A successor for the ”Visibility” program for the visibility distance to longitudinal road markings

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1. Background in the COST Action 331

COST Action 331: 1999 “Requirements for horizontal road marking” carried out in the late 90's led to new knowledge about the visibility of road markings and the need for visibility. Much of this knowledge was implemented in the “Visibility” program for calculation of the visibility distance to longitudinal road markings.

The program had a number of input variables:

- driver's age, the driving speed, glare and the vehicle geometry,
- the headlamps of the vehicle in an interplay with the coefficient of retroreflected luminance R_L of both the road marking and the road surface,
- illumination from road lighting or daylight in an interplay with the luminance coefficient in diffuse illumination Qd of both the road marking and road surface,
- the location of the road marking relative to the vehicle and its geometry (width and pattern of broken lines),
- horizontal and vertical curve of the road.

The output is the visibility distance and a "preview time" pvt, which is the time it takes to drive a distance equal to the visibility distance at the given driving speed. In COST Action 331, it was found that drivers need a pvt of minimum 2 seconds and that comfortable driving requires a longer pvt.

The report of COST Action 331 can be downloaded from http://www.cost.eu/COST_Actions/tud/331

The window of the original Visibility program is shown in figure 1.

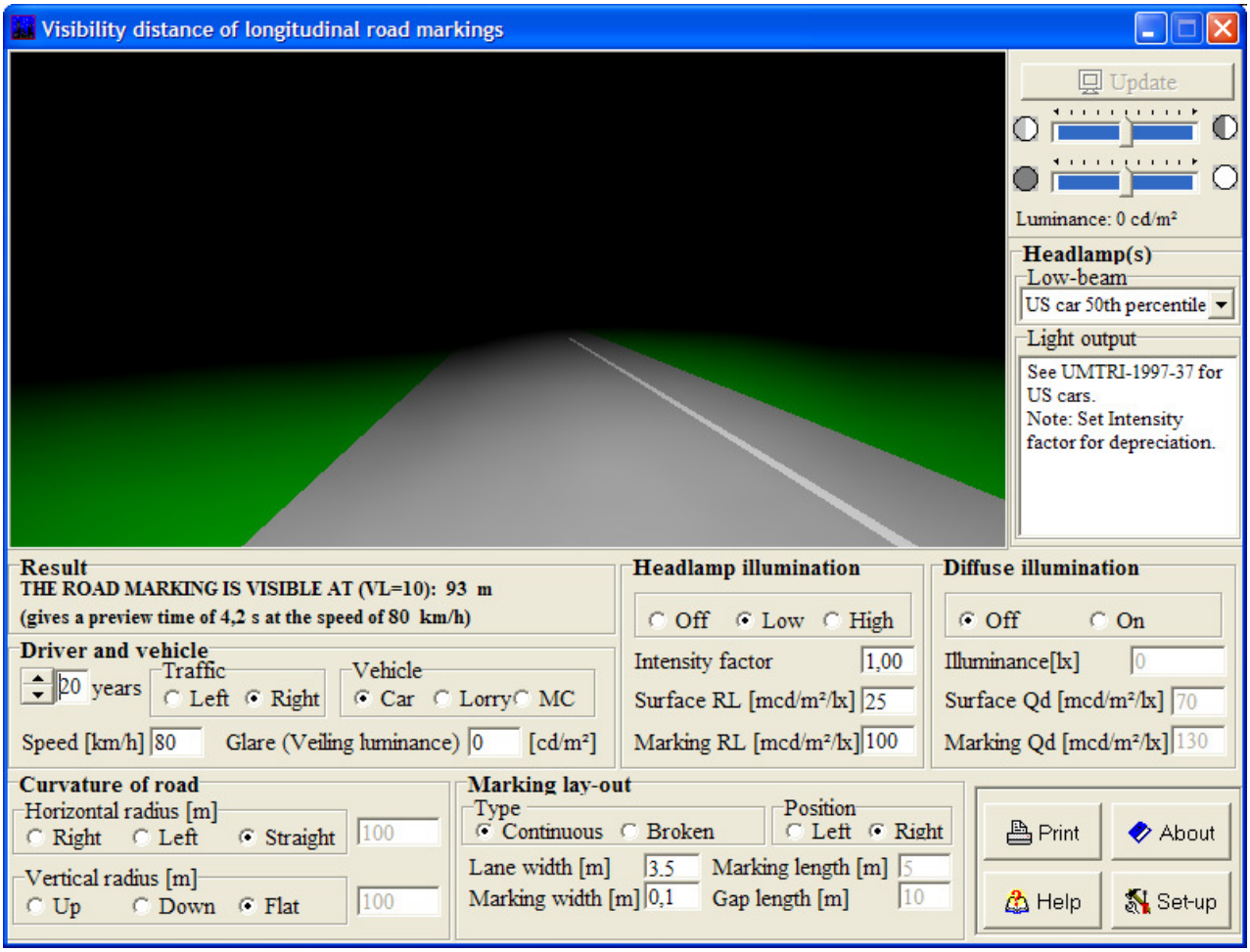

Figure 1: The single window of the original Visibility program.

2. Opdating of the COST Action 331

COST Action 331 is now of older date, there is uncertainty about at least one of its assumptions and there has been technical developments.

Therefore, the Nordic NMF Cooperation on the improvement of road equipment decided to perform a project in three sub-projects:

- 1: to establish a new platform for the Visibility program,
- 2: to measure light distributions of modern headlamps,
- 3: to supplement the driving experiments that were carried out in COST Action 331.

This report relates to sub-project 1 about a new platform for the Visibility program.

The original Visibility program is still in use, but it can not be updated because it is programmed in an old platform, and because the source code unfortunately has been lost. There is probably not any easy way to obtain the original Visibility program anymore, except for asking for a copy from persons who have it. It does run on some modern computers, but not on all.

It was decided that excel files should be the new platform, partly because they will not become outdated and partly because excel files are comparatively easy to update.

There has led to an excel file, which also has the name “Visibility”.

Sub-project 2 serves to provide updated knowledge about the luminous intensities of headlamps. This sub-project has been completed, with in situ measurement of 50 headlamps on vehicles. Refer to a report " Lysfordelinger af forlygter på køretøjer" of 16 February 2015 (in Danish, can be obtained from www.nmfv.dk).

Sub-project 3 is currently in progress.

3. Light distributions of headlamps used by the excel file

The results of sub-project 2 have been implemented in the sense that the excel file includes average light distributions for both the low and the high beam of the headlamps. These average light distributions are re-scaled so that they correspond to 25%, 50% and 75% fractiles of all the headlamps.

These light distributions are referred to as NMF 25%, NMF 50% and NMF 75%, and are available for both the low and the high beam.

For the sake of continuity, the two artificial light distributions in the original Visibility program labelled COST 331 – for respectively the low and the high beam - are also included and with the same labels.

However, in the original Visibility program the artificial light distributions were fitted by logical operations, while they are included in the excel file as tables. For this reason, there may be some small differences in the results

The last version of the original Visibility program also included light distributions tabulated on the basis of an UMTRI-2000-36 report on headlamps on European vehicles. In addition, light distributions tabulated on the basis of an UMTRI-1997-37 report on American vehicles were included as well.

The above-mentioned UMTRI light distributions are not included in the excel file, as they may be considered less suitable than the NMF light distributions.

NOTE: The UMTRI light distributions for European vehicles are also presented by 25%, 50% and 75% fractiles like the above-mentioned NMF 25%, NMF 50% and NMF 75% light distributions. A comparison indicates that vehicles of 2015 have significantly stronger low beams than vehicles of 2000.

4. How the excel file works and its range of application

The excel file uses the same visibility model as the original Visibility program, and as described in the report of COST Action 331 (Adrian, W. (1989) Visibility of targets: Model for the calculation, Lighting Res. Technical 21 (4) 181-188).

The result of a calculation is the visibility level, VL "visibility level". A visibility level of 1 means that a person with normal vision can distinguish an object, when he can devote his attention to the visual task and have ample time.

In practical driving, a much higher visibility level is required. The driving tests performed at VTI as part of COST Action 331 could be fitted by the model, when assuming a visibility level of 7,2. In practice, it is recommended that the visibility level should be 10.

The original Visibility program is based on the assumption that only the part of the road marking that lies from the given distance and onwards contributes to the visibility level. This visibility level depends on the distance and will typically decrease strongly with increasing distance. The original Visibility program repeats the calculation for different distances until it finds a distance where the visibility level equals the required value.

The excel file does the same as the original Visibility program. Tests based on the artificial COST 331 light distributions show minor deviations only.

The required visibility level, whose value was fixed at 10 in the original Visibility program, can be altered in the excel file.

The excel file has the same range of application as the original Visibility program with the exception that it does not include curving roads.

Note: Curving roads lead to calculations that are hard to implement in an excel file.

Additionally, the excel file omits the geometrical configuration of a motorcycle and includes only those for a passenger car and a large vehicle. This is intended as a simplification.

Like the original Visibility program, the excel file generates a picture of the current situation. An example is shown in figure 2.

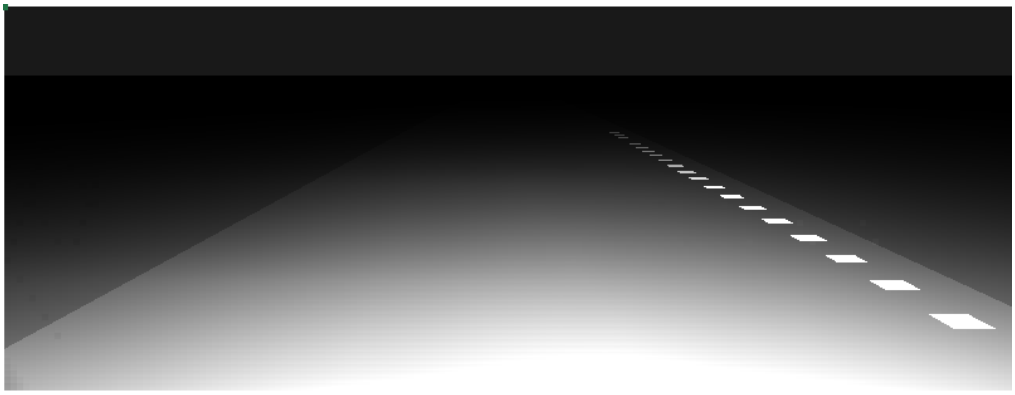

Figure 2: Exsample of a picture.

5. Use of the excel file

The input/output is found in the "Operation" sheet, and is shown in figure 3 below. The values in a red font are inputs that should not cause any problem for a user of the original Visibility program. The output is the visibility distance and the preview time. As in the original Visibility program, the output is automatically changed for each change of input.

The picture is found in the sheet "Picture". Two values can be set, which are the luminance values that span the greyscale. By setting those, there can be a certain degree of focus on a particular range of luminance.

Note: Fields with a luminance below the top value are reproduced in black, while fields with a luminance above the lower value are reproduced in white.

Driver, glare and vehicle				
driver age:	20			
veiling luminance (cd/m2):	0	Refer to the COST 331 action report		
vehicle:	1	1: passenger car		
		2: large vehicle		
Headlamps and RL				
factor for luminous intensity:	1,00			
light distribution No.:	2	se tabel	Distribution	Low beam
RL of road marking:	100		1	NMF 25%
RL of road surface:	20		2	NMF 50%
			3	NMF 75%
Diffuse ilumination and Qd			4	COST 331 *)
illuminance (lux):	0		Distribution	High beam
Qd road marking:	130		5	NMF 25%
Qd road surface:	60		6	NMF 50%
			7	NMF 75%
Location and geometry of road marking			8	COST 331*)
lateral location (m):	2		*) approximated by tables	
(to the right from vehicle centre)				
width (m):	0,2			
broken when these are provided				
marking length (m):	1			
and gap length (m):	2			
Criteria for visibility				
visibility level (normally 10):	10			
driving speed (km/h):	90			
Results				
visibility distance (m):	81,5			
preview time (s):	3,3			

Figure 3:
Operation sheet.