Lane Change Test 1.2
User Guide

28.06.2005

version 1.2 vs. 1.1
- *height of view changed from 65 cm to 120 cm*
- *blank signs – without information – are always visible*
- *viewing distance for the information on the signs set to 40 meters*
- *speedometer is visible at startup*
- *TCP/IP logging mechanism*

version 1.1 vs. 1.0
- *steering ratio and progressivity can be set in config.ini file*
- *viewing distance for signs can be set in config.ini file (e.g. 40 meters)*
- *automatic renaming of output file with date and time (old: "result.txt"; new: "040228_115533.txt").*
- *new time format in output file (time in milliseconds after 1st January 1970).*
- *markers can be set directly on NUM-block*

The Lane Change Test (LCT) was developed to test driver distraction caused by in-vehicle tasks. The LCT consists of simple driving simulation software and analysis software. Standard hardware (PC plus game steering wheel) is sufficient to administer the LCT.

Contents

1. Hardware requirements

- PC with Windows 2000 or Windows XP and DirectX 8 (or higher) installed. DirectX is a software interface which can be downloaded from Microsoft free of charge.
  Recommended: 512 MB RAM and Processor speed >= 2GHz, XP professional; but less might also be sufficient.
- Graphics board with real DirectX8 features (Vertex- and Pixelshader; e.g. "gforce 3 Ti", "gforce 4 Ti 4xxx", Radeon 9xxx)
  Note: There are two kinds of gforce4 graphic boards: "Ti" and "MX". The simulation works only with a "Ti" board (e.g. "gforce 4 Ti 4800") since the MX board does not support vertex- and pixelshader!
- Force-feedback game steering wheel with foot pedals (accelerator and brake) with USB or Gameport connection (typically a yellow 15-pin connection). If the steering wheel is not recognized by Windows it might be necessary to use a setup of the steering wheel as a "2-axes, 4 button – joystick". The force-feedback is only used for centering the wheel.
  Note: There are two exe-versions available to start the simulation. If one of them doesn't work, you should try the other. If both don't run correctly (e.g. if the footpadels don't work) you most probably have to use another steering wheel. If no steering wheel is connected to the PC you can test the software with the arrow keys on the keyboard. Press F5 to toggle keyboard vs. steering wheel control.
- PC-Loudspeaker connected to sound card (engine sound and other sounds are simulated)

2. Installation

There is no real installation procedure. Just extract the archives *"LCT Sim v1.2.zip"* and *"LCT Analysis v1.99.zip"* to your hard disk. Make sure you have selected the "Extract with pathnames" option in your compression software!
Remember that DirectX 8.x or better must be installed (see above).

3. Lane Change Test driving simulation

Double click *"mbc_pc_std.exe"* or *"mbc_pclogitech.exe"* in directory *"LCT Sim v1.2"* to start the driving simulation. Which version you should apply, depends on the steering wheel you are using; (simply try out, which version works). Use the hardware sound adjustment of your loudspeakers to adjust the engine sound to a moderate level.

Key assignment

ESC	end simulation
X	toggle speedometer on/ off the screen
D	toggle debugging info on/ off the screen
1-9, 0	put car to the start of track 1-9, 0 (= row of numbers above letters on key-board)
M	increase marker (shown in upper right corner for a few seconds)
N	reset marker to zero
NUM-Block	set marker directly

Other keys (not needed for LCT)

F1	third person view = you see your car, only for demonstration (note that the experiments must be carried out in 1st person view)
F5	toggle input device: steering wheel/ keyboard (use arrow keys to drive)
Crtl/ left Shift	Gear up/down
R	Reset car to road
P	Screenshot (*.bmp file is written to hard disk)
Q	car model parameters (do not change!)

Procedure

1. Start the simulation
2. Press the number of the track you want to drive (according to your experimental plan, see below). Note that when you press the number "5" the car will be set to the very end of lane 4. The driver must navigate through the U-shaped curve in order to reach the start of Lane 5. There are 18 signs on each track, 3 of each kind (change from lane 1 to lane 2, from 1 to 3, from 2 to 1, etc). The order of signs and the distance between signs is different for each track. It is recommended that the tracks be randomized during experimentation to avoid learning effects.
3. The subject drives the U-shaped curve in the middle lane. At the end of the curve he/she must drive at the maximum speed (which is limited to 60km/h in the config.ini file). The subjects are not allowed to reduce speed when they are on the track. Instead, the driver

should keep the accelerator pedal pressed to the floor the entire time he/she is driving so that longitudinal control requires no effort at all.

4. The subject changes lanes as soon as the information on the sign appears. Important: the change should be before the sign; that is, as soon as the information on the sign can be recognized! The subject should change lanes in a deliberate manner. That is, the subject should not drift or gradually change lanes; but do so as quickly and as efficiently as possible.
5. In a condition with a secondary task (e.g. radio adjustment), the experimenter gives the first instruction when the subject reaches the yellow “Start” sign (e.g. “change the radio station to 93.9 FM.”). Keep instructions as short as possible. Make sure that subjects understand the task with short instructions. Give the next instruction (on the same type of task!) when the subject finishes the task. The experiment should be performed in a blocked design: that is, the participant repeatedly performs task 1 on a single road segment, then performs task 2 repeatedly on the next road segment.
6. The subjects are encouraged to start working on the secondary task immediately after the instruction. When the subject starts to work on the secondary task the experimenter presses the key “M” to set the marker to 1. When the subject finishes the task, the experimenter presses the button “N” to set the marker to zero. The experimenter gives the next instruction ("set frequency to 107.1"), presses "M" when the subject starts working, and so on. Alternatively the experimenter can use the NUM-block to set the markers (in this case from 0 to 9) directly.
7. The end of the track is reached after 3 minutes. The experimenter presses “ESC” to end the LCT program.
8. The output file is automatically named according to date and time (e.g. *“040105_093015.txt”* if the simulation started on January 5th 2004 at 9:30:15 o’clock). We suggest to rename that file according to the experimental condition (e.g. from *"010104_093000.txt "* to *"s01_radio01.txt"*).
9. The LCT program is restarted for the next secondary task.

It is also possible to alternate the secondary tasks during one track. Therefore you have to set different markers (one for each task). You can do this quite comfortably by using the NUM-block.

But pay attention: To compare the mean deviations of one subject driving under different conditions / working on different secondary tasks, you have to take care that the subject worked equally long on every secondary task. As a consequence a shorter task must be repeated more often then a longer task during one track.

4. Example for a typical test

Have the participant practice drive on one or two tracks until he/she feels comfortable with driving. Take care that:

- The subject never reduces his/her speed.
- The subject changes lanes immediately after identifying the instructions on the signs.
- The subject changes lanes in a deliberate manner. That is, the subject does not drift or gradually change lanes; but does so as quickly and as efficiently as possible.
- The subject performs good lane keeping.

1. Restart simulation
2. Drive on track no. 7 without secondary task. Quit simulation.
3. Practice “radio tuning” task. Drive on track no. 3 with secondary task “radio tuning”. Quit simulation.
4. Practice “atlas reading” task. Drive on track no. 1 with secondary task “atlas reading”. Quit simulation.
5. Practice “tape change” task. Drive on track no. 2 with secondary task “tape change”. Quit simulation.
6. Practice “use kleenex” task. Drive on track no. 4 with secondary task “use kleenex”. Quit simulation.
7. Practice “adjust sound settings” task. Drive on track no. 5 with secondary task “adjust sound settings” Quit simulation.
8. Practice “have conversation” task. Drive on track no. 8 with secondary task “have conversation”. Quit simulation.
9. Drive on track no. 10 without secondary task. Quit simulation.

After the whole experiment has taken place, you should rename all output files according to subject number and experimental condition (e.g. *“s01_radio.txt”* if subject number 1 worked on the radio tuning task).

Example:

Task	**Original name**	**New name**
Baseline at the beginning	040105_093015.txt	s01_base01.txt
Radio tuning	040105_093315.txt	s01_radio.txt
Atlas reading	040105_093615.txt	s01_atlas.txt
Tape change	040105_093915.txt	s01_tape.txt
Use kleenex	040105_094215.txt	s01_kleenex.txt
Adjust sound settings	040105_094515.txt	s01_sound.txt
Have conversation	040105_094815.txt	s01_conversation.txt
Baseline at the end	040105_095115.txt	s01_base03.txt

Note that baseline driving (without secondary task) was done at the beginning and at the end of the experiment to control for learning effects. The order of the secondary tasks, tracks, and the pairing of tasks with tracks should all be counterbalanced to the best of the experimenter's ability.

Verbal instruction:

"Thank you for volunteering to participate in this study. Throughout this study, you will be performing several different types of tasks while driving on a simulated roadway. First, you'll practice driving on the simulated roadway until you feel comfortable with it.

Before each new type of task, I will give you instructions related to the task. Then I will give you a chance to practice the task.

After the practice, you will perform the task by itself a few times.

Finally, you will perform the task while driving on the simulated roadway. Then we'll repeat this process with the next task. Do you have any questions, or shall we start?

Remember to start the task as soon as I'm finished giving you the instructions, but don't start until I've stopped talking."

5. Lane Change Test analysis

Double click *"LCTA.exe"* in directory *"LCT Analysis v1.99"* to start the analysis.

The general principle of the analysis software is to load raw data files which belong together in a "project", define what to do with these files and then run the analysis.

Select raw data files for your project

You should see a window named "driving data files project [unbenannt]". If not, open it by selecting in the menu: Project → Driving data file list → show. Press "Add" and go to the directory where your raw data files are (e.g. *"s01_base01.txt"*, *"s01_radio.txt"*, etc.). Select the files and open them.

Display data (not necessary for analysis)

Double click on a raw data file. Change display settings in Driving Data → Display. Most important are the red line (the actual course of the subject) and the green line (the normative model to which the real driving is compared).

Choose settings for data analysis

1. Open Project → Settings
   You can load settings from another project with the button at the bottom.

Reference Lane Change	Defines the normative model (green line in the graph). We suggest the following values: 30m (Start lane change), 10m (Change length for two lanes) and 10m (Change length for one lane). Use the Change type "linear". (see Figure 1)
Track section	Should be self explanatory. Use the defaults: First start sign and Last lane change sign + 50 m
Variables	Defines which dependent variables to analyze. Define a variable for mean deviation and length (the latter for control purposes only, i.e. to have a check if the raw data file is complete). Use the same settings as in Figure 2 and 3.
Track data	use the defaults: 3.85, *"Schilder.txt"*, *"Startpunkte.txt"*

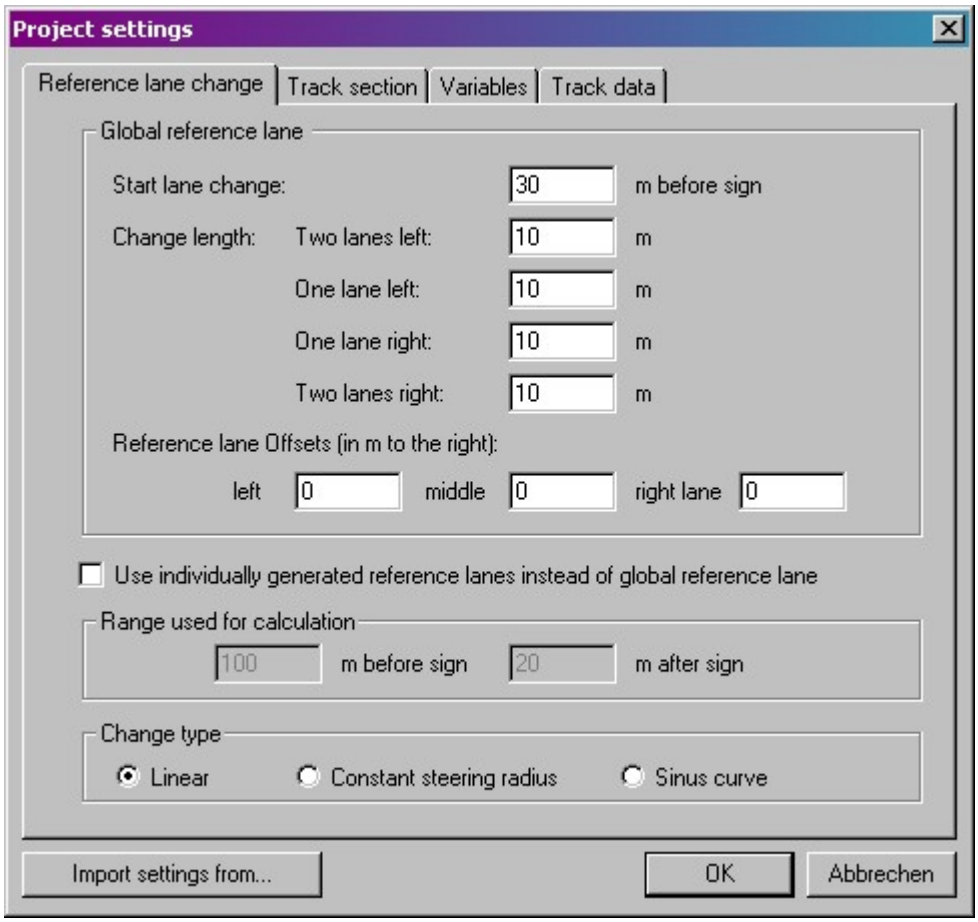

Figure 1: Settings fort he Reference Lane Change

2. Press "OK".

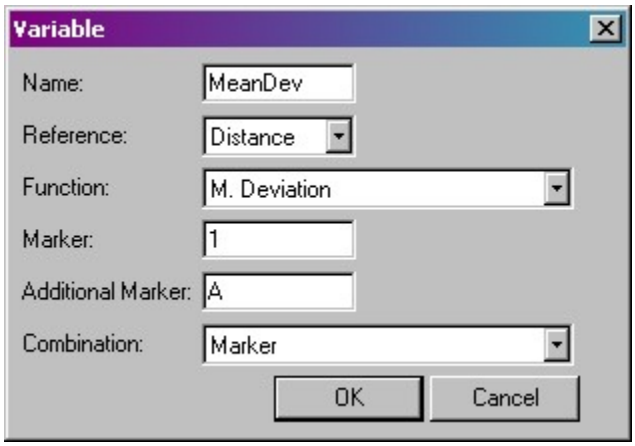

Figure 2: Settings for the variable "Mean Deviation"

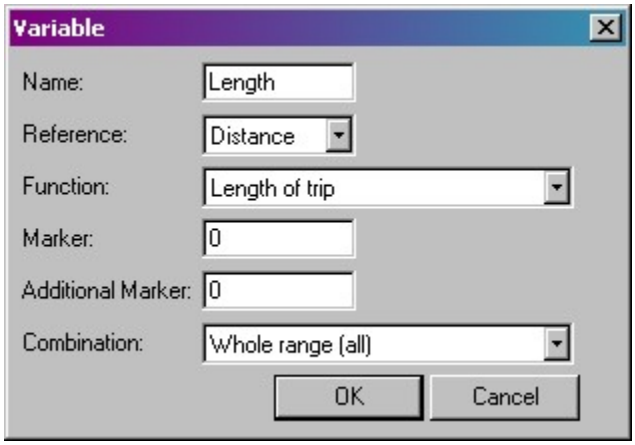

Figure 3: Settings for the variable "Length"

Analysis

Choose a filename for the output, e.g. *"Experiment1.csv"*. Filenames of raw data files and the respective results will be written to that file. These files are in a plain ASCII format and you can open and edit them with any text-editor.

The results will look like:

FahrDat	MeanDev	Length
s01_base01	1.1211	2955.4
s01_radio	1.4397	2927.5
...		

This means: Subject number 1 has an average lane deviation of 1.12 meters in the first baseline condition and 1.44 meters with radio tuning as a secondary task.
Note, that if you chose the option “Marker” in the Combination field, the calculated mean deviation concerns only those parts of the simulation, the subject is performing the task. These results can then be further processed with a statistical package like SPSS to test for statistical differences.

6. Appendix: Time course for information on the signs

The following tables show the time course when approaching a sign with fixed speed of 60 km/h. When driving on the center lane the information on the signs are fully visible for 1.84 s. On the left or right lane, at least one sign with the necessary information for the next lane change is fully visible for 2.07 s.

Center lane (symmetrical)			Δt
Information on the signs appear	-40.00 m	-2.40 s	
Outer boarder of signs at boarder of screen	-9.38 m	-0.56 s	1.84 s
Inner boarder of signs at boarder of screen (= both signs vanished completely)	-7.43 m	-0.45 s	

Left or right lane (asymmetrical)			Δt
Information on the signs appear	-40.00 m	-2.40 s	
Outer boarder of far sign at boarder of screen	-13.53 m	-0.81 s	
Inner boarder of far sign at boarder of screen (= far sign vanished completely)	-11.36 m	-0.68 s	
Outer boarder of near sign at boarder of screen	-5.44 m	-0.33 s	2.07 s
Inner boarder of near sign at boarder of screen (= near sign vanished completely)	-3.46 m	-0.21 s	

7. Appendix: TCP/IP logging

Since version 1.2 the LCT simulation can send all information from the logging files via a TCP/IP port to a logging client. All you have to do is to activate TCP/IP logging by adding the following lines in the *"config.ini"* file of the LCT simulation (values need to be adapted to your inidivual needs):

```
[Logging]
IP=127.0.0.1
Port=4955
Nagling=0
```

IP is the IP address of the machine where your logging client runs (here: localhost, which means that the logging clieant runs on the same machine as the LCT simulation). Port is the TCP/IP port on which your logging client is listening. If you set the port to null (Port=0), TCP/IP logging is deactivated. Nagling is a feature of TCP, which allows for a better data rate, but in turn can lead to delays up to 100 milliseconds. If you set nagling to null (Nagling=0), nagling is deactivated.

LCT simulation sends a plain string for each sample, consisting of 9 values, seperated by commata:

1. Time(GMT): Date and Time in General Mean Time format (millisaconds since 1st of january 1970
2. Xpos: lateral position on the track
3. Ypos: longitudinal position on the track
4. Speed: speed in km/h
5. steering angle in grad
6. track number: number of the track (0 to 9)
7. marker: marker set by keyboard input during LCT simulation (0 to 9)
8. revolutions per minute
9. gear

To be able to analyze the data with the shipped LCT analysis software you have to produce data files equal to those which are created by the LCT simulation:

- Heading line must be as follows: “Zeit in ms(GMT),Xpos,Ypos,Geschw in KmH,Lenk in Grad,Strecke,Marker”
- sample lines must contain the first 7 values of the TCP/IP packet separated by a tabulator in the given order
- each sample line must be closed by a carriage return+linefeed