

BMW i Vision Dee - Your Ultimate Companion - Driven by Technology

Michael Brachvogel¹, Olivier Pitrat², Dr. Stella Clarke³

michael.Brachvogel@bmw.de, olivier.Pitrat@bmw.de, stella.clarke@bmw.de

^{1,3}BMW Groupe, Research Technologies, User Interaction, Human Machine Interface, Driving Simulator, Parking 19-23, 85748 Garching, Germany

²BMW Group Design, User interaction, Knorrstrasse 147, 80788 München

Keywords: BMW i Vision Dee, Panoramic vision, Color changing car, Neue Klasse

ABSTRACT

BMW i Vision Dee demonstrates our digital product vision for the future. It is a holistic thought on the way to Neue Klasse and comprises a new user interaction concept guiding the customer from outside/in into a world which emerges from real and virtual content. The technologies applied have been derived from BMW Group research programs.

1 Introduction

With its presentation at CES 2023 the BMW i Vision Dee added another chapter to BMW future vision of cars. "With the BMW i Vision Dee, we are showcasing what is possible when hardware and software merge. In this way, we are able to exploit the full potential of digitalisation to transform the car into an intelligent companion". (O. Zipse CEO). The name "Dee" stands for Digital Emotional Experiences. And that is precisely its aim: To create an even stronger bond between people and their cars.

BMW i Vision Dee is redefining the appearance of a car and its user interaction. The car will become an ultimate digital companion, interacting with us and knowing our needs and habits in every reality. It's operation is intuitive and personal and it starts way before entering the car.



Fig. 1 BMW's electric, digital, sustainable Vision cars

With just a blink of an eye the car's shape and color is recognized. Wake up and individual communication may start sensor based while approaching the car. Once inside, the customer has the choice between various modes of reality up to a full virtual immersion appealing to all senses. Key to the concept are technologies which enhance the user interaction such as the Vision Dee advanced HUD (Head-up Display), animated head and taillamps around the exterior, a voice-based interaction and finally a color

changing outer skin. This presentation addresses the development approach, the technologies used and the outlook to future requirements.

2 Dee - The Ultimate Companion

Cars accompany us through many hours of our life. But how may they become an ultimate digital companion?

For us, a digital vision is not accumulating huge screens and maximizing computational power. Future digital functions will go far beyond the level of voice control and driver assistance systems we are familiar with today.

With the BMW i Vision Dee, we are showcasing what is possible when hardware and software merge. In this way, we are able to exploit the full potential of digitalisation to transform the car into an intelligent companion.

With its intelligent, almost human capabilities, BMW i Vision Dee accompanies drivers not only through real-life situations on the roads, but also in their digital environment.

2.1 Dees User interaction concept

Dee's user experience is driven by a new interaction concept which is derived from 3 strategic principles:

- (1) it is human centric,
- (2) its tech is magic,
- (3) and its operation is intelligently reduced.

Central to the user experience are various display technologies which allow for an interaction of the customer with its car from different positions. A second strong contributor is natural voice interaction which simplifies handling and emotionalise experiences.

We would like to differentiate the interaction concept into 3 phases: a) when you approach the vehicle, b) when you are getting involved with it and c) while you are inside driving or just resting.

2.2 First approach - Exterior communication

BMW i Vision Dee is redefining the appearance of cars. The digital experience already begins outside the vehicle, with a personalised welcome scenario that combines graphical elements, light and sound effects.

The headlights and the closed BMW kidney grille form a common new element, which changes its appearance to react on the user.

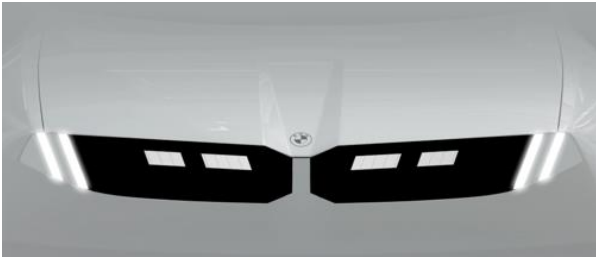


Fig. 2 E Ink based headlamp for facial expressions

Based on an E Ink display with about 56 pixels each side the car may show emotions itself through 9 different facial expressions. Around the side and the rear further 900 segments are arranged to guide the user. Sensors identify from where the user approaches the car.

Beyond that, the car might vary its appearance by changing color and pattern. Following the spectacular debut of the BMW iX Flow featuring E Ink in 2022 the technology has been developed further to display now 32 colors in 240 segments. Each segment is controlled individually and allows an almost infinite numbers of patterns to be generated and varied within seconds.



Fig. 3 World premiere for full-color E Ink technology

For the first time Dee showcases a multi-colored, fully variable and individually configurable exterior to express the user's mood and to adapt to the environment.

2.3 Getting involved - Voice Integration

A natural speech dialogue evolves as the new dominant modality of interaction and replaces physical knobs or display menus. Outside the car, speech bridges the distance of direct operation, like touch or handles. A more humanlike dialogue can be achieved by combining voice and an image corresponding.



Fig. 4 Welcome scenario by Avatars and dialogue

Dee can also project an image of the driver's avatar or digital twin onto the side window to further personalize the welcome scenario and enhance the dialogue.

2.4 Getting inside – into mixed realities

BMW ergonomic and driver-oriented cockpit layout has always been a benchmark to enhance user interaction and safe driving. It follows the principle: *hands on the wheel, eyes on the road*, and minimizes all kind of distraction for the driver. In the 90s the cockpit layout was dominated by a gauge-based instrument in front of the driver and many switches and knobs to control the car's functionality. Then, since 2000 digital information made headway into the cockpit and the BMW iDrive Controller became a central masterpiece for user interaction.



Fig. 5 Evolution of driver orientation

With the introduction of the first Head-up Display in 2003 in the 5 series sedan a further evolution began, where real world and additional driving information were merged into the driver's field of view.

Now the next stage of Head-up Display, the Vision Dee advanced HUD offers further opportunities using the full width of the windscreen and providing information right where and only when you need it.



Fig. 6 BMW Vision Dee advanced HUD

The new central operating control for the Vision Dee advanced HUD is the BMW Mixed Reality Slider. Using shy-tech sensors on the instrument panel, drivers can decide for themselves how much digital content they want to see on the advanced Head-Up Display.

The five-step slider selection ranges from:

- (1) pure analogue,
- (2) show driving-related information,
- (3) add contents of the communications system
- (4) add augmented-reality projection
- (5) full immersion into virtual words

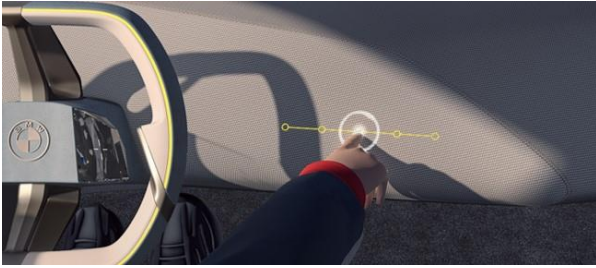


Fig. 7 BMW Mixed Reality Slider

For the driver this reduces the complexity of operation and the risk of distraction. The unconventional design of the steering wheel with its central vertical spoke creates additional touchpoints that can be operated by moving the thumb. These touchpoints control the selection of the content projected onto the windscreen and, together with the Head-Up Display, thus support the principle of *hands on the wheel, eyes on the road*.

3 Dee – driven by technologies

The unique Dee experience is not made for the driver alone. The mixed reality can be experienced by all passengers in a most immersive way. It engages different senses without any additional tools (e. g. wearing VR glasses or headsets)

All front and side glazing is used for the visual representation, which leads to a near 270° surround view. Shakers in the seat enriches the immersion by a haptic amplification of sounds. On top of it even scent can be used to deepen the journey and create a new dimension of driving pleasure for the user.

But which technologies make it all work?

3.1 Side window projection

To create a 270° full immersion surround view, a combination of very powerful high brightness display technology in the front and laser-projectors for the side windows have been applied. Such kind of projectors with a brightness above 500 lm are already standard in consumer products and now on the way to be qualified for automotive requirements.

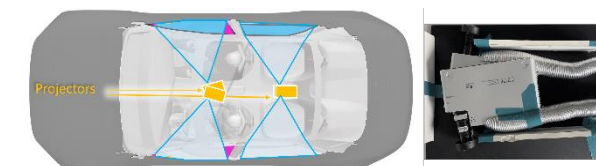


Fig. 8 Layout of Projection to side windows

Complementary to the projectors the plane of projection – the side windows - have been realized such that they serve three different use cases by utilizing switchable optical-functional films (Fig 9).

The technologies used for this purpose are based on suspended-particle technology (SPD) and Polymer-

Dispersed Liquid Crystal (PDLC) which were integrated into the laminated glass.



Fig. 9 Projection to side windows with switchable glazing

- (1) The passive estate is transparent, → no films are switched on
- (2) Outside projection: Welcome with avatar by back projection → only the PDLC film is switched to opaque-state
- (3) Inside projection: Full immersion by front projection, → PDLC in opaque-mode + tinting by SPD to increase contrast

3.2 Vision Dee advanced HUD

BMW i Vision Dee is the first vehicle to present a revolutionary new Head-up Display concept for all passengers. Like with conventional HUDs the image is being projected in front of the windscreen, thus increasing the viewing distance to above 1 m. Compared to conventional cockpit-based LCD or OLED displays this optimizes the interior roominess and a cinema like perception of the content.

The Vision Dee advanced HUD consists only of a slim flat-panel display without any additional optics for magnification (Fig. 10).

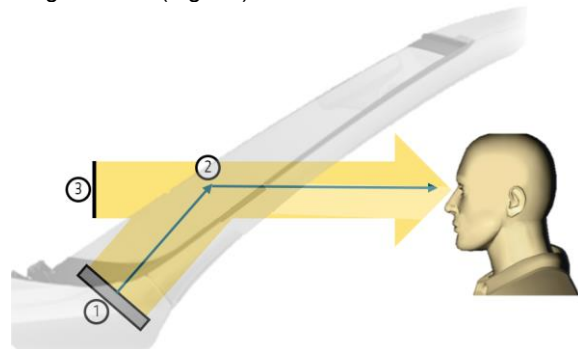


Fig. 10 Principle of Vision Dee advanced HUD system containing (1) Flat panel display, (2) windscreen reflection and (3) virtual image.

The slim flat panel display can be integrated on top of the dashboard surface, floating above all other components in the cockpit. This allows to integrate a panel of ~1.2 m x 0.2 m, giving a continuous display surface from A-pillar to A-pillar and spanning almost half of the windscreen height. The resulting FOV of approx. 64° x 10° would not be achievable with conventional HUD technology.

An additional benefit of this system is, that this type of

HUD display is simultaneously visible for the driver and all other car passengers in contrast to the conventional HUD system which can only be seen by the driver. This feature further enhances the usability of the system as the display can be used in part as a codriver display or for joint entertainment of all passengers.



Fig. 11 Full immersive mode with tinted front screen

Similar to the side windows, a suspended-particle technology film (SPD) tints down the windscreen to increase the contrast for the full immersive mode in level 5. (Fig.11)

3.3 E Ink based color changing Exterior

The full color changing exterior is the consequent next step in the application of E Ink films on the outer skin after the introduction of the iX Flow with black/white in 2022. The laser cutting process used to trim the films and the electronic control design were developed in partnership with E Ink. The adaptation of this technology for curved surfaces, the layout of the segments and the programming of the animations were developed at BMW and enable a level of customization that is unique in the automotive industry.

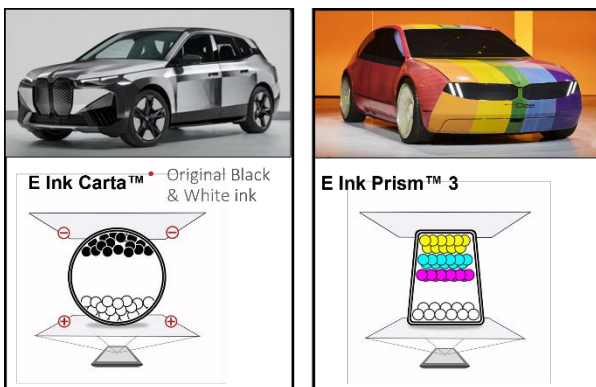


Fig. 12 Evolution of color changing car

3.4 Challenges of new technologies

The full color changing exterior is a mid to long-term product vision, but first steps to make it work in automotive processes are being taken. A huge task is to cover curved freeform shapes by a film which is not stretchable in its current design.

Many new display technologies have their market entry

first with CE (consumer electronic) applications and need a further qualification to withstand the demanding automotive environment, e. g. temperature range, lifetime, EMC (electromagnetic compatibility). Additionally worldwide regulations for the homologation of vehicles require a careful look on the feasibility of new concepts like a tinting down of the windscreen.

Conventional voice assistants are at their limits with respect to a more humanlike, proactive and responsive dialogue. A key enabler will be AI based dialogue, driven by large language models, which are trained onto automotive usecases.

4 Conclusion - Re:Imagine tomorrow

The future of the BMW Group is electric, circular and digital. BMW i Vision Dee represents the digital aspect of this trio and will be another milestone on the road to the next vehicle generation, the NEUE KLASSE (Fig. 13).

“A BMW lives by its unparalleled digital performance. BMW i Vision Dee is about perfect integration of virtual and physical experiences,” (Frank Weber, CTO). BMW i Vision Dee will change our perception of cars in the future and is the guiding vision for our digital product development.

The core innovations can be summarized:

- Dee is your ultimate companion
- Dee enables avatars and digital twins
- Dee enables a full immersion 270°
- Dee merges real and virtual world in an intuitive way.
- Dee changes its appearance and color by your choice



Fig. 13 BMW Vision Neue Klasse @ IAA 2023