Item 0.4

Automotive Front Lighting

Roadmap GTB Front Lighting WG

Chairman: Dr. Rainer Neumann
Secretary: Jean-Marc Prigent
Automotive Front-Lighting

Agenda

Future Trends
Future Needs
Short Term Actions
Summary & Outlook
Front Lighting Technology Market Demands

Value
- Increased Safety and Convenience
- Improved Lighting Performance
- Added Functionality
- Brand Differentiation

Driver Assistance Systems
- Adaptive Driving Beam
- Automatic Levelling
- Improved Performance/Safety

LED Light Source Modules
- Standard

Reduced Package
Reduced Weight
Headlamp Cleaning

Improved Styling, Performance, Functionality
- Reduced Package
- Reduced Weight
- Headlamp Cleaning

Full Adaptive Lighting
- Bi-Functional HID with LED indicator lips
- Bi-HID AFS
- Halogen AFS
- Dual Projector

Improved Year of Availability
- 04
- 05
- 06
- 07
- 08
- 2012+

Added Functionality, Full Lighting Systems
- Path Prediction
- Adaptive LED Lighting
- LED Forward Lighting
- Car to Car Communication

Front Lighting Technology Market Demands
- LED Light Source Modules
- Standard

GTB Document No. CE-4563

GTB
The International Automotive Lighting and Light Signalling Expert Group
Groupe de Travail “Bruxelles 1952”
Bi-Xenon Full AFS Projector 70mm
• HID 25W SYSTEMS
Bird's eye view – comparison of different beams

- H7 projector

- Bi-HID 25W projector

- Bi-HID 35W projector
Technology Roadmap - Headlamp Global

Penetration 2020: LED HB/LB 5% - Xenon 35%
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**Improved Styling, Performance, Functionality**
- Reduced Package
- Reduced Weight
- Headlamp Cleaning
- Bi-HID AFS
- Bi-HID with LED indicator lps
- Halogen AFS
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**Value Added**
- Full Adaptive Lighting
- Improved Performance/Safety
- Path Prediction
- LED Forward Lighting
- Car to Car Communication

**Added Functionality, Full Lighting Systems**
- Improved Styling, Performance, Functionality
- Full Adaptive Systems

**Year of Availability**
- 2012+
LED Headlamp - Premium Class Vehicle
Future Trends

- Green Car Initiative (Electrical / Hybrid vehicles) requires:
  - Power Consumption Reduction
  - Fuel Consumption Reduction
  - CO2 Reduction
  - Weight Reduction
  - Long Life Time

Attractive Styling

LED
Color – Effect

http://www.ass-cuna.org/Video1.wmv
Front Lighting Technology Market Demands

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- Adaptive LED Lighting
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- Camera
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**Adaptive LED Lighting**
- Driver Assistance Systems
- LED Light Source Modules
- Standard
LED Light Source Module (DRL/Driving Beam)
The International Automotive Lighting and Light Signalling Expert Group

Front Lighting Technology Market Demands

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**Driver Assistance Systems**
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**Improved Performance/ Safety**
- Automatic Levelling
- Improved/ Safety

**Standard**
- LED Light Source Modules

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**Full Lighting Systems**
- Added Functionality, Full Lighting Systems

**Added Functionality**
- Full Lighting Systems
- Path Prediction

**Year of Availability**
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Adaptive Driving Beam

Multifunctional HID unit driven by camera
Driver Assistance Systems

http://www.ass-cuna.org/Video2.wmv
Path Prediction Using GPS/Map Data

Every Curvature Point is associated with a curvature value, a distance value.

Look-ahead distance is a function of speed (max=180 meters)
Predictive AFS
Addressable LED chip array driven by camera
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Front Lighting Technology Market Demands

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Car to Car Communication

Automatic traffic messages sharing
Traffic Conditions
Future Needs

- There are two main categories, which we do have to cover from legislation point of view

1) Harmonization of legislation with all kind of light sources (Halogen, Xenon, LED) and all kind of light applications standard dipped/main beam, AFS, LED-array generated or micro-mirror variation of light distributions

2) Driver assistant lighting systems with external parameter variation of light pattern (e.g. Adaptive Driving Beam, Predictive AFS, Car to Car Communication)
Short Term Actions

- Automatic Levelling
- Headlamp Cleaning
- 2000 lm criterion
### Automotive Headlamps - Comparison Current Status

<table>
<thead>
<tr>
<th>Feature</th>
<th>Halogen</th>
<th>Xenon</th>
<th>LED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automatic Levelling</td>
<td>-</td>
<td>- X</td>
<td>- X</td>
</tr>
<tr>
<td>Headlamp Cleaning</td>
<td>-</td>
<td>- X</td>
<td>- X</td>
</tr>
</tbody>
</table>
2000 lm Criterion

1. 2000 lm hurdle for automatic levelling and cleaning device was historically introduced to avoid glare caused by high power Halogen bulbs (HIR bulbs)

2. There is and was no scientific argument for a 2000 lm definition and limit for whatever automotive Front-Lighting request

3. This has caused some confusion and corresponding special solutions avoiding such an amount of light volume
Bi-Xenon Light Distribution

Glare situation for inclination: Cut-off $\Delta = +0.5^\circ$

CIE TC 4.45 Rating
• The GTB Front Lighting Working Group Forum
• Turin, Italy – 25 January 2011

• “The Contribution of Mandatory Installation
  of Static Auto-Levelling to reduced glare”

• 6 Speakers, 40 GTB experts

• An Overview of the Main Points
The GTB Front Lighting Working Group Forum  
Turin, Italy – 25 January 2011

**Presenters**

- **Dr. Wolfgang Huhn**: “Cost-Benefit Analysis of mandatory requirement of auto levelling”.

- **Dr. Ernst-Olaf Rosenhahn**: “Glare and Auto-Levelling: degree of influence and future outlook.”

- **Paul-Henri Matha**: “Reality of car production tolerances and automatic levelling involvement”

- **Aurélie Darnoux**: “Automatic Levelling: Safety aspects and real application in motor vehicles.”

- **Dr. Tomasz Targosinski**: “Aiming influence for visibility distance and glare”

- **Dr. Thomas Reiners**: “Headlamp cleaning effectiveness.”
Factors Influencing Passing Beam Misaim resulting in Increased Glare or Reduced Forward Visibility

<table>
<thead>
<tr>
<th>Factor</th>
<th>Research Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dynamic Vehicle Movement: acceleration and braking</td>
<td>PhD Dissertation 1995 - Joachim Damasky</td>
</tr>
<tr>
<td>Geometry: Road curvature, driver’s eye position Slopes and hills, bends, headlamp mounting height, etc.</td>
<td>PhD Dissertation 1995 - Joachim Damasky</td>
</tr>
<tr>
<td>Variation of load in passenger compartment, in trunk and due to weight of fuel Static Automatic Levelling will only address these variations</td>
<td>UMTRI 2007 Matha 2010 Mobility Investigation 2008 (Funded by German MOT) GTB study 2011</td>
</tr>
</tbody>
</table>
Glare and Headlamp Levelling

Different effects and tolerances in „real life“, which lead to glare or decreased range of headlamp light distributions:

- **horizontal & vertical adjustment process** (EOL, garage)
- Variations of load in passenger compartment, trunk, gasoline
- Dynamic Vehicle Movement: acceleration and braking
- Geometry: Road curvature, driver’s eye position, slopes and hills, bends, SUVs, trucks, etc.

Automatic Levelling
### Summary

<table>
<thead>
<tr>
<th></th>
<th>90% Interval</th>
<th>98% Interval</th>
<th>( \Delta ) (90%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adjustment toler.</td>
<td>± 0.39°</td>
<td>± 0.53°</td>
<td>0.78°</td>
</tr>
<tr>
<td>Vehicle load</td>
<td>-0.1° ... + 0.44°</td>
<td>-0.13° ... +0.61°</td>
<td>0.54°</td>
</tr>
<tr>
<td>Vehicle dynamic</td>
<td>± 0.5°</td>
<td>± 0.71°</td>
<td>1°</td>
</tr>
<tr>
<td>Geometry</td>
<td>± 0.64°</td>
<td>± 0.95°</td>
<td>1.28°</td>
</tr>
</tbody>
</table>

#### Diagram

- **Geometrical Influence**
- **Dynamic Tolerances**
- **Adjustment Tolerance**
- **Pitch Angle by Load**

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Additional Cost and Weight

- Differences between manual and automatic levelling:
  To set up the automatic levelling, we need to fit the vehicle with more wiring (cable harness), a calculator and two or more additional sensors. Only the thumb wheel of the manual device can be removed.

- These additional sensors and wiring will cost between 20 and 35 euros (up to 40 Euros for certain electronic designs of vehicle). Total costs of app. 500 Mio Euros per year in Europe! The thumb wheel is only around 3 Euros.

- This automatic device weighs at least an additional 400-500g per vehicle.

- This generates cost and weight which can only be imposed with a real safety justification.
1. Headlamp Cleaning Device was introduced as a mandatory feature first in Sweden in 1973 as a comfort feature (geographical situation, not to avoid discomfort glare)

2. First Introduction of Xenon in 1991: Regulation required Cleaning Device

3. Application: operates in connection with windshield wipers
Headlamp Cleaning

Question: when is the cleaning process initiated and how effective is the result?

Recent Study by TU Darmstadt (2011)
Summary & Outlook

- Front Lighting is developing rapidly
- Regulation has to make sure, that innovations will be approved and used to improve safety at night
- Pro-active action has to be organized in order to be on time when innovations enter the market
- Challenge to define future driving assistance systems with many parameters precise, accurately, and as simple as possible
Thanks for Your Attention!