

Engineering Consultancies

Published 24 April 2018



Published by Driving Vision News · 3 rue Daumier · 75016 Paris · France
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Executive summary

The cyclical nature of the automotive industry, like that of its aeronautical counterpart, makes advantages to sourcing skillful engineering from outside consulting firms during the expansion phase of the cycle. Labour cost savings and comfortable flexibility in adjusting to economic conditions are highly appreciated, and it is also an excellent way to source specific skills, tools, methods, and testing equipment required for one-off projects.

In the past, engineering suppliers could only increase and diversify their customer base to avoid burdensome staff adjustments in downturns. That's never easy, considering geographical constraints; proximity to the customer is highly prized. As the automotive, energy, railroad, and aerospace industries' activity cycles have usually not been dependably time-correlated, engineering consulting firms have been striving to simultaneously service at least two of these industries, at home and abroad, to stabilise their revenue stream. In this report we present four engineering companies—AKKA, IAV, SEGULA, and EDAG,—who have succeeded along that strategic line and are active in vehicle lighting. They have been selected on the base of their size, their global footprint, their shareholders' stability, and their track record.

Currently there's a great deal of public discussion about looming changes in the automotive industry with the arrival of electric vehicles, autonomous driving, and vehicle communication to other vehicles, drivers, road users, and infrastructure. The automotive industry is now facing a major disruption: significant changes in consumer behavior—namely, a much greater focus on the in-vehicle experience rather than the driving experience—will almost certainly disrupt the status quo. Specifically, automakers and tier-1 suppliers who want to survive and thrive will need to transform their products, capabilities, and organisational structures. These changes present both great risk and great opportunity. Automakers and T1s are busily hiring for new skills to cope with electrification, autonomous driving, digitalisation, and the far-reaching rollout of e-mobility. New resources are scarce, and so some skills and tasks must be outsourced to suppliers and engineering consultant companies.

The engineering companies presented in this report display the skills and capacities to take over some of the automakers' and T1s' lighting design and development tasks. These engineering companies can also bring added value in new areas like creating or improving in-vehicle experience, slashing development times by dint of virtual reality and artificial intelligence, and tackling challenges posed by future mobility modes. The four engineering consultancy companies are introduced in this report with their profiles, expertise, and their newest achievements.

About the Authors

Salomon Berner



Salomon Berner is a senior Management Consultant and Coach based in Paris. He first graduated as a polytechnic and aeronautical engineer, and then successfully took over managing responsibilities in small and medium sized industrial and service companies in France and abroad. His business experience was very helpful in setting up the Driving Vision News business model and website.

Hector Fratty



Hector Fratty's entire career has been in automotive lighting. From 1995 to 2006, he was Valeo Lighting's chief of R&D. His level of expertise in lighting gained him recognition as one of Valeo's five Master Experts. In 2008, he initiated the launch of his own company, Driving Vision News, which has become the automotive lighting and driver assistance industry's journal of record dedicated to keeping the community informed and communicating about the latest progress and developments.

Daniel Stern



Daniel Stern, DVN's General Editor based in Vancouver, BC, Canada and Seattle, Washington, USA, is one of the 5 greatest lighting experts in North America. He is an appointed member of the US transportation Research Board Visibility Committee, which steers North America research on matters related to automotive conspicuity, lighting performance and regulation. He attends and participates in the world's automotive symposia, and is the author of this report.

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Offices	France & Germany
2017 turnover (millions €)	1,330
Employee count	16,300
Country count (operations)	29
Office count worldwide	70

Founded in 1984, AKKA has become a globally operating European leader in engineering consulting and R&D services in the mobility sector. Supported by 16,300 employees distributed across 29 countries, the group recorded revenue of €1.3bn in 2017. AKKA's clients include most of the major European industrial groups in the automotive, aerospace, and rail industries as well as in the life sciences, energy, services, telecoms and defence sectors: Airbus Group, Alstom, Audi, BMW, Daimler, GlaxoSmithKline, Renault, Škoda, Safran, Thales, Volkswagen, Volvo and many more.

AKKA provide technological solutions for clients to improve their innovation processes, add value, and boost productivity and efficiency from the design phase right through to the volume production phase of new products or processes. AKKA's unique geographical positioning around their Franco-German axis, their ability to deliver cross-sector and transnational solutions, and their in-depth expertise in the ascendent technologies—including AI, ADAS, IoT, big data, robotics, embedded computing, machine learning—allow them to assist their clients with globalization and digitalization. The automotive sector represents 43% of AKKA's activities and revenue and if added to aerospace and rail industries mobility reaches over 70% of AKKA revenues.

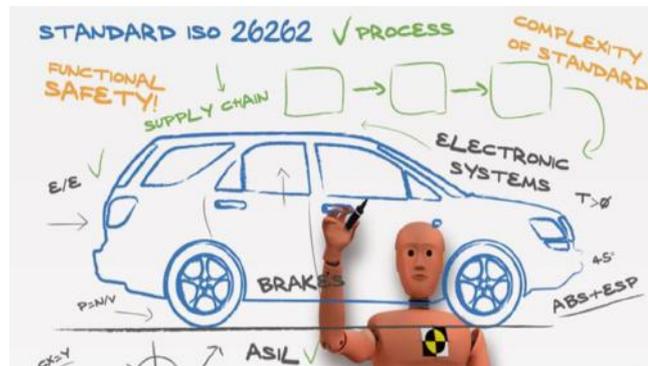


Global Footprint Strategy

Globalization is one challenge AKKA are addressing for their clients. AKKA's footprint covers 29 countries in 70 locations. Relying on a strong Franco-German dual-bases foundation representing 78% of AKKA turnover, they can support their customers' own footprints and location strategies worldwide and onsite with their specialist skills and capacities.

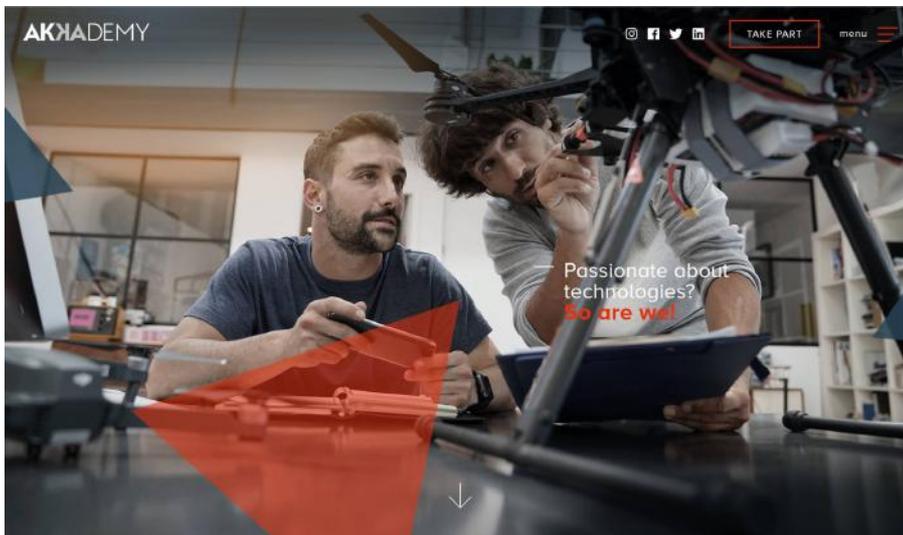
Turnkey Project Management

From design and pre-development to full testing, AKKA cover the whole range of expertise to manage full turnkey projects for parts and whole vehicles—turning a combustion-powered car into an electric or hybrid car, for example. AKKA development processes comply with the process-oriented automotive SPICE functional safety levels and ISO 26262.



The AKKADEMY

In order to provide clients with the best possible engineering talent, AKKA has created the AKKADEMY in Geneva, Switzerland. The AKKADEMY's Graduate Engineering Program is designed to attract fresh or recent EU engineering graduates from premier universities and engineering schools by providing them with a balanced mix of class-room education and on-the-job training. By investing in their future from the first day they join the AKKADEMY, AKKA creates a leadership talent pipeline and consultants who master both innovation and business consulting techniques along with the latest technologies clients need.



Prepping for Tomorrow's Industry

The digital revolution and the arrival of new players accelerate technological cycles and transform industrial ecosystems across all sectors. New technologies such as artificial intelligence, big data, and virtual reality are disrupting industrial processes and product creation cycles, requiring agility and speed applied to innovation and production. This is particularly true in the mobility sector, where the transition from product to service offering is driving industrial players to rework their business models. The industry of tomorrow, as foreseen today, will no longer simply be simply a production system. Rather, it will be a value-creation chain, fully integrated into an interconnected system and built round new services and user behaviours.

Design, Development, and Testing Services

Core Disciplines and Expertise

As already stated, AKKA covers the total spectrum of expertises necessary to manage full turnkey projects : Research and development, Concept and program management, Sketch, styling, and design, Modelmaking, show cars, and prototypes, Calculation and simulation, Design engineering, Powertrain calibration, Software and hardware development, Testing and validation, Benchmarking and cost engineering, Test equipment (insourced and outsourced) , Manufacturing engineering, Launch management, pre-production, mass production, Tool design and construction, Project, quality, and supplier management, Process management, methods, tools, documentation, Logistics and sales support, After-sales management consulting for the mobility sector.

Development Workshop and Prototype Production

11,000 m² of special workshop area allow AKKA to turn their customers' development and integration projects into movable and accessible reality. In these workshops AKKA produce prototype parts, run small-series production, and apply measuring and testing technology to test platforms. They also customise existing vehicle chassis, user interfaces, and interiors for motor shows and other exhibitions.

Test Facilities and Execution

AKKA's range of services is effectively complemented by their own facilities, which are certified to the industry standards: Full scale EMC test laboratories and measuring centres in Ingolstadt and Stuttgart, an electrical/electronic test centre, a test track in Papenburg, engine and transmission endurance test rigs for conventional and alternative drives, eDrive systems test rigs, and a hardware-in-loop test centre.



Track in Papenburg



EMC test laboratories and measuring centres in Ingolstadt & Stuttgart

Whole-Vehicle & Individual Functional Domains

Whole-Vehicle

For the smooth flow of a whole-vehicle project such as derivative development or integration, AKKA plan and manage all development activities centrally. They act as a general contractor, coördinating suppliers and service providers. They offer:

- Project planning from the feasibility study to the structuring of the project, always considering the interdependency of all components in the vehicle;
- Execution of project volumes from development to the start of production and beyond;
- Complex-project management, adapting their well-tested methods, tools, and processes to individual customer systems;

- Reporting and documentation to create the fundamentals for prompt decision-making, thus translating to more leeway and flexibility in the project.

Body in White, Chassis, Interior, Exterior

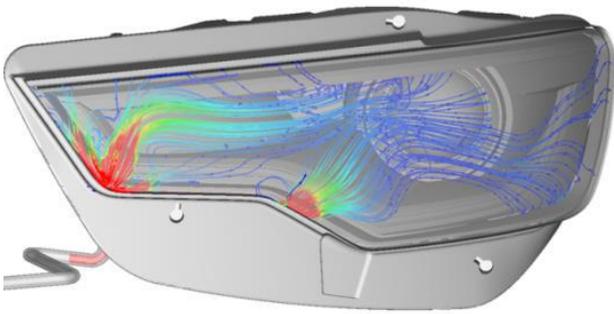
AKKA apply their formidable experience in materials application and in lightweight construction, tribology, surface technologies, structure/electronics integration, and minimisation of NVH (noise, vibration, harshness).

Electric Components & Electronics, Car IT

AKKA customers benefit from the company's expertise in fields such as operating strategies, energy management, HV architecture, and batteries for both electrification and the progressive interconnectivity of vehicles. This expertise is applied to projects including:

- Connected car
- Light and sight
- Driver assistance systems, advanced driver assistance systems
- Telematics, infotainment, navigation, vehicle system
- Architecture and wiring harness
- Hardware and software development, IT security
- Diagnostics (on-board, off-board) and maintenance services

Overview of Lighting Engineering skills



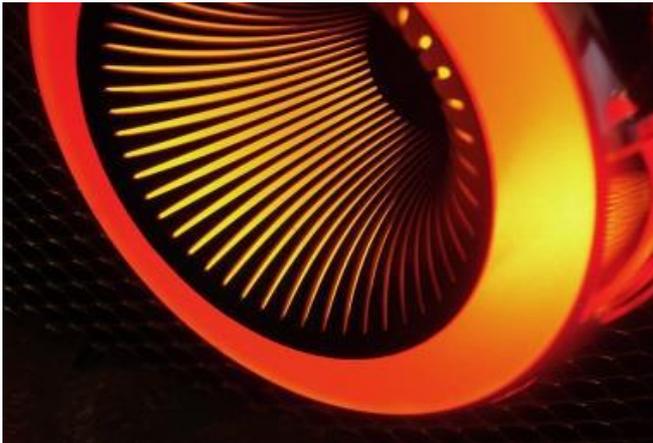
AKKA's lighting expertise is centred in Ingoldstadt, Munich, and Stuttgart in Germany; Mlada Boleslav in Czechia; and Udine, Italy. In addition, prototyping of light samples, light guides, and reflectors is performed in Weissach and Munich, Germany, and in Plzen, Czechia. Core competence includes concept design, mechanical development, serial design, optical simulation, defogging and thermal simulation in early concept phases, and validation through environmental and EMV/EMC testing.

Optical and defogging simulations are performed indoors through partnerships with subcontractors.

Here are examples of AKKA's exterior and interior lighting development work:



Software simulation tools include Synopsys' LucidShape, Optis' SPEOS, Star-CCM+, Catia V5, and ANSA. Functional safety impact analysis can be performed, with hazard analysis and risk assessment, hardware and software verification and validation, and analysis of failure modes and diagnostics.



Interior and exterior lamps are prototyped as clay models, data control models, mockups, show cars and ergonomic models in AKKA's specialised workshop in Plzen, Czechia.

Partnerships for New Technology Application

On 6th March 2018 Chinese electric vehicle company Iconiq Motors announced their collaboration with Microsoft and AKKA Technologies to develop their first Autonomous Vehicle, called the L5, by 2020. Iconiq Motors celebrated the European debut of their Model Seven at the Geneva Motor Show, describing it as the world's first all-electric passenger-focused MPV with a focus on connectivity and passenger convenience. Iconiq President Alan Wu described "taking a leap forward to announce the next level of partnership with Microsoft and AKKA to make driverless technology a reality".



The three partners' goal is to successfully launch Iconiq's fully autonomous (Level 5) vehicle, the L5, at Expo 2020 in Dubai. This is to be followed by mass production of the L5 at the end of 2022.

Ahead of its launch, the L5 will undergo testing in China and in Abu Dhabi's Masdar smart city, providing important preliminary data and securing early-stage participation in one of the world's most ambitious sustainability-focused urban projects.

Interview with



Stephane Bollon-

*Group Chief Commercial & Strategy Officer
Member of AKKA Executive Board*



and Sylvain Barthelemy,

AKKA, Senior Vice President Automotive, global leader

DVN : Can you briefly present yourself?

Answer Stephane BOLLON: I'm member of AKKA Executive Board, Group Chief Commercial & Strategy Officer.

Answer Sylvain BARTHELEMY : I am the Senior Vice President Automotive for AKKA. I have been for more than 20 years in the automotive industry in particular at major Tier one suppliers and specifically I spent 10 years within the Lighting Business.

DVN : What specific competitive advantages does your company usually rely on when approaching new automotive projects or customers?

AKKA: As a consulting and engineering Group and European leader in the mobility segment, AKKA Technologies operates in 20 countries through 21 centers of excellence. Our goal is to offer you the best in service and expertise. Driven by innovation and a passion for technologies, AKKA Technologies combines an entrepreneurial spirit with a visionary strategy. Our strength is that we understand the challenges our clients face. We assist them throughout the product development process, no matter how complex their visions are. Our remarkable positioning with our in-house research center AKKA Research and our unique Franco-German axis qualifies us to be a leader on the global market.

DVN : Do you think your company experience in other industries, for instance aeronautical, software, electronic hardware, banking, digital networks or communication, could represent a valuable asset for automotive customers ? In what sense ?

AKKA : AKKA combines new trends, technologies and applications from a diverse range of sectors such as aerospace, automotive and railway, demonstrating a broad range of skills and the successful intercultural collaboration within the Group. It offers our clients various approaches to topics such as design, new systems concepts, social and environmental features, infotainment and smart connectivity.

DVN : Simulation, test, and measurement tools are expensive investments. Which can you offer to your automotive customers?

AKKA : We offer a wide-ranging portfolio of validation services to our customers in the passenger car and commercial vehicle division.

Due to our state-of-the-art facilities, our products are qualified for diverse environmental conditions which enable us to ensure economical and sustainable product development.

- Commissioning and Environment simulation : Commissioning and E/E-Testing, Climate testing, Corrosion testing in staged atmospheres, Salt spray chamber and salt spray mist testing, Corrosion change testing.
- Full vehicle-Testing: Full vehicle integration, NVH-Testing, Homologation, Driving dynamic und driver assistance systems, Passive safety.
- Test facilities: EMC facilities (Stuttgart, Ingolstadt, Shanghai), Automotive Testing Ground in Papenburg, Environmental Testing facility in Stuttgart

**DVN : Can you describe one of your latest achievements which you are particularly proud of :
AKKA :**

- AKKA Automotive has been awarded a major contract for the comprehensive development of a new 4x4 off-road vehicle by British chemicals and energy giant INEOS.
- AKKA Group opened a new test centre for electromagnetic compatibility tests in Ingolstadt (Bavaria) with a size of 1,600 square metres.
- AKKA partnered up with ICONIQ Motors and Microsoft to develop a full Level 5 autonomous car.

DVN : How do you see automotive lighting in the next decade ?

AKKA : The interior light segment of the vehicle will rather serve the well-being of the passengers, since the passenger cell will develop fundamentally from the current form towards a living-/office room in the near future.

In the Exterior we see the development from the pure illumination of the road in the direction of communication with the environment, like other vehicles, pedestrians, etc.



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Headquarters:	Germany
2016 turnover (millions €)	734
Employee count	6,500
Country count	13
Office count worldwide	32

A Strong Engineering Partner for Digitalisation

Everybody wants to drive a car that is safe, comfortable, and ecologically sustainable. IAV have made many substantial contributions in those fields over the past 30 years. They support nearly all carmakers and their suppliers with a wide array of expertise spanning combustion engines, non-combustion drive systems, exterior bodies, lighting technologies, electromobility, electronics and software projects involving driver assistance, lightweight construction, and safety. As a major partner in the OTS 1.0 research project in Germany, IAV are involved in all aspects of fully-automated driving in real city traffic including vehicle, infrastructure, traffic planning and management, and legal framework.

IAV engineers provide support at every stage of the development process, beginning with the initial idea and continuing with simulations, prototyping, and bench tests. IAV also support everything from road tests to the start of production. They have their own advanced development operations, conduct primary research, and provide solutions with a methodical interdisciplinary approach. Cutting-edge testing technology and workplaces and realistic testing environments complement their broad foundation for advancing projects with experience and passion. Close contact is maintained with universities and research institutes.

Digitisation is the catalyst to IAV integrated approach to their new vehicle Product Development Process (PDP). IAV have reorganised their 2 divisions, powertrain and vehicle development, to bring their engineering to a completely new level. All members of their staff are busy reorienting their working methods, their tools and their skills towards tomorrow's digital engineering: use digital models as the basis for testing and validation. IAV deliver not only ideas and solutions, they deliver added value and open new options for their customers.

Employees and Locations:

IAV work from many sites throughout Germany, Europe, Asia and the Americas. Around the world IAV have over 6,500 employees to support their customers in global and local projects. The growing number of turnkey projects and the benefits of handling contracts across borders have ensured IAV's status as a centre of engineering excellence, and the company have built a global footprint covering 32 locations in 13 countries:

Germany: Development centres in Berlin, Chemnitz/Stollberg and Gifhorn. Further locations in Dresden, Friedrichshafen, Ingolstadt, Kassel, Ludwigsburg, Munich, Neckarsulm, Neustadt, Nuremberg, Regensburg, Rostock, Ruesselsheim, Sindelfingen, and Weissac

Europe: France, Italy, UK, Sweden, and Russia

Asia: China, Japan, India, and Korea

America: USA and Mexico

Shareholders

Volkswagen: 50%

Continental: 20%

Schaeffler: 10%

Freudenberg: 10%

Sabic: 10%

Customers

Virtually all automobile manufacturers and their system suppliers are IAV clients: Audi, Bentley, BMW, Bosch, Bugati, Continental, Daimler, Delphi, Faurecia, FAW-VW, FCA, Ford, Freudenberg, GM, Honda, Liebherr, Man, Opel, Porsche, PSA, Renault, SAIC-VW, Scania, Schaeffler, SEAT, Škoda, Smart, Toyota, VW, Volvo, and ZF.

Methods, Tools, Test Facilities

IAV devise their own methods and tools for efficient development processes, always striving to improve them to handle their clients' projects quickly and efficiently while lowering costs and providing constantly high quality.

Testing for efficiency and safety

IAV invest heavily in high-quality, state-of-the-art measuring equipment at every level of testing. For instance, they have their own 130-metre crash facility—an exceptional asset at an independent development provider. IAV's test facilities satisfy the same high quality standards automobile manufacturers place on their own facilities.

New Climate Roller Dynamometer for Altitude Testing

IAV's new high-altitude climate roller dynamometer is one of the world's most modern and versatile facilities of its kind, and gives the company a key unique selling point. It facilitates reproducible results even under extreme conditions, reduces the need for test drives in high mountains, and brings higher reliability in the development process so IAV customers benefit from shorter development cycles and lower development and validation costs.

Exterior and Interior Lighting

IAV's key competencies in vehicle lighting include:

- Optical simulation, thermal management, electronics, LEDs;
- Development support with complete solutions, electronic & optical conception and validation;
- CAD conception and validation, industrialisation support;
- Testing for light homogeneity, EMC, environmental factors, and advanced front lighting system tests

Light and Driver Assistance hall

- 40m long × 16m wide × 8m high
- Light level in the darkened hall is below detection limits
- Independent of environmental influences
- Daylight simulation: 5,000 lux
- Solar altitude simulation: 50,000 lux
- Screen for measurements at variable distance

Measurements carried out in the hall include:

- Pre-selection type approval
- Photometry of headlamps and signal lamps (intensity, illuminance)
- Near- and far-field light evaluation
- Glare and recognisability
- Quality control & styling
- Homogeneity & uniformity
- Evaluation of interior and ambient lighting

The stray light level in IAV's light and driver assistance hall is low enough that the light distribution can be measured accurately even in the critical region above the cutoff. IAV have developed their own measurement method very useful for innovative lighting systems with dynamic lighting functions such as high resolution ADB light distributions.



Tools Developed In-House

Evaluation of a dynamic headlamp system with dynamic glare-free high beam is performed through a fast, two-step process: Luminance measurements in the hall followed by the transformation of these measurements into light intensity distribution files (.ies files) which can be visualised with a light simulation tool like LucidShape. Multiple scene files are then "played" and automatically evaluated. IAV claim up to 30% faster validation of dynamic light distribution with their testing method. Additionally, the tool can be adapted to different measurement geometries (room size, camera position, etc).

IAV have also developed a Computer Aided Glare Evaluation tool (CAGE) able to assess and evaluate the direct as well as indirect glare ratio during a passing situation. This can be used, for instance, to assess the influence of weather conditions and road wetness, and geometrical aspects like the headlamp mounting position. Furthermore, disability glare can be calculated using CIE's scientifically substantiated equations. As the IIHS headlamp evaluations becomes more and more important, IAV have developed their own tool to

analyse all acquired data of an IIHS measurement and generate a measurement report automatically. An add-on for the IIHS evaluation tool can simulate IIHS Measurements using .ies files of light simulations and goniophotometer measurements. Additionally, a vehicle model is implemented to analyse the influence of its dynamics on visibility and glare.



Benedikt Kleinert, Team Manager, Light & Vision Projects

IAV's partly automated test bench can accurately position headlamps and other lighting devices in realistic mounting position for the assessment and benchmarking of dynamic lighting systems under reproducible measurement conditions.

Collaboration with Universities and Research Institutes

To maintain their leadership in cutting-edge vehicle lighting technologies, IAV maintain close contacts with universities and research institutes including:

- TU Berlin, Fakultät IV: Fachgebiet Lichttechnik, Prof. Dr.-Ing. Stephan Völker
- Ernst-Abbe-Hochschule Jena: Fachgebiet Augenoptik, Optometrie, Dr. rer. nat. Carola Wicher
- Technische Hochschule Nürnberg: Elektrotechnik, Feinwerktechnik, Informationstechnik, Prof. Dr.-Ing. Alexander von Hoffmann
- TU Darmstadt: Fachgebiet Lichttechnik, Prof. Dr.-Ing. Tran Quoc Khanh
- TU Karlsruhe, Lichttechnisches Institute: Prof. Dr. rer. nat. Cornelius Neumann

Here are a few concrete illustrations of IAV's approach to the development process, particularly in exterior and interior lighting as well as in the Mobility sector.

Development of Advanced Low beam to reduce reflection glare on wet roads

At night when the road is wet, drivers are dazzled by reflected light from other vehicles' lamps. New high-resolution headlamp systems make it possible to control the light in a precise way and drastically reduce wet-road glare. IAV use their own tools for the development. The road is wet and the windshield is covered with rain drops. When an oncoming vehicle approaches, the driver is dazzled, and crashes can result. Modern headlight systems have up to three megapixels of light, which can be individually controlled to guarantee optimal visibility on wet roads without glaring other drivers.

Targeted control of light intensity

In developing these modern headlamp systems, IAV use tools of their own making. First a parametric model is created for the design. It calculates, from the location and height of the headlights, the glare point for an oncoming vehicle. A computer-aided glare evaluation environment provides virtual security in the early concept phase and during the development of the first prototypes. It uses specifications such as the dimensions of the headlight system, the road width and condition (wet or dry), the distance between the vehicles, and the oncoming driver eye placement and calculates the glare potential implied by these data. This result is then used to develop pixel

masking strategies. Different forms of masking can be introduced—trapezoids, rectangles, or triangles, for example.

Successful use in series projects

These self-developed tools have been successfully used in series projects for two years, reducing the number of test drives significantly, thus supporting the current trend of prototype-free development.

Context-based Ambient Lighting

The interior lighting of the future is personalised, context-based, and able to learn. Interior lighting has a strong influence on our wellbeing and mood. Light exerts a powerful effect on the body's metabolism and influence moods such as overstrain or performance, or can interfere with it. Interior lighting is a key step in the vehicle development phase as it is not just a differentiator for the driver but also an important safety feature. The driver should never be blinded or distracted. In addition, lighting in the vehicle should also take into account the current weather and lighting conditions in the surrounding area.

Individual light zones for every passenger

When considering autonomous driving it is important to provide the passengers with suitable ambience, optimally one that is individualised and personalised. At the 2017 Consumer Electronics Show (CES) in Las Vegas, IAV launched their concept of context-based ambient lighting and are working on new functions showed in a test vehicle at 2018's CES.

With autonomous driving, the demands on the interior lighting continue to increase as the car becomes a living space and a mobile office. That calls for types of lighting not previously associated with car interiors. Through an appropriate spatial organisation of the lighting system, for example, two occupants in the rear can get their own light zones. Ideally the vehicle should recognise each person by his smartphone ID and find in the cloud their basic data and previous experience including preferred colour and intensity. Cultural differences can be automatically taken into account: in the West, red means danger; in China it means luck.

Sensors monitor passengers

People are not always in the same state. They might use a car ride to relax, or they might get tired while on a purposeful journey. Context-based interior lighting can also take this into account: With sensors monitoring heart rate, and eye-tracking systems, the car can keep track of how alert or tired a passenger is—and adjust the light accordingly.

At shows like CES, IAV have showed off their outlook of the context-based interior lighting of the future, using such props as an LED demonstration ceiling which can produce many different light scenarios. It can detect the passengers clothes and automatically adapt the temperature to their current state, and it can provide entertainment and ambience as well, such as a dynamic starry sky in the car.

"Our demonstration vehicle have received in Las Vegas very positive feedback", said Bogdanow, especially visitors from Asia were thrilled and wanted to buy the system immediately. Bogdanov and his colleagues are currently working on the second version of the demonstrator, which has be shown in 2018 and which will be especially tailored to the requirements of an autonomous vehicle, including the automatic identification of passengers through biometric status recognition and separate control of individual zones of light.

Artificial intelligence recognises new preferences

It is important that the context-based, intelligent interior lighting of the future supports the passengers and does not manipulate them. That's why we're conducting studies with different people" says Bogdanov, who wants interior lighting to know what the person prefers in different situations, such as having a different colour after a while. With the help of artificial intelligence, the system should recognise these changes, for example, based on cloud-based data of the passengers and automatically respond to them.

Mobility Solutions

As part of the research project OTS 1.0, IAV are developing a fully-autonomous passenger transporter tailored for future mobility in cities.

Cities and municipalities are facing major challenges: urban areas are becoming ever more densely populated and expanding, and rural areas are being thinned out. This has an impact on the transport of the future, which must ensure mobility within the city while also serving as a connection of the outer districts to the city centre. One solution is a fully automated, driverless transport system of electric vehicles IAV have developed together with their partners Siemens, IKEM.TU Munich, and others. It is part of the Renewable Mobility funding program by the German Federal Ministry for the Environment, Nature Conservation, and Nuclear Safety.

Unlike research projects more limited in scope, OTS 1.0 covers all aspects of fully-automated driving in real city traffic—including vehicle, infrastructure, traffic planning and management, and legal framework. The goal is not just a demonstration or showcase, but a feasible public transport system to join real traffic.

Within the OTS 1.0 research project, IAV are in charge of the development of the complete vehicle. This includes, among other things, the complete hardware and software including sensors for the fully-automated driving functions and the communication interfaces to the infrastructure from Levels 1 to 5. Starting from the cornerstones of the mobility concept, IAV have opted for a complete new vehicle development tailored to the complex requirements of level 5 operation.

In addition to lidar, the IAV concept has radar sensors and cameras whose signals are combined by data fusion. Theoretically, the shuttle can thus autonomously travel without communication with the infrastructure. However, in unpredictable traffic situations, for example at intersections, outside support from environmental information is helpful. Project partner Siemens are developing an intelligent infrastructure that forwards information about other road users directly to the vehicle and also sends traffic information to the entire fleet via a control centre.

No-Wheel Interior Concept

IAV have also redesigned the interior for the vehicle. During the test phase, the driver will be present only to monitor the driving functions. In a possible later normal operation, no human driver will be necessary any longer, so the drive deck may no longer need a steering wheel.

Already in April 2018, the test operation of the passenger shuttle commences on the Siemens campus in Munich Perlach. After completing the everyday test in mid-2018, practical insights will be available on how safe operation of fully automated transport can be ensured by combining vehicles and infrastructure sensors in day-to-day life. Due to the approach of OTS 1.0, which takes into account not only vehicle and infrastructure but also urban and road-related aspects, the transport system is especially suitable for urban new development areas or for newly designed districts. The project is expected to bear fruit in the form of real fully-automated passenger shuttles sometime between 2025 and 2030.

Digital Age of the Development Process

About two development cycles instead of three, IAV Executive Project Manager Veit Lemke says:

“Today’s product development process (PDP) takes about three years; the first actual prototypes are usually available after twelve to fifteen months. The large time-and-money costs of prototypes are something we want to avoid in future. Our aim for future development activities is to dispense with physical prototypes besides developing representative models, new methods and make necessary development of the process.

In the concept and early development phase, we only want to run through two cycles instead of three which will leave us more time per cycle and lead to better results. Staff from different divisions develops ideas for this new PDP approach, and the associated methods and tools. By increasing the level of virtualisation, they want to make use of digital prototypes as the basis for testing and validation instead of constructing real-world prototypes. This new PDP for virtual development processes has already been discussed with initial customers. Eventually we will be able to release the production tools at an earlier stage and start work on final validation sooner using pre-production vehicles.”

And about shared data platform for all developers working in Agile teams he adds:

“Along with digital models, the interaction of development tools will be crucial to the new digital development process. These will be developed in-house at IAV, while others we take forward in coöperation with established manufacturers and startups; we will bring together the interdisciplinary expertise of our engineers and work in agile teams. One important aspect here is the gigantic amount of data involved in developing a vehicle today and which, among other things, also contain the models for virtual development. In future, they will be consolidated to a greater extent as the basis for creating a shared platform while maintaining the confidentiality of customer data. New methods in the development process will include VR (virtual reality), MR (mixed reality), and AI (artificial intelligence). VR makes it possible to work on a model from any location. Developers can meet up in the virtual space and work together on an engine, look inside it [and] exchange individual parts—and for customer presentations we can present interim results in shorter cycles and also convey a highly realistic picture.”

And concluding about Artificial Intelligence and VR:

“AI will also change work routines for many engineers: even today algorithms can automatically try out variants and suggest new approaches from which the human engineer can then choose. With AI, systems will be able to continue learning and make ever better suggestions. Initial approaches in this direction are already in place in IAV tools. These will be continuously extended and advanced.

Since 2017, IAV have been set to start actually using the new PDP. Alongside this, the start for a first new development is planned from 2018. And as early as 2020, IAV want to implement the interconnected new digitised work methods throughout the company. “We are taking an all-embracing approach to the subject and are not just limiting ourselves to individual steps in the development process” Lemke says. “Using the new processes, methods and tools, we want to make it possible to develop vehicles on an extensively virtual basis.”

Product Solutions

IAV work to bring quality to volume production, also in IAV's own products that reflect over 30 years' experience in automotive engineering. This is why for many years, manufacturers and component suppliers have not only been relying on IAV development expertise but also on IAV-made products. IAV services have long extended beyond classic engineering and also include specific product solutions: they supply their clients with electronic components from low-volume production and help them bring new products to market. IAV are also one of the most experienced and successful converters of CNG vehicles. IAV also employ state-of-the-art technology and professional development processes in their product solutions.

Interview Sven Bogdanow, Manager Lighting at IAV:



DVN : Can you briefly present yourself?

Answer Sven Bogdanow: I'm working in the area of Lighting since more than 20 years. In former times it was the general lighting, in particular interior lighting. More than 10 years ago I started building up the Light and Vision department of IAV focusing on innovative topics in the area of automotive lighting. Our aim is to provide first-class development services to our customers, worldwide.

DVN : What specific competitive advantages does your company usually rely on when approaching new automotive projects or customers?

SB : Our specific competitive advantages are our knowledge about the whole vehicle development. Furthermore, we are able to take over the full responsibility of turn-key projects for our customers worldwide. Additionally, we have an excellent network to universities and scientific institutions to be always right at the forefront of progress.

DVN : Do you think your company experience in other industries, for instance aeronautical, software, electronic hardware, banking, digital networks or communication, could represent a valuable asset for automotive customers ? In what sense ?

SB: We are already offering development services to non automotive customers for several years. Therefore, our competencies could represent a valuable asset, like IAV's AutoMotive MarketPlace, which was presented at CES2017 and 2018.

DVN : Simulation, test, and measurement tools are expensive investments. Which can you offer to your automotive customers ?

SB: Of course, simulation, test and measurement tools are expensive investments. Nevertheless, it's quite important to develop such tools to support our customers with respect to an prototype free development process. Additionally, they are very helpful for the development of new lighting functionalities as well as innovative light distributions for high resolution headlamp systems. Here we offer a technology neutral virtual assessment platform, called VIRAP, which was presented at the DVN workshop in Munich in January 2018.

DVN : Can you describe one of your latest achievements which you are particularly proud of :

SB: We build up the department successfully during the last ten years. Looking to our latest achievements in the field of AI and interior lighting as well as our assessment platform we are very confident about a rising development in the next decade.

DVN : How do you see automotive lighting in the next decade ?

SB : In the next decade, from our point of view, exterior as well as interior lighting will bring up new challenges for the automotive lighting industry. In the field of exterior lighting highest resolution light sources will penetrate the market. Therefore, our tools will be quite helpful to save time and money. Next, interior lighting will become more important with respect to AI and digital services. Our inhouse development projects will help us to be right on time for the upcoming requirements from the market. The focus of our present projects is set on mood-light and passenger monitoring in combination with digital services. First results are planned to be presented at the LICHT 2018 in Davos as well as the VISION 2018 in Paris.

SEGULA Technologies are an engineering group with a global presence helping boost competitiveness within all of the major industrial sectors: automotive, aerospace & defence, energy, rail, naval, pharmaceutical, and oil & gas. As engineering specialists with innovation at the heart of their strategy, SEGULA conduct large-scale projects, ranging from product design and development to industrialisation and production.

Headquarters:	France
Turnover	Not published
Employee count	11,000
Country count	28
Office count worldwide	140

With close to 90 offices in Europe, seven in the USA, six in South America, five in China, three in Mexico, and local offices in Eastern Europe, the Middle East, India, and Australia, SEGULA support their clients in innovating and developing vehicles and by designing more and more efficient and flexible industrial sites. They offer custom solutions to new challenges in the automotive industry, and can participate as outsourced technical platforms to help design and industrialise subassemblies, or even a complete turnkey vehicle, all while adapting to local specificities.

With the recent acquisition of Austria's EK Design, SEGULA are strengthening their position as a respected lighting engineering specialist. This and the recent acquisition of automotive styling firm Technicon Design serve to illustrate SEGULA's strong growth. Laurent Germain, who chairs SEGULA's international department, says automotive and industrial vehicle activities have always formed the company's core business, and describes these recent acquisitions: "Our group now have all the qualities required to position themselves as a preferred partner in the sector: enhanced skills throughout the entire value chain, an extended local presence and a level of responsiveness that is already well known among a great many industrial players all around the world."

The expertise of EK Design's 400 employees and their 25 years of expertise in mechanical and electrical & electronics engineering, lighting and signaling, interior and exterior equipment, are real assets in the conquest of new premium projects.

Skills and Software Tools



Almost all software tools used by their 300 customers are also used in-house at SEGULA to handle product design and development from styling, surface modeling, pre-studies, design & concepts, digital Mockup, body-in-white interior and exterior equipment, chassis & powertrain, electrics & electronics, CAE, and prototyping as well as validation processes.

Tests and validations are performed in their numerous test and measurement facilities covering all aspects of functional, aspect quality, and

technical validation: safety, crash, corrosion and external factors, worldwide test tracks and obstacle test drives, ADAS and AD tests, endurance and durability tests.

Hagora Pulse: the Ultra-Connected SEGULA Concept Car

At the 2017 Geneva International Motor Show, SEGULA presented Hagora Pulse, their "ultraconnected concept car" with an innovative design, including innovations in :

- Pedestrian detection and visual feedback: the system of cameras embedded in the windscreen identifies the passenger about to cross in front of the car, takes control of the vehicle, and informs the pedestrian that they may cross, through a visual displayed on the bonnet.



- E-sense monitors the medical health of the vehicle's occupants through sensors incorporated into the steering wheel and seats to monitor vital signs and accelerate medical care if necessary.
- Car2Car transmission field, based on LiFi technology and integrated into the car's optics, enables the constant transmission of information between vehicles.
- Gestural commands, combined with augmented reality, promote the display of information on the windscreen by a simple movement of the driver's head without removing hands from the steering wheel or taking eyes off the road.

Core competences in Lighting Engineering

With lighting specialists in France, Germany, Austria, and China, SEGULA cover all the development skills from concept, styling and detail design, visualization, and rendering to electronic engineering, choice of materials, plastic and optical engineering, prototype construction and series production support, and thermal simulation for dimensioning heat sinks.

Their outputs run from premium LED headlamps to passenger and commercial vehicle rear lamps, light guides, from predevelopment stage to prototyping and support of series production.

Expertise

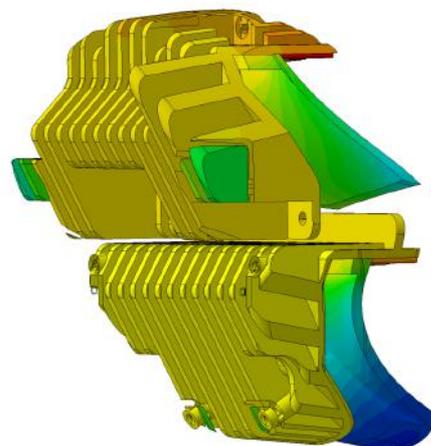
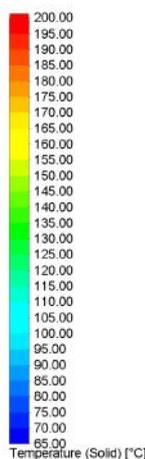
Representation of light technical basis concepts in terms of:

- Cold and warm appearance (photorealistic and physically correct presentation)
- Light technical appearance (raytracing, false colours, homogeneity, real colour simulation, spectral representation)
- Consultation for optimisation of problem factors (leaked, scattered, and stray light)
- Engineering support for realisation of light prototype
- Modification of light technical components according to manufacturing process
- Consulting services for choice of applicable partners at prototyping, tooling, finishing, and coating
- Operationalising and evaluating light prototypes
- Consultation and implementation of light technical optimisation into series process



Engineering Support in the Realization of Light Prototypes

- Modification of light technical components according to the manufacturing process
- Consulting services for nomination of applicable partners for tooling, finishing, and coating
- Operationalising and light technical evaluation
- Consultation and implementation of light technical optimisation into the series process.
- Thermal simulation for heat sinks
- First thermal concepts for power dissipation of LED chips
- Simulation of thermal concepts according to the requirements of the customer
- Simulation & control of thermal impacts for surround and contact parts near the heat sink
- Proposals for the optimisation of heat sink size



Light Development Example: BMW Motorcycle Headlamps

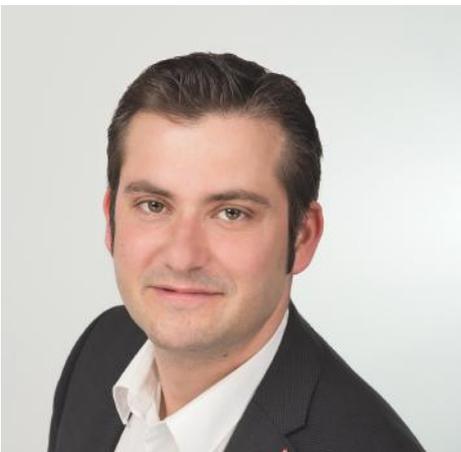


The task was to develop a Full LED variant including daytime running light and additive cornering light on the basis of a Halogen K53 and K54 headlamp. This involved development of a symmetrical visual appearance on the basis of the asymmetrical split-face K54 headlamp, a feasibility study of scaling the K53 headlamp to 80% of its original size, and preparation of functional prototypes.

The scope of services included modification of space conditions as required for the K54 to integrate additional symmetric light functions; design drafts for detailed engineering design; photometric design, thermal analysis, and engineering design. A final functional prototype was tested on a night ride by BMW themselves to check the work. The headlamps'

efficiency was higher than the simulation suggested, and design and performance results and exceeded all expectations.

Interview with Martin Gerger, SEGULA's Head of Lighting Competence Hub, CTO EK Design:



DVN: Can you briefly present yourself??

M.G.: EK Design/ SEGULA offers full service across the entire light and sight development process from the first idea to serial production. We develop innovative solutions for rear view mirrors, windscreen wipers, head and auxiliary lights and fog lights in the exterior sector as well as mirrors, ambient and functional lighting in the interior sector.

DVN: What specific competitive advantages does your company usually rely on when approaching new automotive projects or customers?

M.G.: We are able to support the whole development process for our customers from the styling until the serial production out of one hand. EK Design-SEGULA have ongoing innovation projects to improve the knowledge of our employees on the market, as well as to show our competences to our

customers. As opposed to other engineering providers SEGULA have a large network around the world.

DVN: Do you think your company experience in other industries, for instance aeronautical, software, electronic hardware, banking, digital networks or communication, could represent a valuable asset for automotive customers? In what sense?

M.G.: Yes, in every sense! Look at our SEGULA competences.

DVN : Simulation, test, and measurement tools are expensive investments. Which can you offer to your automotive customers?

M.G.: Light simulation tools: Lucid Shape, SPEOS CAA V5;

Engineering support: Dassault Catia V5, Siemens NX, Pro E Creo, Solid Works;

Mechanical Simulation tool: Ansys

Styling: Alias, Maya, ICEM, Showcase, Adobe Package Communication, Photoshop, Visualisation 2D/3D, and sketching for ideation.

DVN : Can you describe one of your latest achievements which you are in particular proud of?

M.G.: A Motorcycle concept headlamp prototype for a German maker with nearly serial light values; a bicycle headlamp with homologation function for high beam and low beam; and an aircraft seat for which we won an award.

DVN : How do you see vehicle lighting in the next decade?

M.G.: Styling terms have become very important during the last years and this focus will be as well getting stronger for the future, to improve the optical aspects in the automotive industry. In the case of autonomously driving cars, lighting will become very important to achieve support functions for the “driver/passenger” themselves and as well for all other road users.

EDAG Engineering GmbH



The development of mobility is not an isolated process, but the fully integrated interlinking of a wide variety of disciplines. As leading independent engineering experts, EDAG know all about these disciplines and the way they interact. EDAG supply top performance when it comes to promoting vehicle evolution - They know how the production and processes need to be devised to meet future market requirements.

Under the EDAG Engineering GmbH, their subsidiaries and affiliated companies help to provide this interdisciplinary expertise with customized solutions.

Locations

EDAG Engineering GmbH (Head Office)
Kreuzberger Ring 40
65205 Wiesbaden
Germany

Phone: [+49 611 7375-0](tel:+4961173750)

Headquarters:	Germany
Turnover (millions €)	715
Employee count	8,260
Country count	17
Office count Germany	21

EDAG has offices in 20 other cities in Germany as well as in Switzerland, Italy, Spain, Poland, Czech R., Netherland, Hungary, UK, Sweden, Russia, India, USA, China, South Korea, Japan, Mexico, Brazil, and Malaysia.

Facts and Figures

EDAG was founded by Horst Eckard in Groß-Zimmern near Darmstadt on 1st February 1969, at which time the company was known as "Konstruktionsbüro Horst Eckard". EDAG are one of the world's

leading independent engineering partner to the global automotive industry with Euros 715 million sales revenues.

Employees

Employees: 8,260 (as of 31.12.2016), 49% of whom with an academic or similar background
The company invests heavily in education and training.

Customer Industries

EDAG focus is on the international automotive industry, for which they develop and improve mobility : 78% automotive OEMs, 17% automotive suppliers, 5% traffic, transport, logistics.

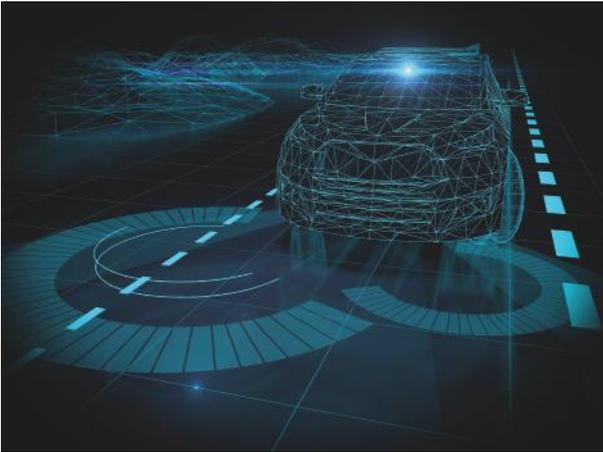
EDAG opinion on Disruption, Big Data, and Data Exchange Hypes:

According to Wikipedia: "A disruptive technology is an innovation that has the potential to completely supplant an existing technology, an existing product or an existing service." In the discussion about Industrie 4.0, the fact that there will be disruptive changes is stressed again and again. It is then pointed out that, in order to handle this, all one needs to do is pay attention to new business models. The best thing is to employ an innovation consultant, who will then take care of everything. Unfortunately, this is a part of the Industrie 4.0 illusion. Disruption cannot be planned in advance, nor arranged by consultants – otherwise it wouldn't be disruption. Essentially, the company's task is to effectively monitor the market, so as to be able to quickly detect any disruptive change that threatens the company's own business model. By means of intensive customer orientation, the attempt will also be made to discover potentially new products, which will themselves also be able to bring about a disruptive change. It would, however, be foolish to concentrate solely on finding new business models.

Big data would appear to be the fuel on which the Industrie 4.0 engine runs. In the eyes of many Industrie 4.0 promoters, it is the blessings of large data quantities that make progress possible. However, it should not be forgotten that the success of German medium-sized industrial companies is largely due to the fact that the requirements of the individual customers are met in the requisite high quality, and that as a result, premium prices can be secured. Individual details, however, cannot be seen in a big data analysis. There, it is all about patterns relating to the mass. Further, data analysis is always a look back with subsequent extrapolation. But updating past developments is perhaps not really the best approach in times of rapid transition. It is much more a question of finding out what the future will "demand" of the company. Third, data analysis indicates correlations but no cause and effect relationships. In our increasingly networked economy, there are no longer any direct cause and effect relationships that can simply be approximated through correlation. Many medium-sized companies attribute their success to an intuitive rather than a rational analytical understanding of the market, and, in increasingly complex systems, this will probably continue to promise future success.

Great improvements are expected as a result of intensive data exchange. One characteristic of digitization is that control over data is crucial for economic success. Companies that continue to produce hardware need to invest, and therefore bear great risks, must consequently make do with smaller margins. How does the question of data handling need to be organized for a medium-sized company to achieve the best possible results? Can it be good for all production companies to disclose large amounts of production know-how through machine operating data, just to make data-driven preventive maintenance possible? Is it not the case that a production worker has often gathered so much experience that he knows best of all how to keep "his" machine up and running? Should we really stop making use of this knowledge? There is certainly no such thing as good or bad data exchange. What every company has to do is to make a conscious decision with regard to data handling. To this end, core areas of responsibility must be defined, and rigorous safeguards must be applied to know-how, and no data exchange be allowed. In the other fields, the attempt can then be made to secure economic success by means of the selective disclosure and acquisition of data.

**EDAG Engineering GmbH:
EDAG develops the driver assistance systems of the future on behalf of BMW**



Wiesbaden, October 26th 2017:
EDAG has received one of the most important orders from BMW, to develop and secure driver assistance systems. Together with BMW, EDAG develops the future generation of driver assistance systems that will meet the requirements for highly automated and autonomous driving. The order also includes securing all developed assistance systems.

EDAG will open a new development site for this technology project in the 4th quarter 2018 on the Business Campus in Unterschleißheim and continue its growth in southern Germany.

EDAG CEO Jürgen Vogt is pleased about this project and points out: “EDAG and BMW maintain a long-standing and very trusting cooperation. With this project, we are taking a central technological step on the way towards an autonomous vehicle. We are proud that our development team will make a significant contribution to the future automotive world.

EDAG LC-S Light car

Perhaps the most interesting EDAG project as far as light is concerned is the open-source light car by EDAG, which communicates with other drivers using a system of OLED lights. The car is covered with OLED panels—including the front and rear lights—and includes an all-OLED dashboard.



EDAG has extended its Light Car electric concept range the “LC-S, Light Car - Sharing hire fleet concept”



The needs of a car designed for such brief excursions have been identified by EDAG as being significantly different to regular rental cars, with a self-explanatory rental and usage system being highly prized. Since its inception, the Light Car has featured illumination as central to the idea. In this latest iteration, LEDs integrated into gel pads are employed, rather than the OLEDs in the original Light Car concept, to display the vehicle's availability.



A traffic light colour system is used to let potential users know whether a given LC-S is available. Green for "available", red for "in use", and yellow for "recharging". Lasers in the wing mirrors project a safety zone boundary onto the ground, which the maker says is to "ensure that passengers can get in and out in safety". The idea is to provide a visual warning to other drivers against coming too close to the LC-S at critical times when people are exposed to moving traffic. The rear window of the car can be rented out as advertising space for use when the car's not in service. EDAG head designer Johannes Barckmann says a car-share vehicle has "the potential to act as a city's visiting card, [so] top priority goes to a high recognition factor and iconic character."

Intelligent Headlight with High IQ

The fear of colliding with an oncoming vehicle because a driver on the other side of the road is driving on full beam and dazzles them is too great. In a purely reflex action, the driver either screws up his eyes, or averts them from the road.

This brief moment of inattention can have disastrous consequences. It was time for someone to address this problem. With EDAG's support, the Audi engineers have succeeded in bringing light into the darkness – and in the process have given the headlight of the future a generous portion of intelligence.

LED Matrix Beam headlight for intelligent light



The innovative development that has been installed in this Audi A8 is the LED Matrix Beam headlight. These are the first LED headlights to be put to use in a car. They provide optimum road illumination and glare-free full beam light. But how is this safety plus achieved? Why is oncoming traffic not dazzled? How is the headlight able to blank out certain objects? How does it know what to do?

What it boils down to is a small control unit, a camera and numerous individual light-emitting diodes. A signal is sent to the control unit when the camera detects oncoming traffic, for instance. The unit controls the various individual diodes in the headlight, switching them on or off, depending on the situation. Sometimes the brightness of the diodes is dimmed, which helps to prevent other road users from being dazzled. For the driver, the result is remarkable: it seems as though the headlights are on full beam all the time. The only difference is that objects that need to be protected from the glare are

blanked out. And this works with amazing precision - the outline of any vehicle detected is "cut out" of the headlight beam area to within a centimetre.

Norbert Fürnrieder, team leader in EDAG's Complete Vehicle Electric/Electronic department in Ingolstadt, explains exactly why this is so brilliant. More than anything else, he is keen to see his pioneering work change things, set new standards, and show what you can do if you really want to. For seven years now, he has been working on the subject of "car lights". He has set himself the task of improving the driver's visual range without compromising the safety of other road users. No easy task, as it is not always possible to unite these two disciplines just like that. Norbert Fürnrieder is one of those enthusiastic engineers who like nothing more than feverishly searching for solutions. Taxing his brain. Looking for unusual ways and means. Especially where others have already run out of ideas. For him, development means creating ideas in his head, letting them grow and mature, and then using them to work out concepts that are at least as brilliant as the LED Matrix Beam headlight.

"We always come up with a solution, no matter how long it takes us to mull a problem over. Nothing deters us not even if, to begin with, it looks as though it will be impossible to find a solution. We do something that others don't do: we give an issue our full attention. We don't dismiss a task just because it seems tricky. No, we roll up our sleeves and try to work out a suitable solution as quickly as possible - and this is our great strength. This is what sets us apart!" is his enthusiastic conviction.

The latest revolution: only good if it can also be put to practical use.

As we know, there is a world of difference between theory and practice. Not only in the automotive sector. To prove that practice delivers what theory promises and that the LED Matrix Beam lives up to the claims of the developers, there was no alternative than to fit it into a test vehicle. And so the EDAG team set about integrating the invention in the "casing", the headlight. Norbert Fürnrieder's team were responsible for the development of the boards, the control modules, but also for the LEDs definition themselves. The power modules, too, were integrated in the vehicle and cooled. They also had a hand in the software development. In this way, the customer's product specifications developed step by step into a full, serial solution-standard integration.

The final test was a complete success: the light frequency changes, adjustment of the individual LEDs, dimming - none of which the driver even notice. The point was not to allow the "work" of the headlight to distract the driver. He enjoys a perfectly illuminated road situation and can concentrate fully on his driving. Mission accomplished!

Next stop: laser and Car2X

Everyone is delighted. And some of us will marvel at this technology for quite some time to come. However, the system has not yet been fully perfected, it still has its difficulties. For example, the car has to be able to detect its surroundings and other road users by means of a camera. But what happens if one of the headlights of an oncoming car is defective? Will the car then be "recognised" as a motorcycle instead? Will it then not mask out the light distribution around the car properly? There is already a potential solution to this problem, but it is still in its infancy: Car2X.

To this end, the EDAG team have already set up a further test vehicle which, instead of LEDs, features state-of-the-art laser technology. An alternative to the LED method, but still extremely high-priced. The Car2X will no longer need to rely on a camera for communication, as it will be replaced by the direct communication of the vehicle with its surroundings. Objects on the road will "speak" to one another. One example of this might be reducing the force of headlight beam at a traffic light, when the driver is waiting for it to turn green. Or the rear lights could be dimmed so that the driver of the car behind is not disturbed by unnecessarily bright lights.

The advantages of laser light and Car2X are obvious: they save energy and allow the headlights to be adjusted more effectively. As with so many aspects of automobile technology, this variant is still a long way off. Whether the LED variant will prevail, or the OLED will have its breakthrough remains to be seen. There are, however, some things that are certain: EDAG will continue to be involved in the latest

developments. And Norbert Fürnrieder will continue to roll up his sleeves and apply himself to devising practicable future light solutions.

ADAS – A way to Future “Piloted Driving”

ADAS: although it sounds like a disease, nothing could be further from the truth. In fact, the exact opposite is the case, as ADAS (Advanced Driver Assistance) systems are there to help the driver: whenever and wherever help is needed.

Imagine: you get into your car and it safely takes you to a pre-defined destination ... without your taking an active part in the proceedings. Something that would have been dismissed as fiction or nonsense just a few years ago has developed into a very real trend, and is playing an increasingly important role in the automotive industry. Driver assistance systems (ADAS) are already providing solutions for practical day-to-day operation.

Whereas the media are busy examining all aspects of autonomous driving, presenting scenarios for the future and painting us a bright and shiny brave new world, very few people are actually giving any thought to the development of these new systems. Who guarantees the driver the necessary safety? How can these systems be validated? What steps can be taken to ensure that, as precursors of autonomous driving, ADAS systems will work in every country – not just on well laid out German highways, but also in chaotic megacities?

For many people it is still very difficult to imagine that, instead of having to drive themselves, they would hand over all responsibility to a number of different systems. Clear task for EDAG: to make sure that people's trust in these systems is justified. And that they will also work in difficult situations. No matter where or when.

All a question of validation

Driver assistance systems should simplify or even automate driving. Driving situations can be electronically supported and decisions simplified, or even made for the driver. The best known aids are the emergency brake assistant, tyre pressure control system, adaptive cruise control (ACC), parking assistant (automatic parking), blind spot monitor, rear view camera, road sign identification, lane departure warning system,

The fact that these aids also deliver in practice what they promise in theory is a matter of validation - a test and subsequent assessment. In this respect, more and more OEM customers are putting their faith in EDAG's experts. ADAS systems are put through a series of rigorous tests from which possible improvements are derived.

Every country has its own way of doing things – so not all electronic aids look alike

A number of obstacles must be overcome before an ADAS system can be developed, including questions such as which country the system is to be used in, or which vehicle types it is to be integrated in. Another matter of importance when it comes to the market launch is compliance with standards. As we all know, every country has its own way of doing certain things.

One example of this is that the blind spot monitor is radar operated in the USA, whereas ultrasound is used in Germany. A technology with a similar degree of reliability, but which can be realised at a fraction of the price. Differences between countries do not, however, apply only to rules and regulations, but also to social values and norms. Adaptive cruise control illustrates this point perfectly. The ACC system is dependent on the way in which motorists drive in the different countries, and must therefore be adjusted accordingly. Experience has shown that drivers in the USA tend to brake and accelerate smoothly and slowly, whereas Germans brake and accelerate far more sharply. In this context, EDAG checks what tests are necessary, and then carries them out.

Saving cash with an EDAG tool

Drive – brake – drive – brake – it is hard to believe that, simple as it sounds, testing braking and acceleration cues is actually a demanding and cost-intensive practice. A brake robot is used to carry out this type of safety check. A complex procedure, and one for which the EDAG experts found a smart alternative: a software tool developed in-house simulates an ACC control unit (including plausibility checks such as the dynamic check sum, rolling counter) and ensures that pre-defined and reproducible braking requirements are carried out, and in this way, the vehicle's performance is validated.

The tool has now become well established, and is used worldwide.

Performance drive to validate the traffic sign recognition assistant

Apropos saving time and money, a further example gives an impressive idea of which methods can be applied to make this type of validation more efficient.

We have all done it: you have just left a built-up area and are driving along the open road. Lost in thought, you look at the road, and before long, you find yourself asking "Am I actually allowed to drive 100 km/h here? Or was there a sign limiting the speed to 80?" Shortly after this, the first speed trap appears around a corner – and you quickly brake to 60, after all, you never know! The traffic sign recognition assistant has been developed to help here. A useful feature, and one which has become an essential element of any mid-range saloon car. It recognises road signs and helps the driver by displaying the last relevant information.

From a technical point of view, there are two ways of constructing this type of system. The currently valid signs are identified either with the help of the navigation device's position sensor or by means of a camera with image recognition software, which is positioned at the front of the car and can recognise and analyse signs.

The automotive industry makes use of both alternatives. The task of the driver assistance experts at EDAG is now to work out whether it is possible to combine the two possibilities. The thing to do is find out the added value and determine when data from the navigation system is really useful, when redundant, and when it serves no purpose at all.

Here again, the solution lies in an in-house development. With the help of a webcam, the software tool records all test drives carried out. At the same time, it also keeps a record of all the traffic signs recognised by the vehicle. At the end of these performance drives, the EDAG software automatically assesses whether the driver assistance system made the right decisions or needs to be improved upon. Not only an ideal way of coordinating the two technological approaches (GPS and image recognition), but also of judging what traffic signs should be displayed in what order. There is after all no need for every single one of the huge number of signs that a car passes to be displayed.

And while the challenges relating to the road sign identification assistant have been largely dealt with, EDAG is already busy developing the next aid: automated checking of parking systems. The idea here is for laser distance sensors and test automation to record the parking position of a piloted vehicle, in this way checking the performance of the parking system. There are a number of points that will require validation in the future, and the question as to whether it is easy to get out of the car once it has been automatically parked is just one of them.

The future of "piloted driving"

The development of various ADAS systems will help to advance piloted driving. The fusion of sensors plays an increasingly important role here. It is, for instance, already possible for ultrasonic, radar and optical sensors to interconnect, so that they can work together to get a better picture of their surroundings. Added value that will come to bear in a wide variety of vehicle features. Features which will shift more and more responsibility away from people and towards technology, with the aim of making driving a safer and more relaxed experience.

It pays here if manufacturers of such systems and features have at their side a partner who, apart from being able to validate the assistance systems, also possesses the necessary knowledge in the

fields of chassis development and active/passive safety, because the closer we come to autonomous driving, the more complex and challenging will interventions in chassis and engine control become.

The person in the machine, a learning-based concept for Automated driving

Highly automated driving, ADAS, autonomous driving – terms that have been in people's minds for a long time now. Only the experts know the exact difference. But when we hear them, we all understand more or less the same thing: hands off the steering wheel! Suddenly, "keep your eyes on the road", something we all had to learn, no longer seems quite as important. We expect it to bring us more comfort, so that we are relaxed on arrival, creativity instead of wasting time at the wheel.

But there is a long and stony road to travel before we get there. Every further innovation brings with it unresolved questions and seemingly insurmountable hurdles. One of these hurdles is that the car of the future will need to be able to reliably recognise the behaviour of other road users. A hurdle that has now been tackled, thanks to EDAG's experts.

"Forward-looking algorithm" is how Alexander Hirschle modestly describes it. However, what the electrical engineer graduate is working on is nothing less than the core elements of automated driving. Even if the vehicles of the future are fitted with better and better sensors, from mono cameras and stereo cameras through to radar, each car will nevertheless require a "brain". An algorithm that defines what to do in what situation. A set of rules subject to continuous optimisation.

Empirical values for the machine

Take the example of driving on a dual carriageway or the motorway. To the right, you see the acceleration lane for traffic joining the road you are on. You know that a vehicle in this lane that is driving parallel to you will very shortly change to your lane. Instinctively, you change lane or brake to leave room for the car to make this manoeuvre. This is a basic rule that you have learnt. Your driving experience means that you are familiar with and able to correctly assess just about any situation. For you, there is practically no difference between a normal road and an acceleration lane to your right – regardless of what the road and your surroundings look like. Or to take another equally familiar example. You notice that, behind a heavy goods vehicle some way ahead, there is a vehicle that is constantly "twitching" over towards the left. The driver seems to want to pull out into the other lane and overtake the HGV, but is prevented from doing so by passing traffic. The closer you get to the driver, the stronger you suspect that he might soon pull out in front of you. Your logical reaction is to slow down in good time and be ready to apply your brakes.

Hard work for vehicle technology

As simple as this might sound because in reality it really does feel simple to us, this is very hard work indeed for vehicle technology. What is needed is a very finely thought-out algorithm, as capable as we human beings are of correctly assessing driving situations. More in fact - capable of predicting situations. A "human in the machine" if you like.

The algorithm developed by Alexander Hirschle and his team in Ulm becomes all the necessary data from vehicle sensors in the form of an environmental model and object list. During the first stage, the individual vehicles in the immediate vicinity are checked for striking features or anomalies. These "features" should provide information on driving behaviour. The "twitching" over towards the left described above would be one of these features. During the second stage, the current driving situation is calculated on the basis of this information. The statistical analysis then predicts the most probable driving behaviour in the cars in the vicinity. In the final stage, the car then plans the ideal route, already reacting to other vehicles.

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