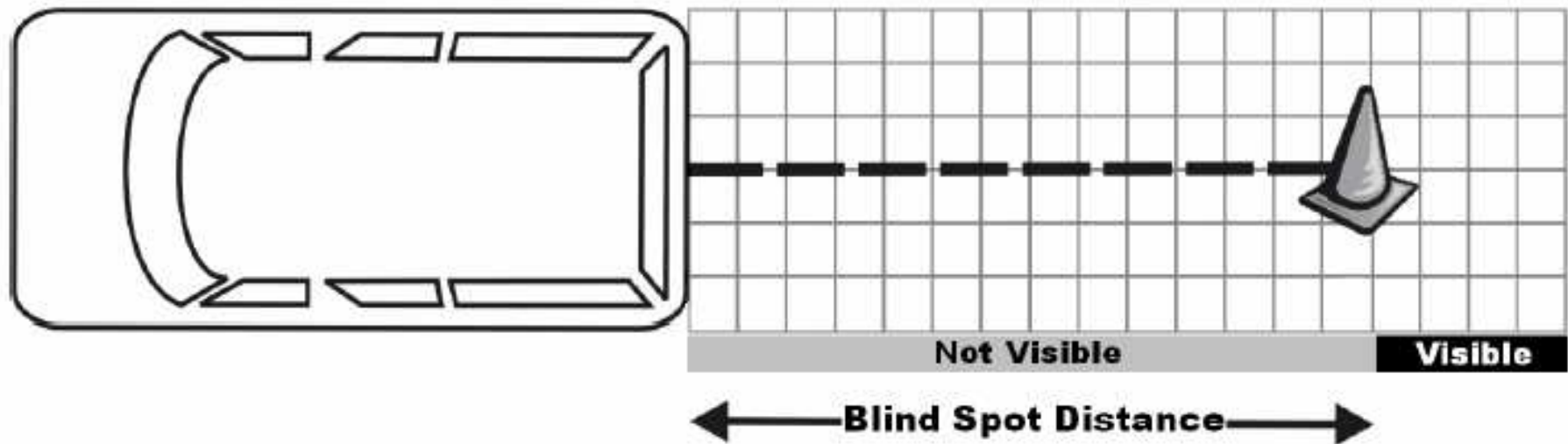


## Starting Principle

There are more effective and reliable ways to protect people and property than warnings:

1. Eliminate the hazard through improved design, or
2. Offer some form of protection to limit damage.
3. If that does not work then - Warn

## Warning System Last: Example



1. Eliminate the blind spots
2. Actively prevent back-up collisions
3. Warn



## Guidelines

1. Warnings should be distinguishable in the driving environment (Sweden).
2. Warnings should be distinct from other warnings. (Japan).
3. Warnings should be displayed in a least two modalities (UK).
4. Warnings should provide spatial cues to the hazard location (Canada).
5. Warnings should inform the driver of the hazard (UK).
6. Warnings should elicit timely responses or decisions (Canada).
7. Multiple warnings should be prioritized (Canada).
8. False / nuisance warnings rate should be low (France).
9. Non-operational system status and degraded performance of warnings should be displayed (Australia).



## Guideline 1

**Warning shall be distinguishable in the driving environment.**

The warning shall be possible to detect in the presence of irrelevant signals and ambient noise.

Testing should be undertaken to determine if a warning can be correctly perceived.

## Examples





## Guideline 2

### **Warnings should be distinct from other warnings**

Warnings should be noticeable without confusion with other messages or warnings.

Testing should be undertaken to determine if a warning can be correctly distinguished from other warnings in the context of use.



## Example 2







## Guideline 3

**Warnings should be displayed in at least two sensory modalities.**

Warnings presented in only one single modality may be missed if that modality is already occupied. Presentation in more than one modality increases the probability of perception.

## Example 3





## Guideline 4

**Warnings should provide spatial cues to the hazard location.**

Hazards can be located to the front, sides, rear and corners of the vehicle. They can be near, far, stationary and approaching.

Where is it?

Orienting a driver to the source of a hazard can hasten responses and lead to more appropriate responses.

If this is not possible, care should be taken not to orient the driver inappropriately – away from the hazard or appropriate response options.

## Example 4



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## Guideline 5

**Warnings should inform the driver of the nature of the hazard**

Communicate the element(s) of the situation that the warning system has identified as an immediate threat to the safety.

What is it?

## Example 5





## Guideline 6

### **Warnings should elicit timely responses or decisions.**

Warnings should increase a driver's opportunity to avoid threats. Timely responses are critical for threat avoidance.

Onset of warnings should account for driver perception-response times.

Early warnings provide more opportunity to avoid a situation, however they can be a nuisance if they become frequent and unnecessary (McGehee et al., 1998).



## Examples 6

**Good Example:** A forward collision warning comes on with just enough time for most drivers to detect the warning, chose an avoidance response and take action.

**Bad Example:** A forward collision warning system warns the driver too late, when it is no longer possible to avoid or mitigate the collision. Or it warns the driver too early, and the signal becomes a nuisance.





## Guideline 7

### **Multiple warnings should be prioritized.**

Multiple warnings should be prioritized so the most urgent and critical messages are effectively communicated to the driver.

Warnings can be managed by prioritization procedures that establish the relative timing and urgency of messages. Prioritized warnings will help to avoid confusing the driver with overlapping signals.

In the case of simultaneous high-level warnings, all messages should be communicated to the driver.

## Examples 7



1. A forward vehicle starts braking as your vehicle crosses the lane marking.

The Forward Collision Warning (FCW) overrides the Lane Departure Warning (LDW) due to higher priority (urgency and criticality).

Use case from INSAFES (2007)

2. Simultaneous LDW and message from the navigation system (e.g., turn left). Guidance message is overridden by a lane departure warning.





## Guideline 8

**False and nuisance warnings rate should be low.**

High false alarm rates reduce driver trust in the system and a lack of trust can reduce response time.

Too many nuisance alarms can be irritating and effect the utility of the system. Adjustable warning thresholds can help to reduce nuisance alarms.

Providing some control over sensitivity settings may help to improve acceptance and performance.



## Examples 8

**Good Example:** A lane departure warning system that only warns when the vehicle is crossing the lane boundary.

**Bad Example:** A forward collision warning system that frequently warns for non-threatening obstacles beyond the vehicle's path of travel.



## Guideline 9

### **Non-operational or degraded performance of warnings should be displayed.**

The driver should be informed whenever the system is malfunctioning or operating outside its operating conditions (non-functioning).

A brief auditory tone can be used to indicate a malfunction followed by a continuous visual message (Campbell et al., 2007).

The driver should be informed whenever the warning system is off.

## Example 9





## Summary and Conclusions

- HMI is crucial for ITS warning system effectiveness
- First consider ways to eliminate or mitigate hazards rather than relying on a warning system
- Consistent application of good HMI standards and warning guidelines will improve system performance
- Further research should focus on warning parameters, particularly for assessment procedures.



# Thank you