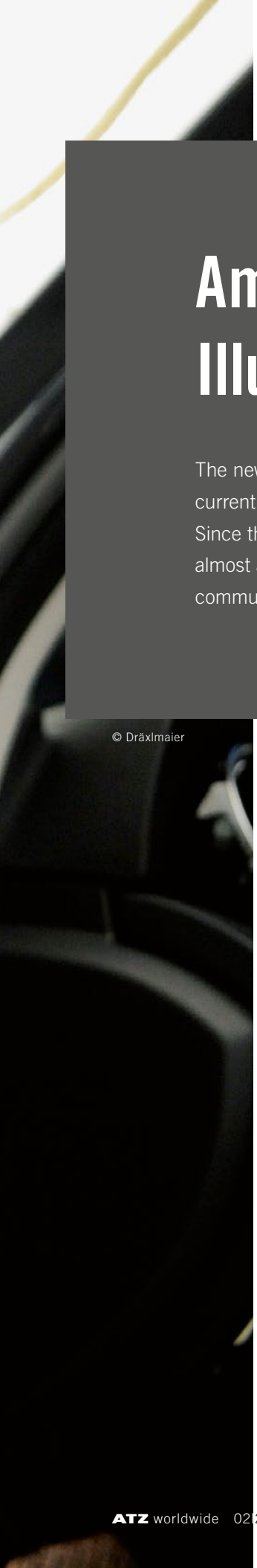
Ambient Lighting between Illumination and Communication

The newest generation of ambient lighting does not only adjust the illumination to the drivers' current mood. Thanks to its special properties, Dräxlmaier has now developed other scenarios: Since the new ambient light can be intelligently controlled, which means that you can simulate almost any type of light movement and an unlimited range of colours, it will also be able to communicate and warn about potential hazards.



A TREND – SHARING INSTEAD OF OWNING

Mobility has now become a basic requirement of our daily life and our economy. Being mobile means having a chance of getting an attractive job, being independent and being able to carry on a self-determined life for every individual. However, mobility behaviour is changing due to discussions concerning scarcity of resources and the requirements for sustainability. If you believe the forecasts, less and less people will own their own car in the future. Sharing instead of owning – this is a trend which has already partly become reality on our roads. And Uber taxi service provider is only the beginning.

INDIVIDUALISATION WITH LIGHT

The thing is if a passenger car has different users and therefore has to comply with a range of different personal wishes – how will it have to be designed? How will it be possible to offer carpool members the largest-possible individuality? One thing is sure: The interior will have to be completely rethought. This means that vehicle physiognomy will consist

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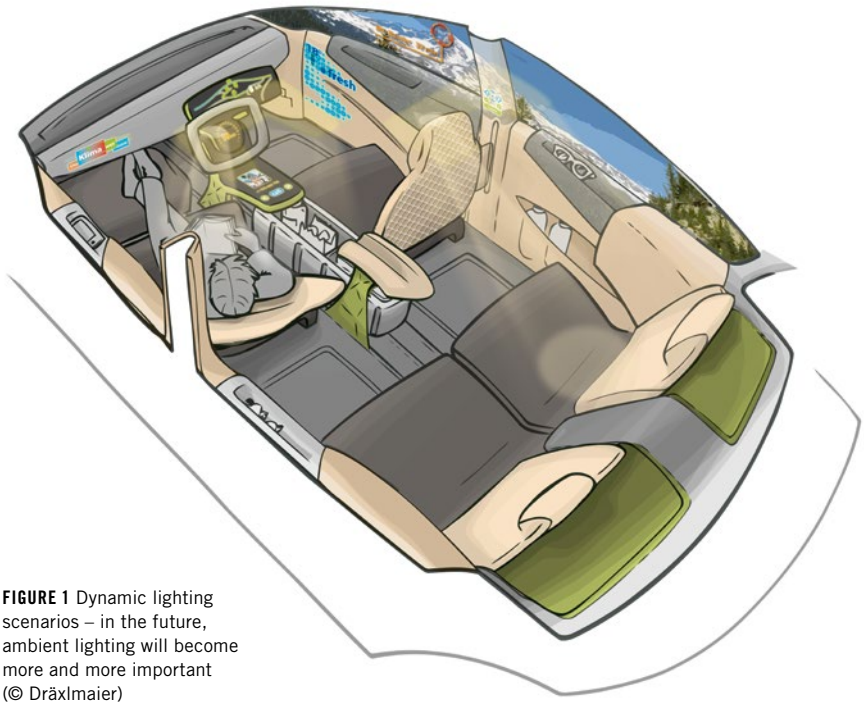


FIGURE 1 Dynamic lighting scenarios – in the future, ambient lighting will become more and more important (© Dräxlmaier)

more of individual components and modules which can be flexibly and easily replaced and configured.

Driven by the megatrends of our time, the Dräxlmaier Group started to develop highly flexible, dynamically-desirable interior solutions several years ago in order to provide answers to the questions of how the shared economy can be dealt with. If up to now ambient lighting was mainly a design element designed to make travelling for vehicle users more comfortable and, not least, to underline the premium character of a vehicle brand, light is of course also a component which is suitable for redesigning a vehicle interior again and again depending on the user's requirements.

COMMUNICATION AND WARNING MEDIUM BETWEEN VEHICLE AND HUMAN

The newest development created by Dräxlmaier now demonstrates possibilities for implementing lighting in a vehicle in the future which is far more than just aesthetics: The developers were able to implement an intelligent controllable dynamic light effect which is also visible during the day and which can display exceptional individual and therefore brand-specific scenarios in the interior, **FIGURE 1**. This means that the "Dynamic Light" is capable of simulating movements of different speed depending on the required scenario. On top of this, the luminaries can, theoretically, display an unlimited number of colours. Whether colour, intensity or dynamics – almost no limits are set for the designers of the OEM. They can predefine their individual required scenarios from the wide range of facilities and combinations which the final customer can select completely freely in the end.

The „Dynamic Light" has properties which could even enable the ambient lighting to take over communicative and safety-supporting (warning) functions in the future. Since light which is moving is recognised quicker than static light by the eye, it is particularly suitable for the display of functions and warning information during the journey. This is a way of thought which the Dräxlmaier developers can transfer to a door warning light as an example: When the door is opened, a bright light impulse which moves towards the outside of the door is triggered – starting at the interior handle. The warning light also continues out to the exterior so that even passers-by or cyclists on the road are warned when a car door is being opened, not just the vehicle occupants being warned of hazards outside. For this purpose a flat warning light is implemented to the side of the door lock area and in the outside door handle in a functional sample, **FIGURE 2**.

Customer feedback already shows that the dynamic ambient lighting already will have an exciting future. It is also

FIGURE 2 Styling meets safety – the red door warning light, which moves dynamically from the inside to the outside, as presented in the functional sample, could warn approaching passers-by or cyclists if a vehicle door is being opened (© Dräxlmaier)

even possible to avoid accidents with its support. The technology for this purpose is already in existence.

MORE RAPID SCENARIOS, MILLION-FOLD COLOUR POSSIBILITIES

FIGURE 3 shows the presentation sample used by dynamic ambient lighting which has been fitted to the door cladding of a premium vehicle model. In order to implement the required lighting sequence dynamics, the diffusing lens normally used in the series has been replaced by a newly-developed diffuser. This can be represented using a three-dimensional course and ensures that a homogenous line is created at maximum LED spacing and minimum installation space requirement if adjacent LEDs illuminate simultaneously.

Furthermore, the diffuser material selection is decisive for homogenous lighting. Different materials were investigated in order to create good and simultaneously efficient light diffusion. The best results were achieved by a translucent plastic material which contains extremely fine glass particles. These refract the incoming light rays or scatter these into the interior. Transmission is higher compared with materials containing white pigments, which means that the diffusing disc is designed more effectively.

Crash simulations show excellent results with regard to breaking resistance. It is not only the fibre-optic materials which ensure that the complete system, which consists of fibre optics, LED modules and light seals, does not break during an accident (broken fragments flying around can lead to hazardous situations). The type of fixing used for the LED modules and the fact that these can be flexibly linked together provide the design with its stability. However, breaking resistance is also dependent on how the overall system is fixed to the surrounding components.

In order to implement the dynamic lighting sequence and freely selectable rapid scenarios both in terms of time and colour in the vehicle interior, a suitable solution for the intelligent control of a considerable number of RGB LEDs [1] had to be developed by the electronics department. The project was based on three premises: The development should not only allow more rapid dynamic scenarios, but should also be more efficient with regard to installation space and costs.

FIGURE 3 Colour play – demonstration of dynamic lighting sequence with million-fold colour possibilities using the door panel presentation sample (© Dräxlmaier)

The result of this is a hardware and software unit specially developed for the purpose which ensures that rapid control of the LEDs suitable for the automotive sector is possible which fulfils the premises. The control of colour and brightness for the LED modules over very short time intervals is decisive for the implementation of dynamic lighting sequences. Since slow scenarios should also appear to be "judder-free" to the human eye, the maximum cycle time for updating the colour and brightness values was analysed and defined on a test bench.

Every scenario is defined using mathematical functions in order to specify the control values for each point in time at very fine staging. The developers at Dräxlmaier therefore purposefully decided to use an algorithm and a signal description which automatically calculates the values when programming so that a message catalogue was able to be created. The values saved in this were then implemented in each microcontroller's software. This means that every single LED light source knows its precise

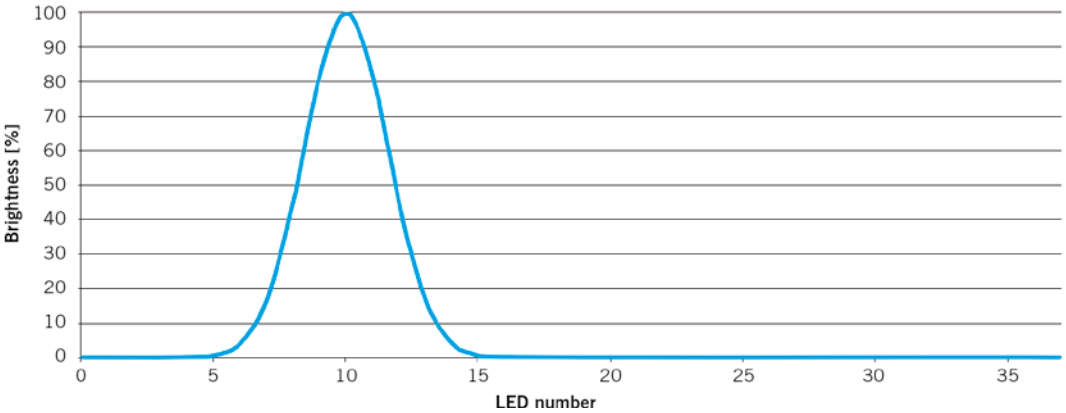


FIGURE 4 Bright as day or gently dimmed – percentage brightness distribution of individual LEDs during a light point sequence at the moment of the peak for LED No. 10 (© Dräxlmaier)

colour and brightness value at every point in time, **FIGURE 4**.

COST REDUCTION IN ELECTRONICS CONTROL

The price also has to be right in order to make a product attractive to the market. For this reason special consideration was given to optimisation of costs for the electronics control system. Work was carried out in close cooperation with electronics and test experts in addition to semiconductor manufacturers. The starting point of the considerations was that every individual LED was managed using a separate microcontroller. At the end, a total of four concepts were available:

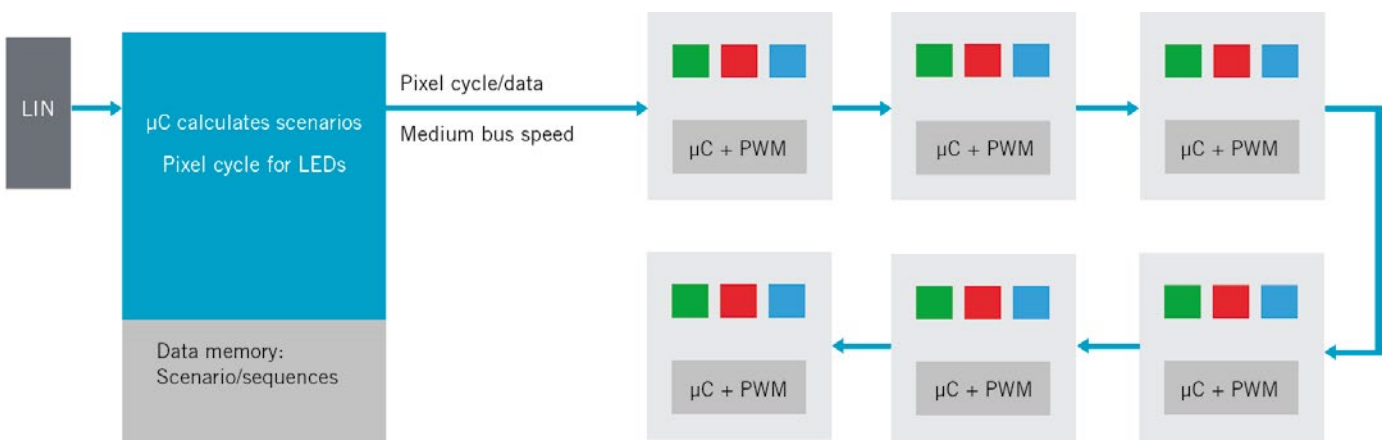
- LEDs with integrated Pulse Width Modulation (PWM) drivers
- LEDs with external PWM drivers
- LEDs with integrated microcontrollers
- LEDs with external microcontrollers.

All four concepts, **FIGURE 5**, were checked and analysed. First of all the LEDs with integrated PWM drivers were investigated more closely. Here, a simple PWM driver module was integrated in the LED. However, an external microcontroller with high computing power and high memory requirement has to calculate the colour and brightness values for each LED depending on the selected scenario. Cost benefits are only provided with extremely long chains since short sections also require a more expensive master controller. Disadvantages are caused by the extremely high bus load and bus speed which are no longer achievable using a LIN bus. Furthermore, these LEDs are currently only available on the consumer market and not yet qualified to the Automotive Electronics Council (AECQ) standard.

In second concept, the LEDs with external PWM drivers are based on the same principle, except that the PWM driver is not fitted in the LED itself, but is localised externally. This means that an LED certified for the automotive sector and an external PWM driver module can be selected. However, the disadvantages with regard to high bus loading, data rate and expensive master still remain.

In the third case of the LEDs with integrated microcontroller, **FIGURE 5**, each LED contains an intelligent controller. This of course has to be very small to fit inside the LED. However, since the memory and computer requirements remain low it can only calculate restricted colours and implementing the colour accuracy of the current LED modules could cause problems. A master which calculates the scenarios would still be necessary even if it required less computer performance in contrast to the first two variations. Several LED manufacturers are currently developing such intelligent light emitting diodes; however these are not yet available on the market. It is probable that the first products will still not be available even within the next three or four years. The advantage would

FIGURE 5 One of four variations – LED solution with integrated microcontroller (µC) (© Dräxlmaier)



be a lower price, a smaller PCB and medium bus loading.

This just leaves to variation number four – the principle of LEDs with an external microcontrollers. In this case with multiplex operation, the controller memory and computer requirements can be designed so that they can take on both calculations of the colours and also of the scenarios. A simple trigger signal from the master would be sufficient to start the required scenario. Each slave module could currently manage up to four LEDs simultaneously using the multiplex process. The number of slaves which can be controlled by a master is freely scalable. In this case, the length of the overall chain would only be limited by the electrical properties – to put it precisely, the communication signal looping – and the electromagnetic compatibility (EMC) requirements on interference emissions and interference resistance.

Further advantages of this variation number four are that components certified for the automotive sector are already available on the market that a low bus speed is sufficient and that high colour accuracy can be achieved. Apart from this, costs can be considerably reduced in contrast to individual LED modules, even if this is not quite as much as for the concept with LEDs with their own integrated microcontroller.

MATURITY TESTS AND FUTURE VISIONS

Dynamic ambient lighting is a new interior feature in premium automobile-making. Dräxlmaier shows that the required technology is already realisable with setting up of the presentation sample. In order to push the developments still further, the company will be subjecting the four variations to different tests. For example, tests will be made as to how far the technology can fulfil the requirements on series production, for example with regard to its EMC. On top of this, the necessary computer performance and memory requirement for a new cost-optimised microcontroller needs to be defined in cooperation with a chip manufacturer.

In the optics sector the task is to draw up further possibilities for further increasing the spacing between the LEDs and decreasing the installation space required. We can all be curious about what role dynamic light will be playing in the vehicle of the future. Interest in the new technology is definitely high – the customers are "excited about the effects". After the presentation sample was presented, there have been several OEM enquiries about dynamic lighting sequences.

The fact is: Dynamic ambient lighting possesses high flexibility, which would enable automobile manufacturers to react quickly to new trends and developments and to meet individual customer requirements. In addition to welcome and goodbye scenarios in which the light points move towards the cockpit when someone gets into the vehicle, or towards the door handle when the wheel drive is turned off, the battery charging state would also be able to be presented with the aid of a dynamic lighting sequence. Contours could also be emphasised so that the driver can orientate himself within the vehicle more easily in the dark. The new generation of ambient lighting will certainly remain a popular talking point in the future.

REFERENCE

[1] Dräxlmaier: For new accents in the passenger compartment LIN-RGB technology. Online: www.draexlmaier.com/produkte/interieur/ambiente-beleuchtung/, 23 November 2016