Paul-Henri MATHA, Volvo cars technical leader Exterior lighting
DVN Novi 2021, How to Save Lives in Nighttime Driving?

VOLVO

SAFETY : HOW DOES VOLVO HANDLE EXTERIOR LIGHTING WHEN WE SPEAK ABOUT SAFETY

Paul-Henri MATHA, Volvo cars technical leader Exterior lighting
DVN Novi 2021, How to Save Lives in Nighttime Driving?

PEOPLE AND SAFETY – Since 1927

”Cars are driven by people. The guiding principle behind everything we make at Volvo, therefore is – and must remain – safety.”

Assar Gabrielsson & Gustaf Larson,

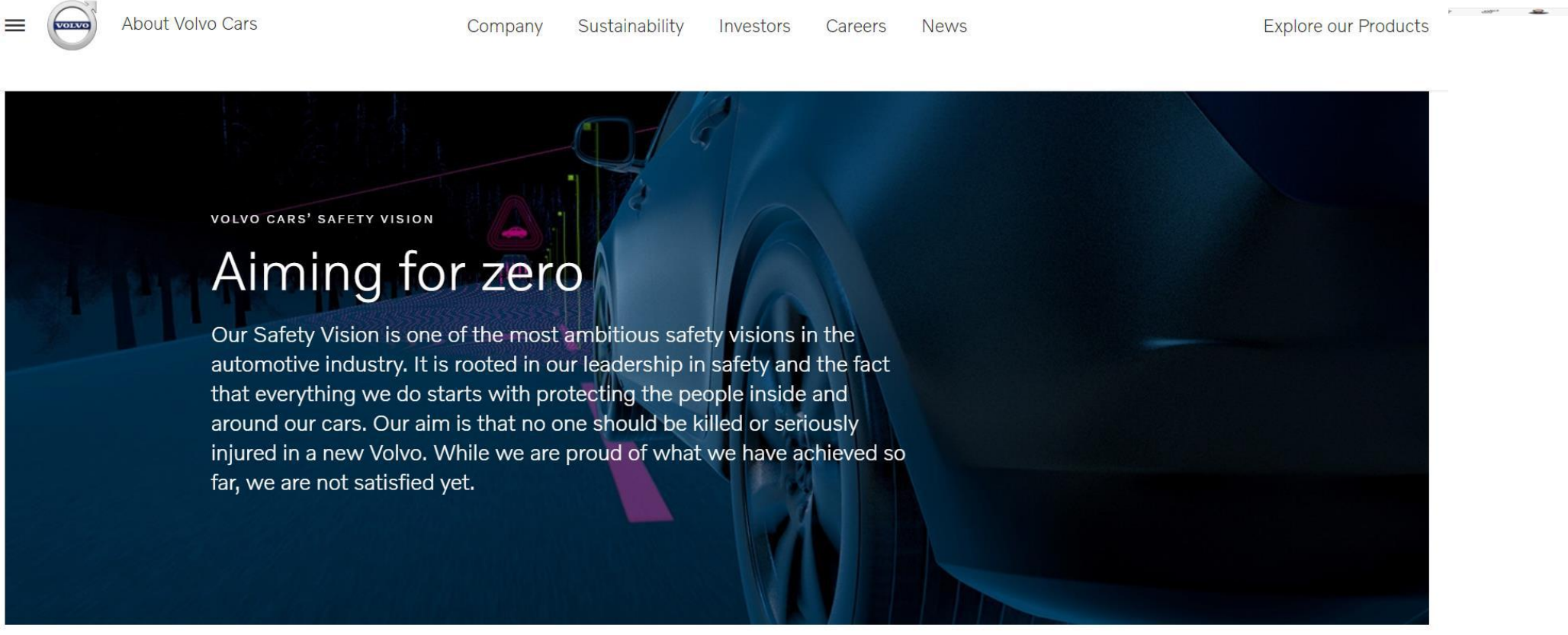
the founders of Volvo

Paul-Henri MATHA, Volvo cars technical leader Exterior lighting
DVN Novi 2021, How to Save Lives in Nighttime Driving?

Volvo Purpose

VOLVO

Safety Vision | Volvo Car Group (volvocars.com)



Paul-Henri MATHA, Volvo cars technical leader Exterior lighting
DVN Novi 2021, How to Save Lives in Nighttime Driving?

VOLVO

Volvo safety implementation

Volvo Cars has been a leader in the field of car safety for decades. That will never change. It’s our vision that no one should be seriously injured or killed in a new Volvo car.

Car safety | Volvo Cars - International

1959 – Three-point safety belt

There can be few men on the planet who have saved as many lives as Volvo engineer Nils Bohlin – he introduced three-point safety belts into the series production PV544. Since then, it’s estimated that over one million lives have been saved as a result of Volvo Cars waiving its patent rights so everybody could benefit.

1972 – Rearward-facing child seat

Remember those early images of astronauts lying on their backs during take-off to even out the force on their bodies? Well, that was the basic principle behind our industry-first rearward-facing child seats. To spread the load and minimise injury.

Paul-Henri MATHA, Volvo cars technical leader Exterior lighting
DVN Novi 2021, How to Save Lives in Nighttime Driving?

VOLVO

Collision avoidance

Intelligent systems can detect and help you avoid a collision with other vehicles, pedestrians and cyclists – any time, day or night. The systems support you with audible, visible and brake pulse warnings when needed. And if a collision is imminent or if you should turn into the path of an oncoming vehicle in an intersection, the car can brake automatically.*

Blind Spot Information System (BLIS)

The Blind Spot Information System with steer assist can ease tension in busy traffic with alerts and active support, guiding you back on track. When a vehicle enters your blind spot or approaches rapidly in a lane on either side of your car, BLIS can alert you via a light in the left or right door mirror. ***

Run-off road mitigation

Run-off road mitigation helps prevent you from accidentally leaving the road. If you stray across the outer lane marking, it will help you steer the car back on the road. If needed, this Volvo safety innovation can also activate the brakes to help keep you on the road. Run-off road mitigation operates at speeds between 65 km/h and 140 km/h.

Cross traffic alert with auto brake

Driver assist with cross traffic alert covers your back when reversing out of a parking space, with warnings for approaching vehicles and auto brake for imminent collision.**

Lane keeping aid

Lane keeping aid adds convenience and safety to motorway driving. If you're about to cross a lane marking without using the indicator, it will gently steer your car back into the lane. If this steering intervention is not enough or you keep steering across the lane markings, you'll be alerted with vibrations in the steering wheel. Constantly monitoring your position on the road, lane keeping aid provides smooth support at speeds from 65 km/h. ***

Connected safety

Cloud-based communication allows you to receive and share road condition information. Real-time data helps you, and others, prepare for what's ahead via a symbol in the driver display or the optional head-up display. You will also be alerted if another connected vehicle on the road ahead of you detects slippery conditions. ***

Surround view camera

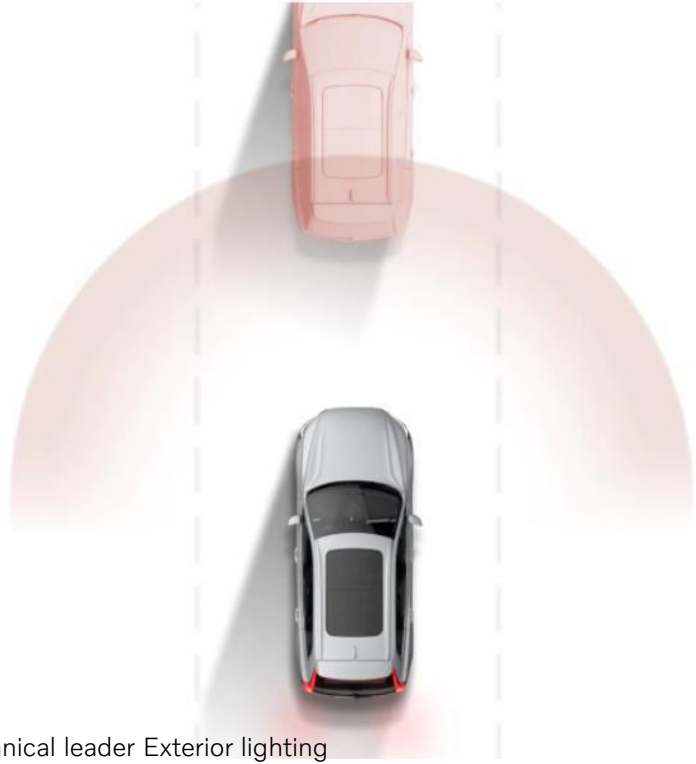
Four high-definition cameras give you a 360° bird's eye parking view so you can enter or exit any confined space with confidence.

Paul-Henri MATHA, Volvo cars technical leader Exterior lighting
DVN Novi 2021, How to Save Lives in Nighttime Driving?

function development with Harware + Software

2008 – City Safety

Starting with the first-generation Volvo XC60, we introduced the autonomous emergency braking system City Safety as standard equipment in all new cars. The system used laser detection and was developed to reduce the risk and consequences of rear-end collisions at speeds up to 30 km/h.



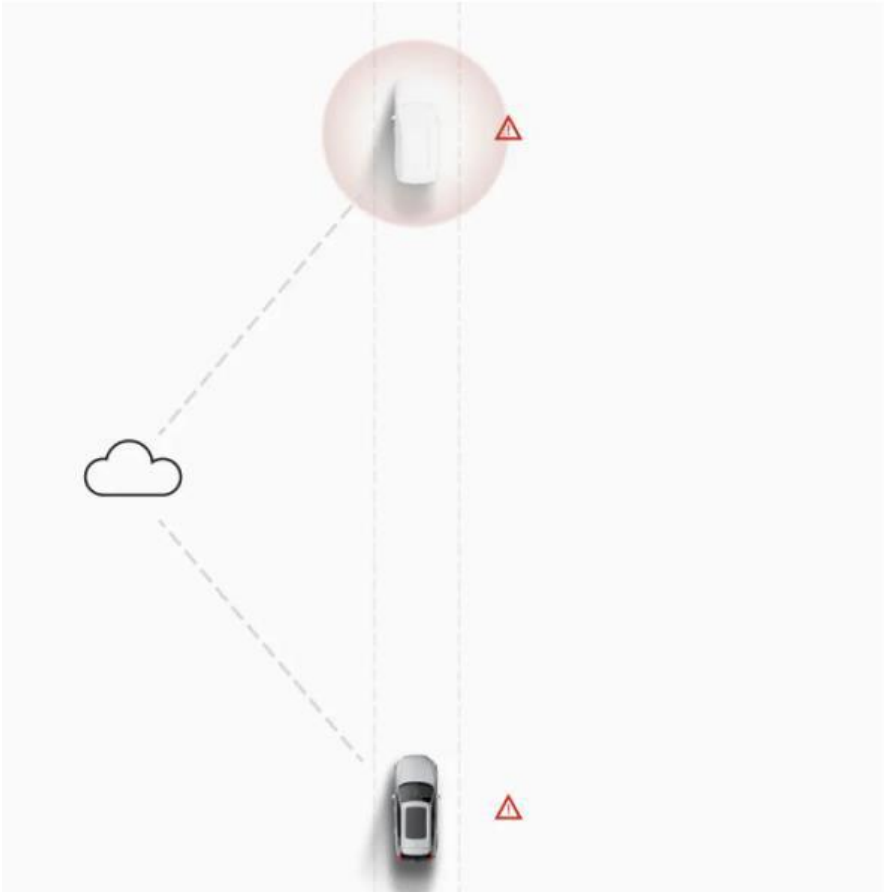
Paul-Henri MATHA, Volvo cars technical leader Exterior lighting
DVN Novi 2021, How to Save Lives in Nighttime Driving?

VOLVO

2010 – Pedestrian detection with full auto brake

We want our safety innovations to benefit people outside our cars, too. So, we've developed a system – using radar and cameras – that is designed to warn the driver if somebody steps out in front of the car, and then to brake automatically if the driver fails to do so.

Paul-Henri MATHA, Volvo cars technical leader Exterior lighting
DVN Novi 2021, How to Save Lives in Nighttime Driving?



2016 - Connected safety

Volvo Cars defines a completely new type of road safety system in a world of connected cars. The connected innovations – Slippery Road Alert and Hazard Light Alert – use the cloud to share critical data between vehicles, alerting the driver about slippery road sections or vehicles that have activated their hazard lights, helping to provide the driver with enough time to slow down.

2018 - Oncoming mitigation by braking

Oncoming mitigation by braking is another unique Volvo feature. The system can help you apply the brakes for an oncoming vehicle in your lane. If an oncoming vehicle veers into your lane and a collision is unavoidable, the system can help reduce your vehicle's speed to try and mitigate the force of the collision.

Paul-Henri MATHA, Volvo cars technical leader Exterior lighting
DVN Novi 2021, How to Save Lives in Nighttime Driving?

VOLVO

2019 - The E.V.A. (Equal Vehicles for All) Initiative

We have collected crash data since the 1970s to better understand what happens during a collision – regardless of size, gender, or body shape. With the E.V.A. Initiative we made our safety research easily accessible in a digital library, open for anyone to download. For everyone's safety.

LEARN MORE >

Paul-Henri MATHA, Volvo cars technical leader Exterior lighting
DVN Novi 2021, How to Save Lives in Nighttime Driving?

202x development

Speed cap
To send a strong signal about the dangers of speeding, we reduced the top speed of all our new cars to 180 km/h in 2020. We are also looking at how smart speed control and geofencing technology could automatically limit speeds near schools and hospitals in the future.

Highway pilot
With support from LiDAR sensors, the next generation of Volvo cars will be hardware-ready for autonomous drive. And over time, we will push out over-the-air software updates to provide fully autonomous highway driving.

Driver monitoring cameras
To help address intoxication and distraction in traffic, we are working on new in-car solutions. Driver monitoring cameras, together with other sensors, will allow the car to intervene when a clearly intoxicated or distracted driver risks serious injury or death.

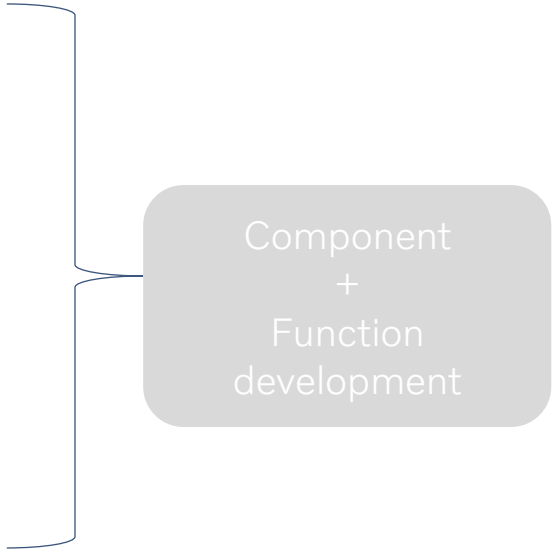
Care Key
We've recently introduced the Care Key, aimed at addressing speeding. With the Care Key, Volvo car owners can put a speed cap on the car when lending it to a younger family member or less experienced driver as a way of ensuring a safer ride.

VOLVO

What about lighting ?

We think “Safety” and offer the best to all markets to have the best light as possible :

- Automatic low beam and high beam activation
- Bending (swivelling)
- Cornering function
- Adaptive driving beam (if allowed)
- Rear position light by day to increase visibility for other road users
- Emergency brake light
- Automatic & dynamic leveling on all cars
- All new development with Yellow turn indicator



WoW

We have developed our own lighting requirement & we take into account all safety rating

VOLVO

How do we develop ?

We take into account all rating

We transform each rating in specification for headlamp suppliers

We specify the best functions that will guarantee a good level of rating

We are able to simulate each rating to evaluate our score during headlamp and car development (lucishape, VRX, Matlab, ...)

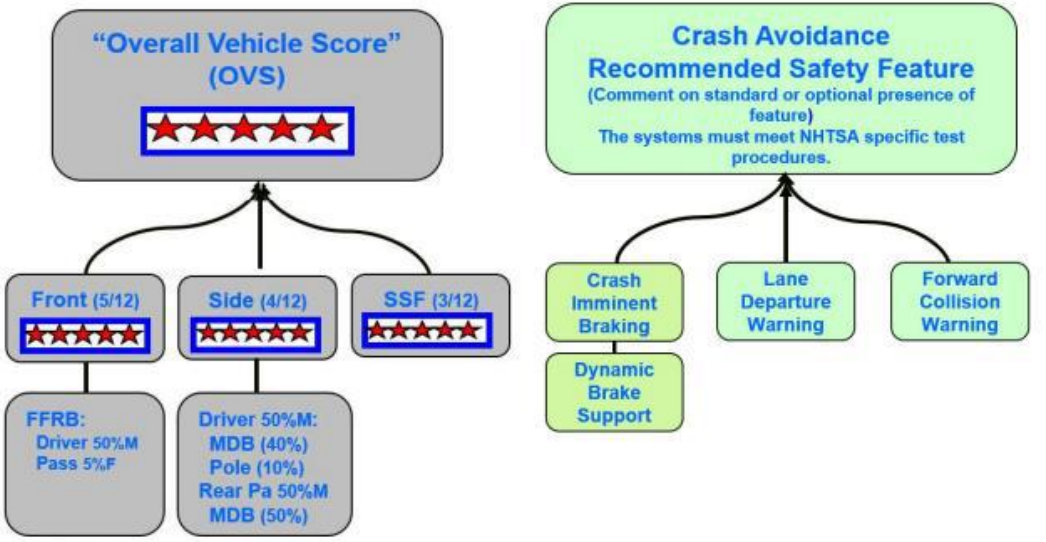
We test cars for each rating before final rating

VOLVO

Focus on US Market

Paul-Henri MATHA, Volvo cars technical leader Exterior lighting
DVN Novi 2021, How to Save Lives in Nighttime Driving?

US NCAP



Lighting :

- Low beam performance
- Semi automatic high beam
- Yellow turn indicator

IIHS

Insurance Institute for Highway Safety
Highway Loss Data Institute

VOLVO

IIHS focus

[2021 TOP SAFETY PICKs (iihs.org)]

2021 criteria

2021 TOP SAFETY PICK+

G Good ratings in the driver-side small overlap front, passenger-side small overlap front, moderate overlap front, side, roof strength and head restraint tests

Advanced or superior rating for available front crash prevention — vehicle-to-vehicle and vehicle-to-pedestrian evaluations

A G Acceptable or good headlights standard

2021 TOP SAFETY PICK

G Good ratings in the driver-side small overlap front, passenger-side small overlap front, moderate overlap front, side, roof strength and head restraint tests

Advanced or superior rating for available front crash prevention — vehicle-to-vehicle and vehicle-to-pedestrian evaluations

A G Acceptable or good headlights available

VOLVO

Volvo strategy

To be Top Safety pick + and IIHS Headlamp Good

15 cars (complete line up) in 2021

Volvo Sets New Industry Benchmark - Only Brand With Entire Lineup Achieving 2021 IIHS Top Safety Pick Plus - Volvo Car USA Newsroom (volvocars.com)

With functions below (best possible functions in the framework of FMVSS108 :

Swiveling

Automatic leveling (load compensation)

Automatic high beam activation

...

Paul-Henri MATHA, Volvo cars technical leader Exterior lighting
DVN Novi 2021, How to Save Lives in Nighttime Driving?

VOLVO

2021 TOP SAFETY PICK+

2021 Volvo V60 Recharge

MIDSIZE LUXURY CAR / 4-DOOR WAGON

Photo courtesy of Volvo Car USA

Crashworthiness	
Small overlap front: driver-side	G
Small overlap front: passenger-side	G
Moderate overlap front	G
Side	G
Roof strength	G
Head restraints & seats	G
Crash avoidance & mitigation	
Headlights	G
Front crash prevention: vehicle-to-vehicle	
Standard system	Superior
Front crash prevention: vehicle-to-pedestrian	
Standard system	Superior
Child seat anchors	
LATCH ease of use	A

Key

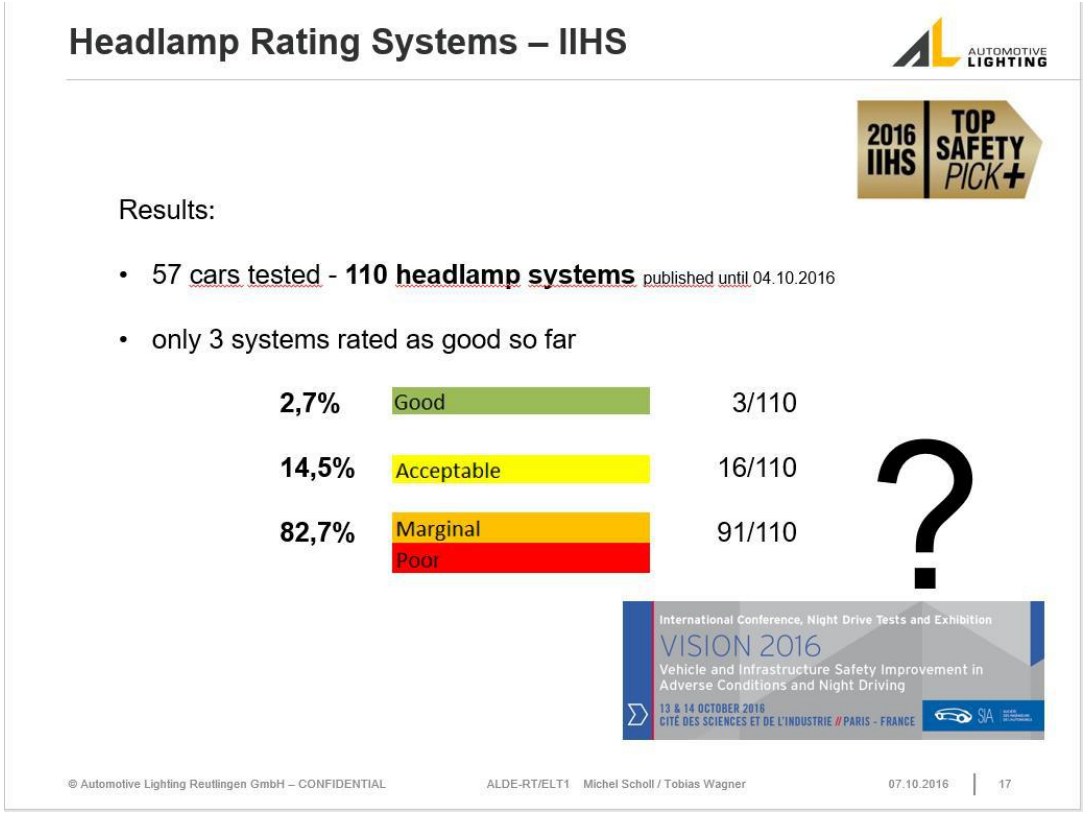
G	Good		Superior
A	Acceptable		Advanced
M	Marginal		Basic
P	Poor		

VOLVO

Huge step done in 5 years ..

Extract of AL Vision presentation in VISION 2016

Less than 3% of the cars with Headlamp rating GOOD



Paul-Henri MATHA, Volvo cars technical leader Exterior lighting
DVN Novi 2021, How to Save Lives in Nighttime Driving?

How to be IIHS Good ?

[Headlight test and rating protocol (iihs.org)]

Visibility and glare performances

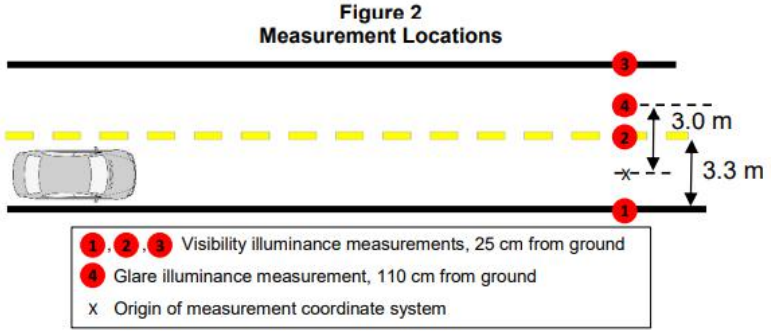


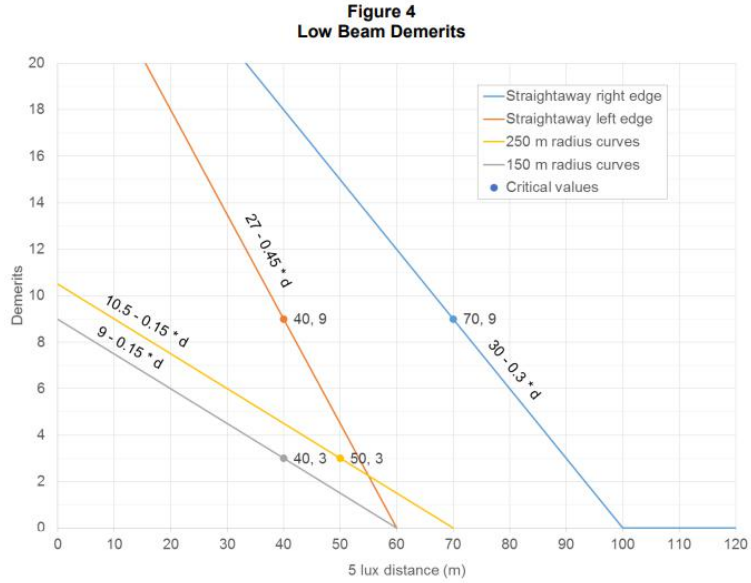
Table 5
Overall Rating Assignment

Headlight rating	Demerits
Good	0-10
Acceptable	11-20
Marginal	21-30
Poor	>30

What is the challenge ?

Where do Demerits come from ?

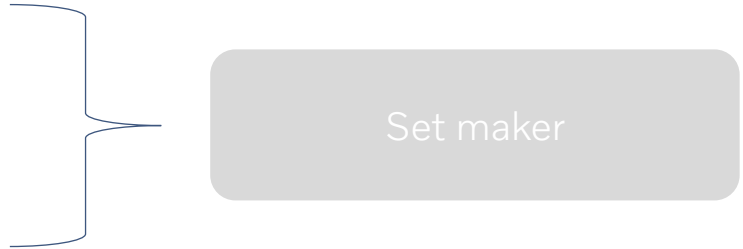
- Lighting performance (number of lumen, beam pattern , ..)



What is the challenge ?

Where do Demerits come from ?

- Lighting performance (number of lumen, beam pattern , ..)
- Glare values from optical design
- Demerits from optical design tolerance
- Lost of performance due to thermal load (flux, Cut off light position)

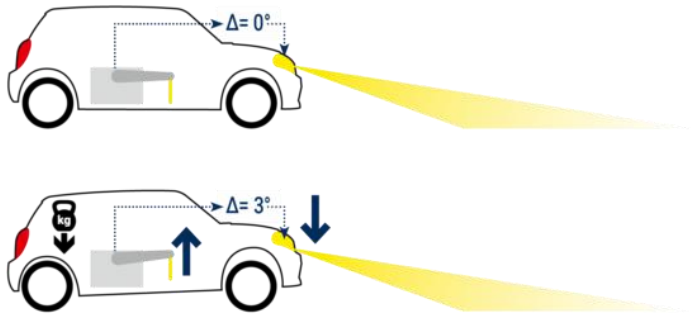


What is the challenge ?

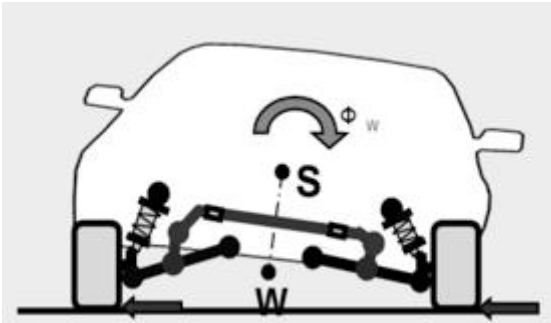
Where do Demerits come from ?

- Glare values due to bad headlamp aiming in plant / service
- Glares values due to chassis behaviour (load, rolling effect)
- Glare value due to position light
- Height of the lamp on the car

Car maker



Load impact on chassis / lamp

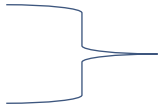


rolling impact on curvy road

What is the challenge ?

Where do Demerits come from ?

- Glare value due to road reflectivity



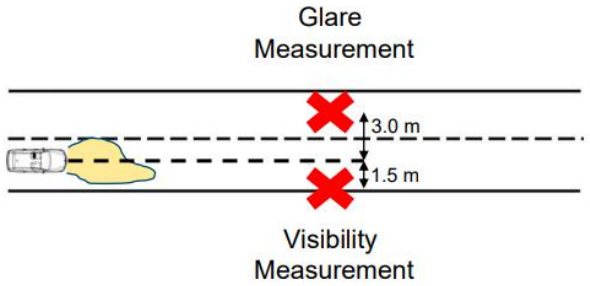
IIHS

Investigation

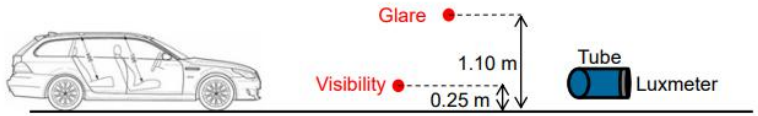
Measurement Setups
Field Test

TECHNISCHE UNIVERSITÄT DARMSTADT

- Based on IIHS Measurements (dynamic)
  - Visibility – on the right edge of the roadway
  - 10 inches from the ground → 0.25 m
  - Glare – on the left edge of the roadway
  - 3 feet, 7 inches from the ground → 1.10 m



- Field Test
  - Static measurements
  - Different Distances (4 m to 100 m)
  - Each headlight separately
  - With tubes (direct light), without tubes (direct + indirect light)

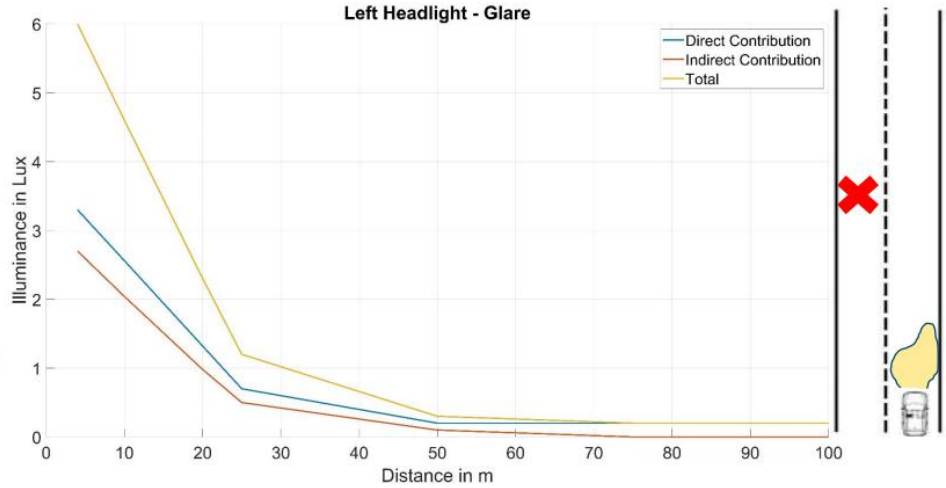


Investigation

Field Test Results
Glare – Left Headlight

TECHNISCHE UNIVERSITÄT DARMSTADT

- Illuminance measurement at height of 1.10 m
  - With tubes (direct light)
  - Without tubes (Total = direct + indirect light)
- Results
  - At shorter distances similar influence of direct and indirect light
  - At longer distances, significantly lower indirect light component
  - Illuminance exceeds glare threshold (e.g., 2 lx) at
    - 14.5 m (direct), 21.5 m (total)



Reflection from road is similar from direct glare from headlamp

VOLVO

Results – Volvo V60 – IIHS Good rating

IIHS TechData

Supplier rating – nominal aiming : 5

IIHS official test : 9,95 (V60 CC) < 10

How to explain the gap ?

HSE21021									Total demerits						
2021 Volvo V60									Without HBA	14,40					
									With HBA (if equipped)	9,95					
Headlight Information															
Adaptive Type	None														
Low Beam Type	LED-R														
High Beam Type	LED-R														
		5 lux distances													
		Left edge			Right Edge								Visibility Demerits with HBA (if equipped)		Glare demerits
HL Condition	**Curve Type**	**Avg**	**Min**	**Max**	**Avg**	**Min**	**Max**	**Glare OK?**	**Glare Average ok?**	**Glare over boundary**	**Visibility Demerits**				
High beams, adaptive	150L	65,8	65,3	66,6	75,0	74,8	75,1	No, No, No	No	2,603	0,209		0,209		n/a
High beams, adaptive	250L	82,9	82,1	83,7	90,8	90,7	91,0	No, No, No	No	7,203	0,000		0,000		n/a
High beams, adaptive	150R	78,4	77,4	79,0	72,2	71,9	72,6	No, No, No	No	7,702	0,000		0,000		n/a
High beams, adaptive	250R	92,3	91,9	92,7	85,4	84,3	86,6	No, No, No	No	7,286	0,000		0,000		n/a
High beams	Straight	141,6	140,2	143,5	152,7	151,8	154,1	No, No, No	No	26,924	0,841	0,000	0,841	0,000	n/a
Low beams, adaptive	150L	62,2	60,8	64,0	48,5	47,8	49,0	Yes, Yes, Yes	Yes	-0,221	1,722		1,148		0,000
Low beams, adaptive	250L	68,4	67,1	69,5	45,9	44,9	47,5	Yes, Yes, Yes	Yes	-0,232	3,609		2,406		0,000
Low beams, adaptive	150R	73,5	72,5	74,3	68,0	67,5	68,3	Yes, Yes, Yes	Yes	-0,431	0,000		0,000		0,000
Low beams, adaptive	250R	79,6	79,3	80,1	75,0	74,0	75,8	Yes, Yes, Yes	Yes	-0,422	0,000		0,000		0,000
Low beams	Straight	57,3	56,8	57,8	77,4	76,7	78,4	Yes, Yes, Yes	Yes	-0,190	1,233	6,781	0,822	4,521	0,000
											14,396		9,947		0,000

Paul-Henri MATHA, Volvo cars technical leader Exterior lighting
DVN Novi 2021, How to Save Lives in Nighttime Driving?

Example – Volvo V60 – IIHS Good rating

Supplier rating – nominal aiming : 5

IIHS official test : 9,95 (V60 CC) < 10

Aiming tolerances (car maker) : 4

Rolling : + 3

Optical design tolerances * : 5-10

Position light : 1

Impact from Height (0,63m to 0,83m) : 2

Reflection from road : 0-5

How to explain the gap ?

Car maker

Set maker

IIHS road characteristic need to be integrated in our simulation / prediction

* (lighting performance in different leveling position, LED/PCB/Reflector/aiming system tolerances)

Example – Volvo V60 – IIHS Good rating

Supplier rating – nominal aiming : 5

IIHS official test : 9,95 (V60 CC) < 10

Aiming tolerances (car maker) : ~ 4

Rolling : ~ 3

Optical design tolerances * : ~ 5 - 10

Position light : ~ 1

Impact from Height (0,63m to 0,83m) : ~ 2

Reflection from road : 0-5

BUT

5+4+3+5/10+1+2+0/5+ … < 10

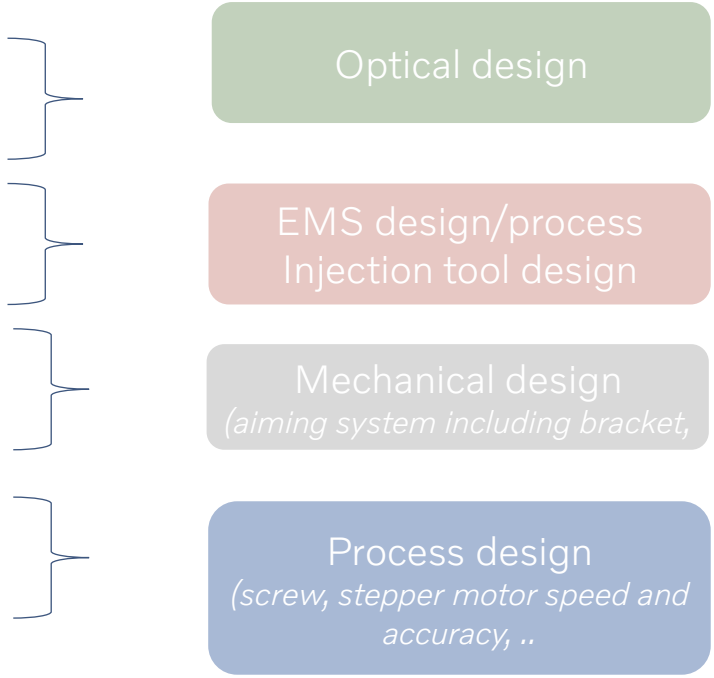
We should not cumulate all risks as a simple addition

* (lighting performance in different leveling position, LED/PCB/Reflector/aiming system tolerances)

Role of set maker

To design some Low beam / high beam module :

- Less sensitive to rolling
- Less sensitive to LED / PCB / reflector tolerances
- Less sensitive to different leveling value in the lamp itself (low interference with inner bezels…)
- Less sensitive to aiming process



VOLVO

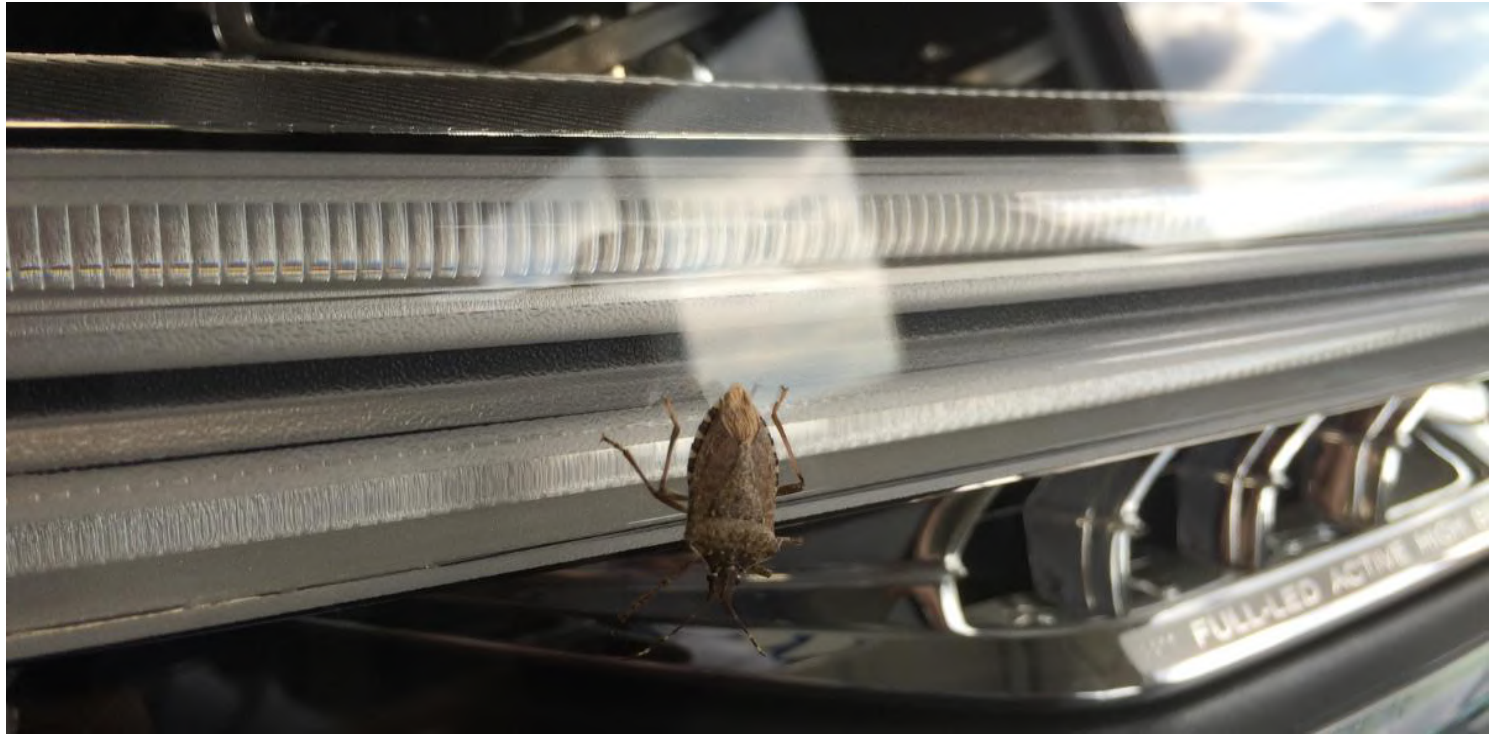
Future – BEV car

Will the life be simpler ?

- Less thermal load : ☺
- Rolling effect : should be less important (lower center of gravity due to battery : ☺
- Battery load impact : impact on chassis / suspension : 😐
- Condensation : Less thermal load ➔ more risk ➔ risk of condensation during IIHS test 😐
- Other risks : TBC

VOLVO

And as usual ..be careful with what you cannot simulate



Paul-Henri MATHA, Volvo cars technical leader Exterior lighting
DVN Novi 2021, How to Save Lives in Nighttime Driving?

Synthesis about IIHS

To be IIHS Good : Need strong support from Set makers :

- Good design with very low demerits in nominal position : 0 is clearly the target
- Good design including tolerance (supplier tolerance, mechanical leveling range, rolling) : maximum 5
- 5 demerits margin is needed for Car makers to handle all the other factors (load, thermal management, tyres, ageing, road reflectivity ..)

VOLVO

This was

Safety : how does Volvo handle exterior lighting when we speak about safety

with a focus on US and IIHS rating

Thank you