

Workshop on Visual Occlusion Turin, Italy

November 12-14, 2001

I. Terminology

A common understanding of metrics and terminology in the investigation and use of the occlusion technique would be helpful. Towards this end, a summary of commonly encountered terms and metrics has been prepared from the available literature (Bibliography) on occlusion related research. This summary may serve as a basis for discussion. It is hoped that this discussion would lead to an agreement among members on the use of one metric to represent each parameter or response.

1. Figure 1, adapted from ISO/DIS 15007-1, is a schematic, on a time base, of eye glances from/to the road and in-vehicle display, and the opening and closing of the shutter on the occlusion spectacles or tachistoscopic device used. In reference to the notes in Figure 1, is the membership in agreement that the notes fairly and accurately reflect commonly understood terminology and metrics in occlusion experimentation, especially Items 4,5 and 6?

2. Figure 2 is a summary of commonly used terminology in occlusion experimentation. Different researchers have used different terms or metrics to capture the same variable (Bibliography). In this figure, definitions in Category A appear to reflect the length of time a display is visible. In reference to the figure, the following questions (Category A) are posed:

- (i) TSOT, TT_{open} and TTT_{open} appear to be identical. Is there a difference between TT_{open} and TTT_{open} ?
- (ii) If yes, then does TTT_{open} belong in Category B where metrics reflect response time of the test participant to complete a task
- (iii) If there is no difference between TT_{open} and TTT_{open} , then which is the preferred term. Does it differ from TSOT?
- (iv) Are TT_{occl} and TT_{closed} identical? If yes, which measure should be used exclusively?

Definitions in Category B appear to reflect the length of time a test participant takes to complete a task in response to a display becoming visible or being occluded. For example, TGT (total glance time) may be larger or smaller than TSOT (total shutter open time); TTT_{occl} may be larger or smaller than the sum of TT_{occl} and TSOT. In reference to the figure, the following questions (Category B) are posed:

- (i) TTT (total task time) and $TTT_{no\ occl}$ appear to be identical. If there is no difference, which one is the preferred metric.
- (ii) If there is a difference, should it be articulated for static and dynamic tasks.

II. Metrics for dependent variables

Several metrics have been mentioned in the research literature. The following is a summary, with questions posed where appropriate:

- (i) Error probability, or error count (or ratio) in completing a task (i.e. simple task, complex task, navigation task, etc.). This is a commonly used metric of task performance, and poses no further questions
- (ii) TGT: If a task is such that $TGT < 2.0$ sec, then the occlusion technique is not appropriate, and hence not needed
- (iii) If a task is such that the time for a single glance > 2.0 sec, then the occlusion technique is not required; suffice to say that the task should not be permitted while driving
- (iv) The Ratio **TSOT:TTT (aka the ratio TSOT:TTT_{no occl})**

This ratio provides a measure to screen out tasks that should not be performed while driving, i.e. if Ratio TSOT:TTT $>$ TBD, then task should not be performed while driving. Till 'TBD' can be definitively established through research, or otherwise, it would be useful to know what is the likely range of values for this ratio.

This ratio may be used as a metric:

- i. for short tasks, e.g. tuning a radio, adjusting volume, adjusting HVAC, etc.
- ii. for long tasks that are interruptible, e.g. a navigation task that is chunkable
- iii. for long tasks that are not interruptible, i.e. tasks shorter than TBD seconds in duration. It has been mentioned that the occlusion technique is not appropriate for use in this type of a task

- (v) The Ratio **TTT_{occl}:(TTT_{no occl} + TT_{closed})**

What does this ratio provide a measure of? It has been recommended that this Ratio should not exceed 1.

The ratio may be used as a metric:

- iv. for short tasks, e.g. tuning a radio, adjusting volume, adjusting HVAC, etc.
- v. for long tasks that are interruptible, e.g. a navigation task that is chunkable
- vi. for long tasks that are not interruptible, i.e. tasks shorter than TBD seconds in duration. It has been mentioned that the occlusion technique is not appropriate for use in this type of a task

III. The Occlusion technique

Validity of the technique:

The validity of the technique is not the subject of our query. It has been documented in several studies that the occlusion technique can be used to tell apart a more visually demanding task from a less visually demanding task. One or more of the following (occlusion) metrics have been used, either individually or in some combination, to reflect this distinction: number of glances, mean glance duration, total glance duration, mean time between glances, task completion time. With minor variation, this is true whether the task is short or long (interruptible), whether static or dynamic, and whether or not performed in the presence of a secondary task.

Usefulness of the technique

We are interested in determining how to use the visual occlusion technique (i) to design in-vehicle tasks, in terms of content, duration, chunking, mode, etc., so that each in-vehicle task may be performed, concurrently with the primary task of driving, without an unacceptable increase in driver visual workload, and (ii) to evaluate the acceptability of each in-vehicle task, in terms of content, duration, chunking, mode, etc., for the additional visual workload imposed by the in-vehicle task, when performed concurrently with the primary task of driving.

We are also interested in determining if the visual occlusion technique is better able to address these issues as compared to the static task completion technique.

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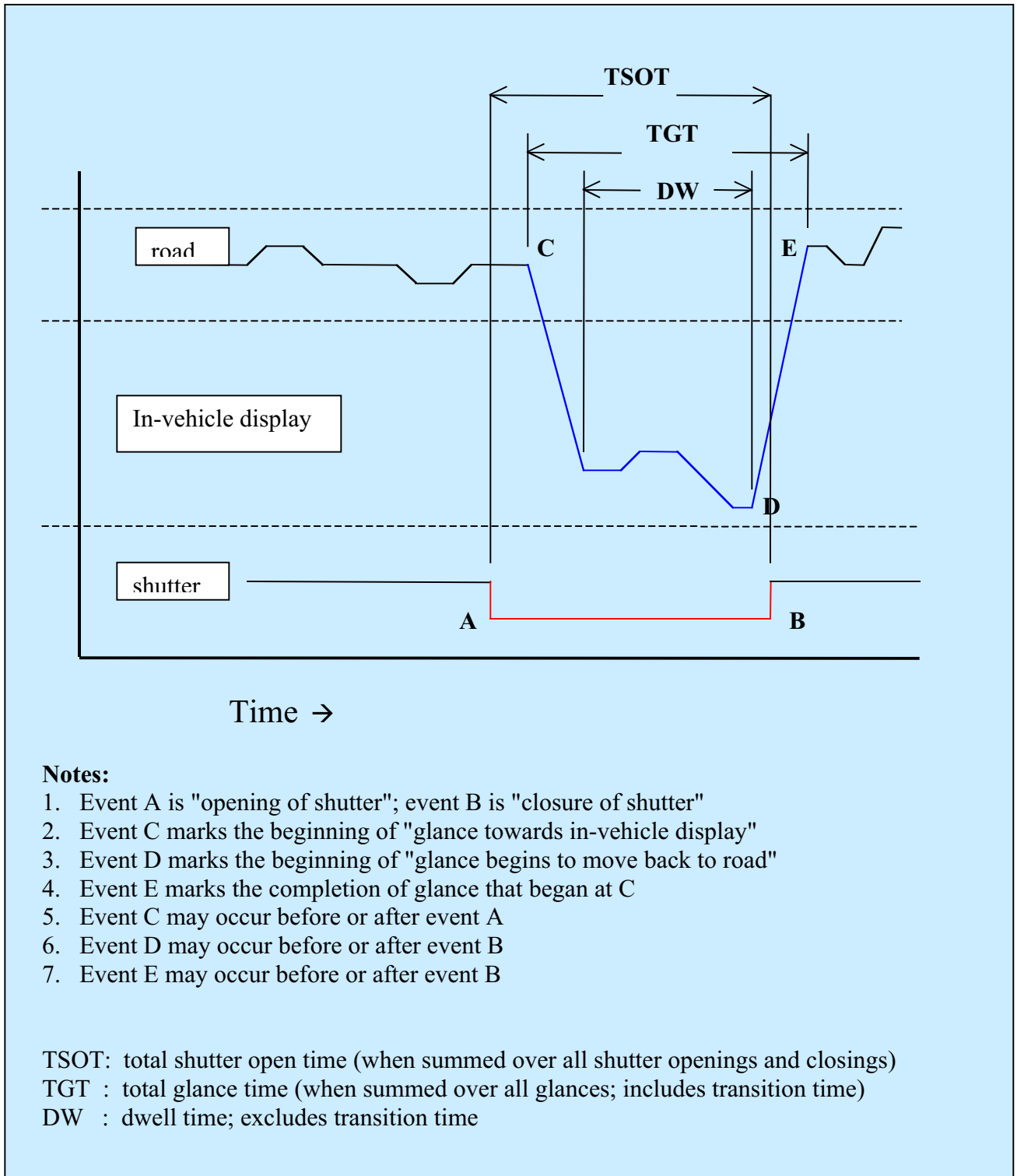
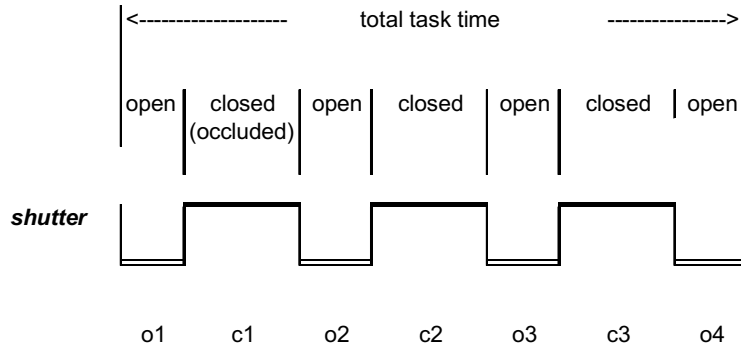


Figure 1: Glance duration in relation to shutter opening and closing
(adapted, with modification, from ISO/DIS 15007-1)



A. Definitions for "mechanical" events

- * **TSOT** Total shutter open time (time for which display is visible) = $o1 + o2 + o3 + o4$
- * **TTopen** Total time for which task (shutter) is open, i.e. display is visible
- * **TTTopen** Total task time (total time for which shutter is open, i.e. display is visible)
In general, $TTTopen < TTTno\ occl$
- ^ **TToccl** Total time occluded, i.e. "goggles closed" = $c1 + c2 + c3$
- ^ **TTclosed** Total time during which goggles are closed, $TTclosed = TToccl$

B. Definitions for events that exhibit variability in response time

- TGT** Total glance time (includes transition time) = $o1 + o2 + o3 + o4 \pm e \sim N(0,1)$
- TTToccl** Total task time with occlusion = $TToccl + TSOT \pm e \sim N(0,1)$
- # **TTT** Total task time without occlusion (goggles not worn during task); task may be static or dynamic
- # **TTTno occl** Total task time without occlusion (goggles not worn during task; task may be static or dynamic)
- TTTstatic** Total task time for a task performed statically; $TTTstatic = TTT\ no\ occl$ (for static tasks only) = TTT (for static tasks only)

Legend:

- * Appear to be identical
- ^ Appear to be identical
- # Appear to be identical

Figure 2: Occlusion Terminology, Definitions and Metrics