

# PFORZHEIM UNIVERSITY'S DISPLAY LAB DRIVES AUTOMOTIVE DISPLAY R&D

by Prachi Patel

A LITTLE MORE THAN 50 KILOMETERS WEST OF STUTTGART, NEAR the German manufacturing hub and headquarters of Mercedes-Benz and Porsche, lies the tree-lined campus of Pforzheim University. For about three decades, Karlheinz Blankenbach has led the university's Display Lab, which he founded in 1998. Blankenbach, a well-known and respected figure in the display community, is a member of the Society for Information Display (SID) Technical Symposium Subcommittee for Automotive/Vehicular Displays and HMI Technologies and the International Committee for Display Metrology (ICDM).

The Display Lab ([www.displaylab.org](http://www.displaylab.org)) has conducted research and development (R&D) in the areas of optical measurements; automotive and other display systems; human-machine interfaces; LED displays; and display system design. The focus is on interdisciplinary research and on transferring knowledge to the industry. Being near the heart of the European automotive industry leads to partnerships with and contributions to the automotive display industry. The lab has generated a steady pipeline of researchers and engineers to academia and industry, and Blankenbach and his team have garnered many prestigious awards.

## Laying the Foundation

Blankenbach was in his late 30s when he was appointed a full professor at Pforzheim. He brought with him seven years of experience in the display

industry. As an engineer at the Mercedes-Benz subsidiary AEG MIS, he worked on display electronics and electronic signage. "We did development and production of LCD displays from scratch," he said. "This was for public signage mostly, for instance at airports and railway stations. Orlando airport was one of the first projects."

In the mid-1990s, the display industry was struggling in Europe and the United States, and there was hardly any future-orientated flat-panel display research or production, besides Philips, he said. "As an engineer looking years or decades ahead, it was hard to see a future, and so you moved on. It's maybe like being in combustion engine development today."

He moved to academia, with the goal of spurring new display R&D for the German industry and motivating students to enter the display field. The Display Lab, which is part of the Information Technology & Electronics department at Pforzheim, started with four student researchers mainly performing optical measurements and interfacing systems for low-resolution displays. As the industry transitioned to higher-resolution displays, the Display Lab followed and broadened its competence to LED displays (Fig. 1), system design, and evaluation.

In nearly three decades, the lab has undertaken multiple projects with support and funding from both government and industry. The government has funded many LCD, OLED, and LED projects. One of the lab's recent projects was in collaboration with engineers at Mercedes-Benz. They developed a new method to ensure the safety of vehicle camera monitoring systems, such as replacements for rear- and side-view mirrors as well as remote operation of robot cars.

### Fig. 1.

Students demonstrate their 3D LED cube to German Chancellor Angela Merkel in 2014. Students fully designed and prototyped the cube starting with LEDs and passive matrix drive, including software and animations of moving objects in 3D.



These systems must reproduce actual scenery in real time without any distortion. Today, only the digital data is supervised for accuracy, and it is assumed that the display converts this digital data into optical output images without any errors. The engineers prototyped a system that optically supervises the display output using photodiodes and a camera. Blankenbach said that a major tier-1 vendor in Germany has acquired this idea and is pursuing cost-effective production of their system by using printed electronics. The research also has won accolades, including a Distinguished Paper Award at Display Week 2020 and the Best Paper Award at the 27th International Display Workshop in 2020 (Fig. 2).

### Ushering in a Talent Pipeline

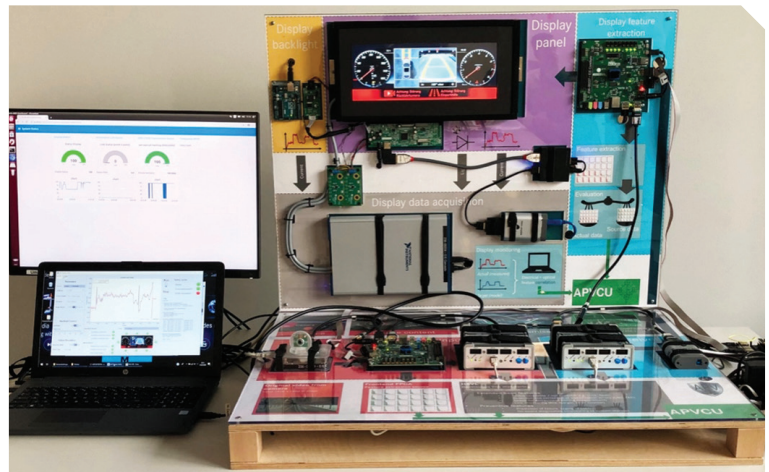
While private partnerships with industry have been steady over the decades, government funding for display research has slowly waned, he said. "You always have to answer questions such as what is the impact on society or how many work opportunities will you generate? And as display production neither happens in the US or Europe, you don't score points with your proposal in this category even if it's innovative."

By comparison, it is easier to get public funding for OLED materials in Germany, given the presence of a strong display chemistry industry with market leaders such as liquid crystal and OLED material supplier Merck KGaA and OLED material provider Novaled GmbH, which was acquired by Samsung. "With materials, because the quantity is so small, you can manufacture more easily in Europe or the US," Blankenbach said.

The amount of external funding dictates how many students and researchers the Display Lab can support, Blankenbach said, with 20 being the group's peak size. Today, the lab has several faculty members and postdoctoral researchers as well as some master and undergraduate students. Of the 200-plus alumni who have trained at the lab, most have gone on to successful careers in automotive display R&D at companies such as Mercedes, BMW, Porsche, and Continental. Continental, located close to Frankfurt, is the largest tier-1 manufacturer of premium automotive displays.

Two Display Lab alumni have found academic careers: Carlos Sampedro Matarin, a professor in the Department of Electronics and Computer Science at the University of Granada, and Jan Bauer, a professor of electrical and computer engineering at Karlsruhe University. In 2007, a small group of Display Lab researchers founded TZ Electronic Systems GmbH, a company working on high-speed and next-generation automotive display interfaces.

Blankenbach said training the next generation of display engineers and researchers requires nur-



**Fig. 2.**

The SID Distinguished Paper Award in 2020 was based on safe video transmission.

ture students' talent, but also treating them fairly. He caters to each student's aptitude and invests time in guiding them to help them achieve their best. The end goal is to ensure that as display engineers, they find what they do rewarding and develop a passion for display R&D.

### Networking and Innovation

The Display Lab team currently is developing advanced optical measurement techniques for two display technologies that he believes are the future of vehicular displays: full array local dimming (FALD) LCDs and so-called "hidden displays" for interior surfaces.

While LCD displays have LEDs placed along the edges, FALD displays have LEDs placed on the back of the display. The LEDs are separated into zones, which can emit light at different intensities. That means the display saves energy, while also improving local contrast so that the perceived quality comes close to OLEDs. "When I first said FALD LCDs, some people thought I said faulty displays," he said with a laugh. "This is one of very few opportunities in engineering where you improve one thing and get twice the return."

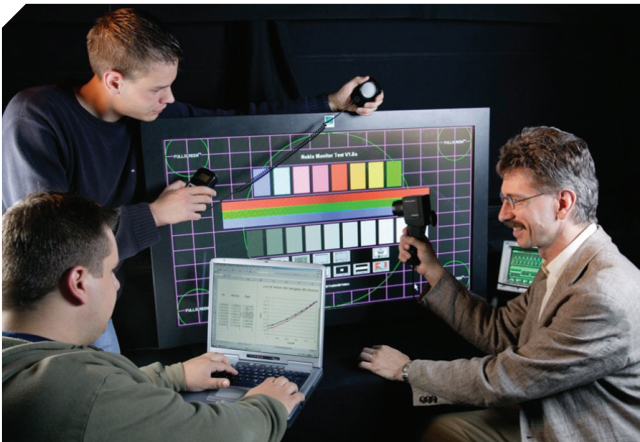
But FALD displays, which are used today in the Apple iPad Pro and some high-end TVs, suffer from a halo effect that arises when brightness from one

LED zone causes a glow in an adjacent darker zone. At Display Week 2022, the Display Lab team presented a new high-resolution measurement method for halos



**Fig. 3.**

Automotive seating buck for evaluating a "Scheibenwurzeln" Display.



**Fig. 4.**

Karlheinz working with staff on a TV evaluation in 2005.

areas with lower transmission.” Figs. 3 and 4 provide examples of the Display Lab’s competence for evaluation

and measurements.

Blankenbach takes pride in the significant contributions that the Display Lab has made to the automotive display industry. Having an excellent team of researchers with good ideas and delivering high-quality results are key to the lab’s success, he said. His involvement in professional networks also has been important, because it allows him to stay abreast of cutting-edge research in the display arena. Besides his involvement with SID, he has been a board member of the industrial display network Display Forum since its founding in 2000, served as its president for eight years, and has been the Honorary Chairman since 2020.

“Playing an active part in the worldwide display community with invited talks and keynotes means all the relevant people know me,” he said. “But at the very end, you have to deliver great results, and that is what the Display Lab does.”

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that involves using black masks to hide the bright content.

Hidden displays, which have semi-transparent woodgrain or metallic surfaces so they can be discreetly embedded into automotive interior surfaces, have their own unique challenges. Here, the bright and dark areas of the wood can create non-uniform light falling on measurement devices. “The challenge is to establish new metrics about image quality that is distorted by the wooden surface. One question is how it is perceived, and can you calibrate this to raise luminance pixel by pixel at



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