Overview

Business Division Lighting
## HELLA Group
Top Topics within the global Trends

<table>
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<th>The HELLA lighting fields of innovation</th>
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<td><strong>Styling:</strong></td>
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<td>Supporting the emotional links to the car and making the topics environment and safety visible</td>
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<tr>
<td><strong>Light based driver assistant systems:</strong></td>
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<td>Creating a maximum safety by giving the driver the best possible visibility under all driving and weather conditions</td>
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<td><strong>LED:</strong></td>
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<td>Energy efficient lighting systems with maximum efficiency to reduce the total energy consumption of the car and long lifetime to create a cleaner environment</td>
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### The HELLA Lighting motivation

Approx. **30% of all accidents** occur **at night**

50% of all accidents are the result of **shortcomings in visual perception**

The human brain absorbs **90%** of all information through the eyes

**The eye is the weak link at night**
Business Division Lighting
Competences

- INTERIOR LIGHTING
- SMALL LAMPS
- COMPONENTS
- REAR LAMPS
- LIGHT BASED DRIVER ASSISTANT SYSTEMS
- HEADLAMPS
Headlamps
Milestones from 1990 to 2004

1908: 1st electrical headlamp
1914: 1st low beam
1957: Asymmetric light distribution
1971: H4 halogen lamp
1983: 1st LED projection headlamp
1988: Free-form reflector
1992: 1st generation of xenon headlamp
1999: 1st Bi-Xenon headlamp
2000: Light guide technology as a styling element
2003: Static and dynamic bend lighting
2004: LED as signal function (daytime running light) Audi A8 W12

1990-2004: Headlamps Milestones
**Headlamps**

Milestones from 2006 on

- **2006**: 1st full-AFS headlamp
  - Mercedes E-Class
  - Opel Insignia

- **2008**: Full-LED headlamp
  - Cadillac Escalade Platinum
    (1st to segment)

- **2009**: Camera based headlamp with adaptive Cut-off Line
  - Mercedes E-Class
    (1st to market)

- **2010**: Camera based headlamp with glare-free high beam
  - Volkswagen Touareg
    (1st to market)

- **2011**: Full-LED headlamp with AFS-functions
  - Audi A8
    (1st to market)

- **2012**: Headlamp with LED main beam function for truck segment
  - DAF XF/CF
    (1st to market)

- **2013**: Full-LED headlamp with glare-free high beam
  - Mercedes E-Class
    (1st to segment)

- **2013**: LED Matrix headlamp with glare-free high beam
  - Audi A8 (1st to market)
In narrow corners, entry gateways or crossings an additional lighting system is switched on and accompanies the low beam. Through the light radiation of up to 90°, the lighting of the crossing area increases. An activation is effected by operating the winker or as a function of speed.
Low beam and high beam are turned via actuators based on the calculated bend geometry.
Headlamps I Dynamic Lighting Systems
Lighting Modules

<table>
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<th>Modules</th>
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VarioLED

Adaptive frontlighting system (AFS)
Adaptive Cut-off Line (aCOL)
Vertical Cut-off Line (vCOL)
Headlamps I Dynamic Lighting Systems
Adaptive Frontlighting System (AFS)
Headlamps I Dynamic Lighting Systems
Camera-based Lighting Systems

Glaring parts of the high beam lighting distribution are automatically faded out.
SOP 2010 in e.g. VW Touareg

Components of a camera-based lighting system

- Camera
- Image processing
- Lighting electronics
- Lighting technology
- Headlamp
The „Adaptive Cut-off Line“ controls the light range depending on the distance to oncoming traffic and to traffic ahead. The visibility range of the driver is increased – glare of the traffic is avoided.
Headlamps I Dynamic Lighting Systems
Glare-free High Beam (vCOL)

Glare-free high beam with Xenon and LED

With glare-free high beam in most traffic situations a light distribution comparable to high beam is available for the driver. In case of oncoming or heading traffic the glaring parts of the high beam lighting distribution are automatically faded out.
Headlamps I LED Matrix Beam
Operating Principle

- Illuminated area
- Dimmed area
- Viewing area of the front camera
  recognizes oncoming traffic and vehicles being followed
- Bending light
  Transfer of the brightest part of the light
- Addressable LEDs enable selective fading out of other road users.
Headlamps I Matrix LED
Market Innovation

USP: 5 reflectors, each with a 5 chip LED

- Carrier frame
- Heat sink
- 5 x 5 chip LED
- Matrix LED reflectors
- Finisher
- Matrix LED group

5 LEDs on one chip

MARKET INNOVATION
Each LED Chip on the PCB is controlled individually. Up to now it was only possible to switch on/off the whole cluster/package.

ELECTRONIC APPROACH
LED is the only light source that can be continuous dimmed btw 0 and 100%. This characteristics is been used to create an dynamic light system without mechanical moving parts

Masking out of up to 8 different road users
Driving with high beam without glaring
Rear Lamps
Milestones from 1995 on

- Free-form technology (1995)
- Macro reflex reflectors (2001)
- 1st full-LED rear lamp (2004)
- 1st application of 3D-shaped light guides (2006)
- Light curtain technology: 1st complete illuminated rear lamp (2009)
- Glowing body technology (2011)

- World premiere with the use of light guides in connection with LEDs (1999)
- Multi-color LED function for tail and direction indicator (2005)
- 1st application of crossing light guides (2008)
- EdgeLight technology in combination with light curtain (2010)
- Tail/brake light with mirror tunnel technology (2013)
# Rear Lamps I Current Styling Trends

## Technical Accentuation – HELLA Solutions

<table>
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<tr>
<th>DIRECT REFLECTOR</th>
<th>INDIRECT REFLECTOR</th>
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</table>
| ➔ Relative simple design especially for compact to mid size cars  
  ➔ Each LED has its own reflector | ➔ LEDs not visible  
  ➔ “Light coming from nowhere”  
  ➔ Separate reflector sections for each LED |

<table>
<thead>
<tr>
<th>LIGHT CURTAIN</th>
<th>EDGE LIGHT TECHNOLOGY</th>
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</table>
| ➔ Light guide as planar surface  
  ➔ LEDs along the edge  
  ➔ Optical structures on the surface | ➔ Illumination of small lighting edges  
  ➔ Light emits from the edge by using structures or optics |
Rear Lamps I Current Styling Trends
Technical Accentuation – HELLA Solutions

GLOWING BODY
- 3-dimensional bar, which seems to glow
- LEDs on substrate emit the light directly
- Homogeneous lit structures

PRISM LIGHT GUIDE
- Linear and homogenous illumination
- Two- or three-dimensional designs possible

DOUBLE REFLECTOR
- Two-dimensional background light
- High photometric efficiency
- Single-part system or matrix of multiple reflectors

MIRROR TUNNEL
- Tunnel-type depth effect
- Open or closed contour possible
- Reflective paths are controlled via mirror surface
Interior Lighting
Milestones from 1969 on

Display lamp as after-market product

1969

1st European central patent for light guide symbol lighting with only one LED

Volvo

1995

Europe-wide 1st application of light guide technology for ambient interior lighting

BMW

2001

Leading role in the field of using complex light guide technology in overhead consoles

2010

RGB-LED ambient lighting
Further projects:
Material backlighting
Opel Adam, Range Rover

2013

1st Europe wide integration of electronic in interior lighting

Volvo

1984

Worldwide unique patented process to produce radar covers

2007

Installation space optimized interior reading light in LED technology for convertibles

Audi

2007

Light guide in panoramic roof and door panels

VW Golf 7, Peugeot 208

2012

RGB-LED ambient lighting. Further projects: Complex overhead consoles

BMW X5

2014
**Interior Lighting**

**Product Range**

- **DOME LAMP**
- **ROOF CONTROL UNITS**
- **AMBIENT LIGHTING**
- **MINIATURE LAMPS**
- **LIGHTING AND ELECTRONIC MODULES**
- **SENSORS**
- **RADOMES***

* Radomes belong to the product portfolio of HELLA Innenlicht-Systeme GmbH (HIS) that is competence center for interior lighting
Interior Lighting
Ambient Lighting

Concept development, optical design, simulation, manufacturing of optical components, light source integration, electronical control units, class A-surface capabilities as HELLA core competences
Small Lamps
Milestones from 1926 on

1926
1st electrical brake lamp

1930
1st fog lamp

1951
1st flashing direction indicators

1966
1st rear fog lamps

1980
1st high mounted stop lamps

1991
1st signal lamp (additional turn indicator) with light guide technology
Nissan Infiniti Q50

2013
1st LED fog lamp

2014
Illumination of the license plate with only one license plate lamp with one LED

1992
1st center high mounted stop lamp with LED technology
BMW 3-Series

Rolls-Royce Wraith
Small Lamps
Product Overview

- FOG LAMPS
- CENTER HIGH MOUNTED STOP LAMPS
- LICENSE PLATE LAMPS
- FRONT COMBINATION LAMPS
- REAR SIGNAL LAMPS
- DAYTIME RUNNING LIGHTS
- INDICATOR LAMPS
<table>
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<th>Concept</th>
<th>Application</th>
<th>Description</th>
<th>Customer Benefits</th>
</tr>
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<tbody>
<tr>
<td>OFL Concept</td>
<td></td>
<td>→ Standard reflector group&lt;br&gt;→ Standard light sources used (H8, H11, HB4)&lt;br&gt;→ Customer specific lens and housing&lt;br&gt;→ O-ring for tightening reflector and housing during adjusting</td>
<td>→ Low weight&lt;br&gt;→ Small package space&lt;br&gt;→ Cost effective (COP reflector group)&lt;br&gt;→ Different functions with changing just reflector</td>
</tr>
<tr>
<td>CFL Concept</td>
<td></td>
<td>→ No standard parts except small parts (ventilation, adjustment parts,..)&lt;br&gt;→ Standard light sources used (H8, H11, HB4, P21W, PS19W,..)&lt;br&gt;→ Customer specific lens, housing, bezel, reflectors&lt;br&gt;→ Rubber membrane or thin plastic wall for adjustment</td>
<td>→ Very flexible to meet customer styling&lt;br&gt;→ More functions in one device&lt;br&gt;→ More versions in one housing for different car levels possible (eg. Fog – DRL, Fog – Cornering Light, only DRL,..)</td>
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Small Lamps | Front Combination Lamps
More than just one Function

<table>
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<tr>
<th>Description</th>
<th>Advantages</th>
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<tbody>
<tr>
<td>→ Bulb and/ or LED light sources</td>
<td>→ Customer-specific range of functions</td>
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<tr>
<td>→ Integration of different front lighting functions in one housing (except low beam)</td>
<td>→ Saves space in the headlamp</td>
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<td></td>
<td>→ Product that combines function, technology and styling</td>
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<td></td>
<td>→ Differentiation of vehicle lines by integration of different functions or different styling</td>
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<tr>
<td></td>
<td>→ Cost effective solutions by implementation of standard reflectors (OFL approach)</td>
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<tr>
<td>→ Fog lamp</td>
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<tr>
<td>→ Position light</td>
<td></td>
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<tr>
<td>→ Turn indicator</td>
<td></td>
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<tr>
<td>→ Daytime running light</td>
<td></td>
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<tr>
<td>→ Cornering light</td>
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<tr>
<td>→ Additional high beam</td>
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Small Lamps | Side Mirror Applications
Turn Indicator integrated in Side View Mirror // Light Guide Solutions

SEPARATED LIGHT GUIDE

INTEGRATED IN LENS

→ Efficient optical system
→ Optical system extensively independent from design surface
→ Smaller tolerances because molding parameters can be optimized to dimensions

→ Optical system less efficient than with separate light guide
→ Design surface has big influence to photometric part
→ Cost effective solution due to light guide and lens as one part

• Customized application possibilities
• HELLA inhouse LED light source and optical system competence
• Indipendent from mirror manufacturer
• Cost efficient lamp construction with two plastic components possible
Small Lamps | Side Mirror Applications
Turn Indicator integrated in Side View Mirror // Further Solutions

REFLECTOR

→ Implementation of translucent material for better homogeneity
→ Multi-part construction with reflexor, lens and PCB
→ Implementation of elongated PCB with several LEDs allows for sequential turn indicator

IMPROVED HOMOGENEITY…

→ Customized application possibilities
→ HELLA inhouse LED light source and optical system competence
→ Independent from mirror manufacturer
→ Cost efficient lamp construction with two plastic components possible
### Small Lamps | Center High Mounted Stop Lamps (CHMSL)

- **Description**
  - Installation from inside or outside
  - CHMSL can take up the styling of the rear lamp
  - Optical systems for implementation
    - Fresnel lens
    - Taifoon lens
    - Direct reflector
    - Indirect reflector
    - Light guide
    - Micro optics

- **Advantages**
  - Increased warning effect due to fast reaction time of LED light source
  - Cost effective solution with light guide (compared to Fresnel optics due to reduced amount of LEDs)
  - Standard module for CHMSL available (housing customer specific)
# Small Lamps | License Plate Lamps

## DESCRIPTION
- Sealed and non-sealed concepts
- Competence to illume the license plate homogeneously with a spot light source

## VERSIONS
- Versions with only one LED where
  - Two compact lamps
  - Only one lamp with special optical system
  illume the license plate
- Standard license plate lamps for multiple platforms as cost effective solution

## ADVANTAGES
- Low energy consumption with LED light source
- Installation from inside due to long lifetime of the light source possible
  - No special theft protection
  - Only lens visible
  - Simplified tightness concepts
- Improved nighttime appearance due to light color of the LED
USP HELLA Lighting

L-LAB (Light laboratory)
→ Results can be transferred directly into innovations
→ Large competency fields due to open research in cooperation with public institutions (e.g. universities)
→ Short distance to HELLA

Member of Light.Sight.Safety
→ A CLEPA initiative
→ Promotion of life-saving assistance systems (e.g. Intelligent Lighting Systems)
→ Committed to inform the society and increase awareness of good quality car lighting

Development of lighting technologies

Lighting tunnel
→ Europe’s largest light testing facility
  • Subjective impression can be gained under almost natural surroundings

Inhouse styling department
→ Inspiration
→ Ideation
→ Visualization
USP HELLA Lighting
Unique international Research Platform for Light Technologies

Partners of the L-LAB: Mutual transfer of knowledge

HELLA KGaA Hueck & Co.

University of Paderborn

University of Applied Science Hamm-Lippstadt

Research Network

University of Applied Sciences Jena

Leibniz Universität Hannover

Lighting Research Center
### Research topics of the L-LAB

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<th><strong>Mesopic vision</strong></th>
<th><img src="image1.png" alt="Mesopic vision" /></th>
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<td>Measurement techniques</td>
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<td>Effects of different light sources</td>
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<td>Evaluation of headlamp light distributions</td>
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<th><img src="image2.png" alt="Active lighting" /></th>
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<td>Sensor systems</td>
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<td>Algorithm &amp; data fusion</td>
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<th><strong>oLED</strong></th>
<th><img src="image3.png" alt="oLED" /></th>
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<td>Long term and perception tests</td>
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<th><strong>Materials and optical design</strong></th>
<th><img src="image4.png" alt="Materials and optical design" /></th>
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<td>Transparent silicone rubber</td>
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<td>Primary optics and flexible lenses</td>
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<th><strong>Human-machine-interaction</strong></th>
<th><img src="image5.png" alt="Human-machine-interaction" /></th>
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<td>Field tests, acceptance, safety</td>
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USP HELLA Lighting
Light Testing Facility | The largest of its kind in Europe

→ Situated in Lippstadt, the centerpiece of HELLA’s technical competence

→ The 140m long and 11m wide facility gives an illuminating, realistic and subjective impression, complementing simulations and calculations

→ Used to test spread, light color, light distribution and the homogeneity of the light when developing for a customer and also to test the wide range of in-house developments

→ Almost natural surroundings can be created in this unique light testing facility
“Good light = Good safety”

→ Coalition of several European automotive lighting companies

→ Targets

  • To bring **technological advancements** to the automotive lighting market
  • To communicate the **benefits** of **good vehicle lighting** to the market
  • To improve **performance, comfort, safety** and **environmental friendliness** of car lighting
  • To **increase awareness** and understanding of advantages of good quality car lighting at **end users, carmakers** and relevant decision-making authorities