My(H)MI

The Road Ahead for
In-Car Human Machine Interfaces

What will shape the development of the passenger car's human machine interfaces (HMI) by 2030 and beyond? What are the opportunities and challenges of this transformation? How can industry leaders adapt their strategic approaches to make HMI a successful facilitator of the software- and service-defined vehicle of the future?

To answer these questions, a rich synthesis of perspectives and professional insights was leveraged, as well as input from a broad spectrum of global contributors, including industry executives, corporate strategists, UX design specialists, usability engineers and researchers. Most importantly, the perspectives of real-world users were explored—the first reference when designing the human-centric in-car experiences of tomorrow.

The term My(H)MI is designed to capture the hyper-contextualized and truly personalized interaction between human and machine that is beginning to emerge.

Version: 0.98

Two People on the Move in 2022

Meet Anna and Haruki. City dwellers who use cars daily, although for very different purposes and under very different circumstances.

Anna, a systems engineer and mother of two, does not own a car but uses several car-sharing options on demand for running errands and shuttling the kids around. Anna has basically given up connecting her phone to the car or figuring out how the on-board navigation systems work. She finds the different HMI systems and operational logic of the various vehicle brands confusing. And since she uses a car for only 10-20 minutes on average, it makes no sense to familiarize herself with the infotainment, assist systems or comfort features. Even so, Anna sometimes wishes she could use her in-car time to continue shopping online, to run a 'car schooling' session with her kids, fully connected via their phones in the back, or simply to continue the conversation she had with her friend before getting into the car. For now, 'shared car time' remains 'digital detox time' for Anna—whether she wants it or not.

Haruki isn't exactly a car nut, but he embraces car ownership and loves his new premium station wagon because it's fast, practical and offers many connectivity and assist features. He uses it to visit business partners or do the weekly grocery shopping, and he enjoys road trips with his wife or friends. Haruki takes pride in being in control of the various HMI features, from extensive driver assistance functions to mirrored, third-party Android Auto apps. He sees his car as part office, part living room, part concert hall. Yet, like Anna, he's often frustrated with the operational logic and complex integration of certain features in the HMI. He also knows that his car will not be state-of-the-art for much longer. He wants to be sure that upgrades will become available that help retain its long-term value.

Setting the Scene
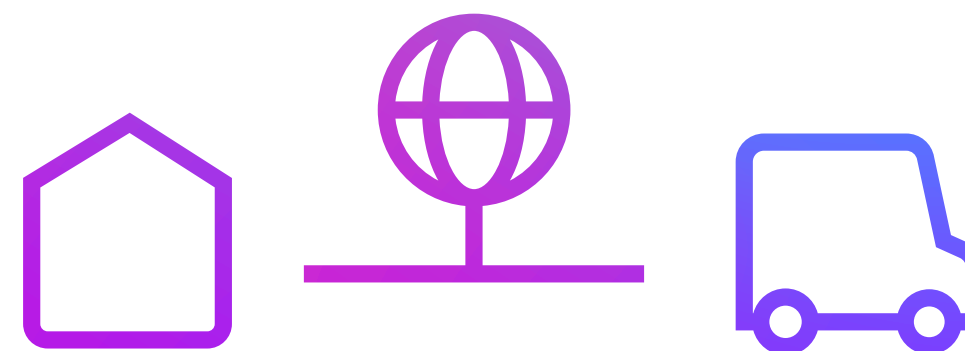
Technology sets the pace of change, but consumers like Anna and Haruki are the true disruptors of the auto industry. Their desire for vehicles that respond better to changing lifestyles and environmental and societal concerns is already driving the development of connected, automated, built-to-be-shared and electrified products—and there's much more to come.

More automated and intelligent vehicles will transform drivers into passengers, and passengers into pampered patrons of a magical space on wheels. Anna and Haruki will soon be able to perform multiple tasks and functions while on the road, enabled through services they are happy to pay for with either money or their personal data—thus generating the rich digital profiles that will underpin the emergence of still more sophisticated in-car services and features.

Data, indeed, is the industry's new fuel, and it's forcing Original Equipment Manufacturers (OEMs) to completely rethink their business models. By fully embracing the software-defined car, the industry will shift to a model based on recurring revenue streams through connected products and services that dynamically address the requirements for greater sustainability and are continuously scalable and monetizable throughout the vehicle's lifecycle.

A combination of trends and enablers will help bring this strategic vision to reality.

2011 — 1.2 million
2018 — 5.5 million

Number of pixels on in-car display [2]

2028 — 90%

Voice assistants are projected to be embedded in nearly 90% of new vehicles sold globally by 2028 [3]

$$\frac{10}{100}$$

10 years ago, high-end premium cars contained 100 Electronic Control Units (ECUs) and used 100 million lines of code. Now every low-end vehicle reaches these numbers since additional Advanced Driver Assistance Systems (ADAS) became a standard. [1]

Navigation	Musical entertainment	Automotive services
81%	70%	70%
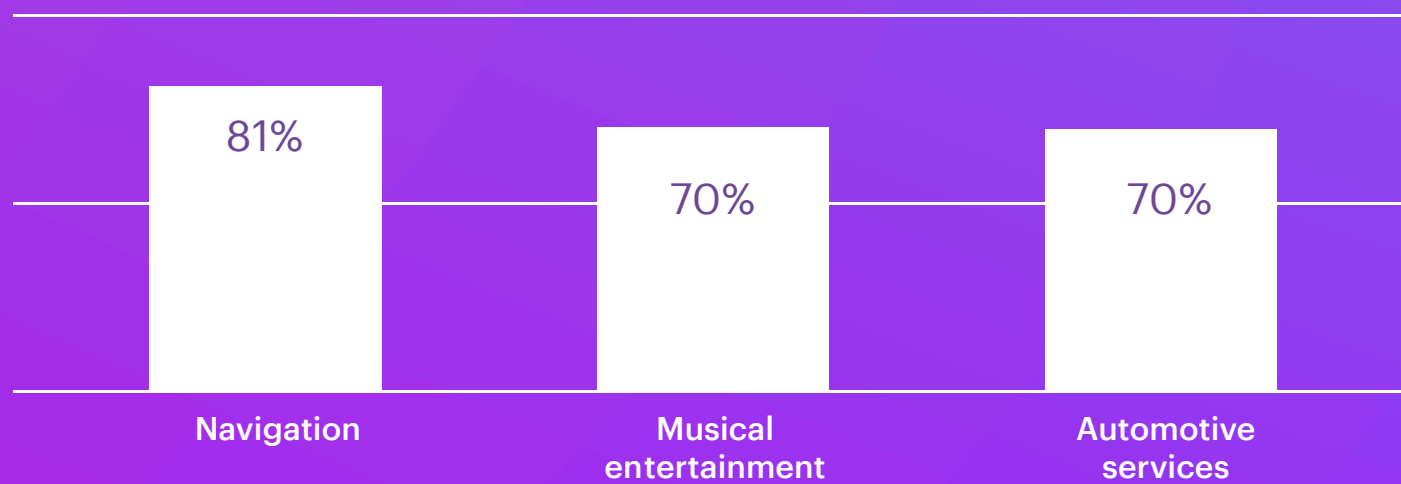
Top 3 desires of in-vehicle voice services (Germany n=780) [4]

(1) https://spectrum.ieee.org/software-eating-car, (2) Daimler Trucks | Presented at CarHMI 2021, (3) Sam Abuelsamid, Principal Research Analyst, Navigant Research at Automotive World, Oct. 2019, (4) 2020 J.D. Power / Alexa Automotive InVehicle Connectivity Voice Study
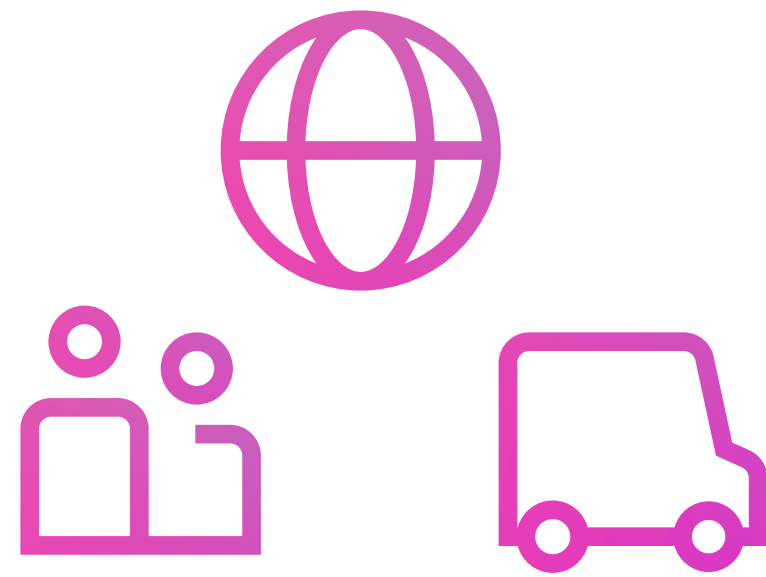
Key trends that will have most influence on in-car HMI development

1. The third space

The car of the future is the ultimate mobile device. No other surrounds the human physique as intimately—or has the potential to know as much about us and our current state. All of which renders the car of the future a hyper-sensitive and highly empowering 'third space.'

In the future, the value of this space will expand by allowing its users to stay connected to their external living and working environments through personal profiles stored in the cloud. As users enter the car, digital user profiles are instantly present, and all parameters and content are transferred automatically or on request.

The car will detect the contextual situation of each passenger, providing tailored services that address all senses by making use of an array of sensors, built-in Artificial Intelligence (AI), smart haptic surfaces, wellness functions, high-end audio and visual fidelity. The vehicle will even be able to constantly measure such bio parameters as heart rate, body temperature, stress levels and possibly emotional state as well. As a result, a digital service layer will unfold between the vehicle and its passengers, creating new opportunities for designers and developers to create unique, brand-shaping, in-car experiences.
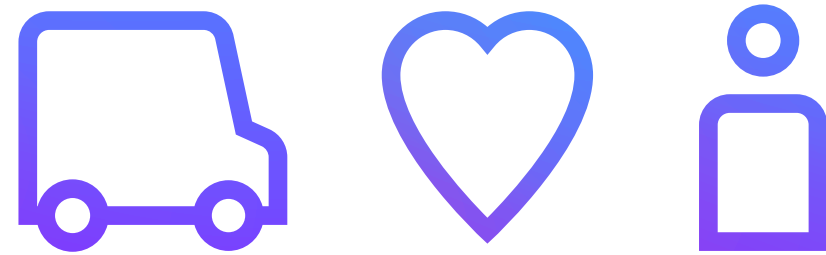
2. Smart new friends

With more sensors, data processing and the promise of AI, the stage is set for truly smart in-car companions. Rather than having to actively search for functions, passengers will become passive approvers of service suggestions. And the services these 'smart new friends' offer will extend far beyond the context of mobility.

Tech players have taken the lead in presenting their vision of how digital assistants can interact with each other to create a multi-assistant world around the user. Initial prototypes have shown how an OEM assistant will be able to co-exist with an assistant from a tech brand. The opportunity for car makers now is to provide unique brand experiences, enhanced by partnerships with technology companies.

Of course, a 'transparent customer' presents opportunities for the potential abuse of personal data. However, beyond the technical parameters for data security, 'design for control'—enabling users to override AI at any given time and using a smart assistant as an initial moderator—can build trust, especially within an automated context. Eventually, users will start to focus on the advantages of being served and less on decision making—an approach that will accelerate AI integration and the adoption of anticipatory, frictionless and assistant-driven HMI solutions.

Key trends that will have most influence on in-car HMI development

"Intelligent products are the key enabler for a shift from output-based to outcome-based business models. 'Outcomes (or abilities), along with great product experiences will be the most valuable currency of the digital age'."

Eric Schaeffer and David Sovie, 'Reinventing the Product'

3. The organic product

The car of the future will be in continuous development, beyond purchase and ownership, constantly renewing itself through software updates and real-time processing of data — an 'organic product' on wheels that adapts to new usage patterns, individual user requirements and societal and economic developments just in time, or even ahead of time, as predictive intelligence will be one of its key attributes.

Tailored experiences (outcomes) will be a unique selling point for this product. In many cases, the outcome itself will be sold, with the car as the delivery device, enabling and supporting Anything-As-A-Service (XaaS) business models.

The HMI of this product needs to be equally 'organic' in nature—requiring modular and adaptive layout patterns and architectural configurations. Consider, for example, how decoupling hardware and software in future vehicle-platform development will influence how vehicle interiors are conceived and designed. Displays and control surfaces could become as independent inside the car as your tablet is when lying on your living-room couch. Imagine, too, an organic symbiosis between hardware and software, the look and feel of both virtual elements and of the vehicle's physical interior space. A new harmony between interior fabrics and virtual backgrounds, between physical levers and virtual touchpoints; a responsive relationship between infotainment color profiles and the color of the shirt you happen to be wearing.
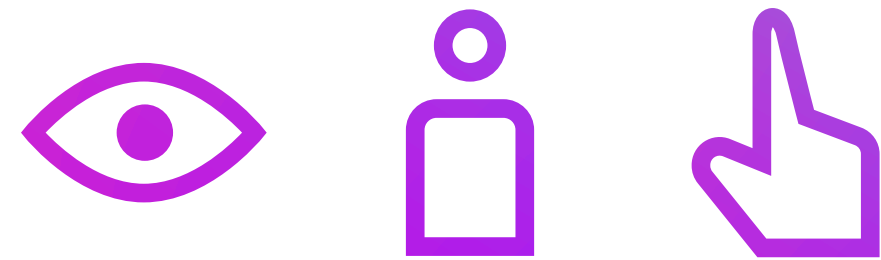
4. Multi-modal interactions

As the boundary between analog and digital interfaces blurs, the separation of input and output channels of interaction disappears.

Regarding output solutions, almost all OEMs have bet on larger screens and head-up displays. But to orchestrate interactions across multiple channels, they need to go beyond purely visual sensations, creating a world around the user by addressing all human senses. Transparent screens instead of glazed areas or VR/AR headsets could replace conventional built-in and head-up displays to enrich driver and passenger experiences. Going forward, sophisticated haptic, auditory, olfactory and possibly even gustatory stimuli will create uniquely 'branded' interactions. Vibration-pattern, peripheral-vision and soundwave-based air-touch technologies could help limit sensory overload by expanding the human ability to process information.

The future of input can be seen in the sophisticated interplay of speech, accompanied by touch, or cameo appearances of gesture controls. In addition, finely crafted physical buttons and levers, augmented with configurable digital elements, could enhance the overall in-car experience while still supporting the remaining desire for tangibility in specific situations. Passive interaction triggered by cameras and sensors, sometimes even beyond users' direct awareness, will become the next milestone on the way to a seamless and efficient interaction experience. Given all these new technologies, hierarchy and the right balance will be needed to manage complexity and determine the right kind of feedback or input method for every situation.

37.6

17.2

2018 2025
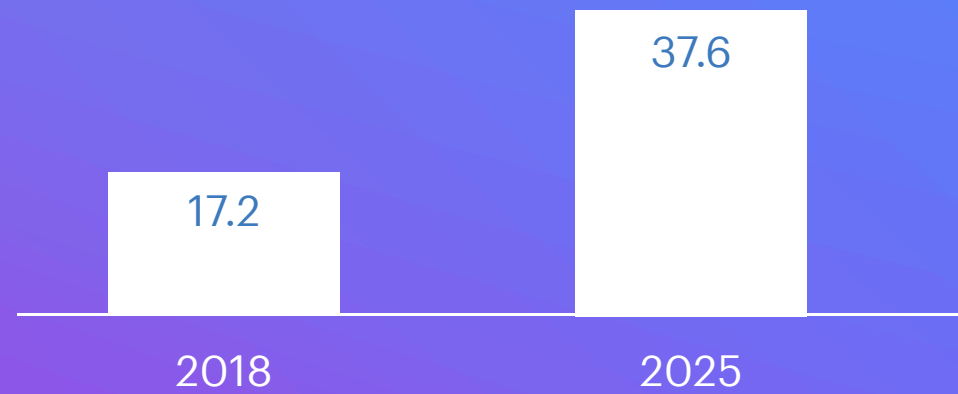
The in-car Infotainment System market is expected to reach $37.6 billion by 2025, increasing from $17.2 billion in 2018[1]

2022 — 70%

By 2022, 70% of enterprises will be experimenting with immersive technologies for consumer and enterprise use, and 25% will have deployed them in production[3]

2028
— 166 billion

Connected cars – global market size by 2025: $166 billion[2]

2030
— 81.1 billion

Projected global revenue for in-car connected services by 2030: $81.1 billion[4]

90%

By 2023, 90% of all new vehicles in the US (and 70% of light-duty vehicles and trucks worldwide) will feature embedded connectivity capabilities[5]

Key enablers that will have the greatest impact on OEM investment strategy

1. Backend standardization

The contextual and qualitative gap between using phones or tablets and using In-Vehicle Infotainment systems (IVIs) is closing as technology progressively disrupts the car's digital touchpoints. For the consumer, this standardization is more than welcome, not least because it's so much more convenient to have the same user interface on a phone, rather than in a car.

For OEMs, however, standardization poses major challenges. How, for example, can they differentiate the brand experience (beyond the purely visual) when layout, structure and hierarchies are near-indistinguishable? There are questions too around data ownership, operational safety and liability.

Depending on the degree of freedom required to decide and shape interaction methodologies, OEMs must either accept the deep integration of tech offerings and utilize a standardized development platform, Android™ Automotive Special Interest Group (AASIG) as a basis for custom Operating System development, or simply retain established alternatives to Android. Each option has implications for development effort, costs and time to market. Some brands will become synonymous with tech players while others will remain as independent as possible, with all the tradeoffs and advantages that choice implies.

Key enablers that will have the greatest impact on OEM investment strategy
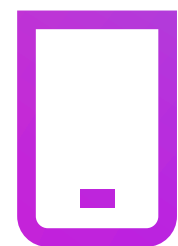
2. V2X connectivity

A key addition to the scope of passenger-vehicle interaction will be 'Vehicle-To-Everything' (V2X) communication, made possible thanks to significantly reduced latency lags and the increased data transmission speed of 5G technologies.

OEMs and suppliers have showcased a multitude of solutions in this space, but four are of particular importance:

1. **Enhancing vision:** targeting the ability to 'see through' vehicles and objects while forecasting their predicted future movements with visual/sensory data provided by other 'V2X-ready' vehicles and connected infrastructure.
2. **Enhancing knowledge/awareness:** realizing the ability to communicate with pedestrians, cyclists and other vehicles via exterior-facing displays, projections or sounds.
3. **Enhancing mobility:** allowing drivers to make intermodal mobility choices during a journey by linking each vehicle to a larger urban mobility ecosystem and platform and enhancing a vehicle's autonomous capabilities by 'talking' to infrastructure.
4. **Enhancing transactions:** enabling drivers as well as road-side businesses to interact and facilitate transactions with the help of location-based services.

Manufacturers need to develop smart solutions to filter and prioritize the flow of information, while providing the right input modalities for a variety of dynamically evolving scenarios. This will require deep collaboration with tech companies (5G networks), cities and governments (infrastructure platforms), large retail players (vehicle based virtual shopping) and financial institutions (payments).

In the future, cars and their passengers will become an important information-sharing node of Internet of Things (IoT) networks and proactively participate in improving these networks. The car, in short, will contribute to the solution of social and economic challenges.

Key enablers that will have the greatest impact on OEM investment strategy

3. Automation

Increasing automation will totally transform an operational and ergonomic set-up that has remained fundamentally unchanged for 120 years—and this implies significantly new levels of HMI adaptivity.

Current solutions rely on a combination of steering wheel buttons and feedback infographics in the instrument cluster, enhanced by sounds and vibrations—a set-up that still requires a high degree of the driver's attention without adding any true value in terms of, say, freedom of movement. Consider, by contrast, operating concepts that temporarily retract such driving-related elements as steering and pedals from the driver, while bringing leisure-related interfaces and interaction touchpoints closer. Buttons and digital touchpoints within the car are highly configurable and multimodal to support different functions in different driving scenarios: the steering wheel as a games console, for example.

A personal assistant can help ensure both swift handover and an uncompromised user experience. If, for instance, the vehicle system suddenly demands the attention of a driver engaged in using a third-party shopping app, the assistant could continue the visual-haptic selection and purchase process in a conversational fashion while the driver focuses on the road. Smile-to-pay technologies are already beginning to revolutionize convenience stores in China. It won't be long before frictionless access and payment technologies become fundamental to a vehicle's automation experience.

Going forward: a fresh approach to innovation

It's time to engage a new mix of talents in the development of in-car HMI systems. That is, experts who have conceived, tested and established tools and methods for digital product and service development, and who can drive forward the human-centric, platform-based and constantly evolving products that enable hyper-contextualized, end-to-end experiences.

Five elements will be critical to successful innovation:

1. Collaboration with an agency partner bringing in a cross-industry perspective in addition to a multi-faceted range of designers, technologists and strategists can forge an alliance that fosters the creativity and process innovation required to transform new ideas into game-changing products.

2. Integration of all disciplines engaged in development. Siloed structures, with siloed development goals and budgets inhibit collaboration and kill innovation.

3. Design-thinking methodologies can help development teams reflect on new knowledge and ideas before an initial product concept is defined, thus identifying a problem before defining the right actions to resolve it, while remaining in constant touch with the people they design for.

4. Rapid-prototyping practices, combined with user clinics, or 'theater plays' that stage future scenarios can help to make product visions tangible at a very early stage, and identify desires and validating assumptions throughout the development process. The continuous analysis of reception factors for HMI solutions using holistic UX evaluation tools will also make it easier to strike a balance between the investment and the actual impact of a solution on the user.

5. Creative freedom. Playfulness needs to become the cultural baseline for any organization that aims to create truly human-centric products. This naturally includes the ability to embrace failure and the insights derived from it.

An organic and constantly evolving product—in perpetual flux, never finished, but better every day than it was the day before—this is the car of the future. And nothing embodies its capabilities better than the universe of digital interactivity between passenger, vehicle and environment: all facilitated through the vehicle's HMI.
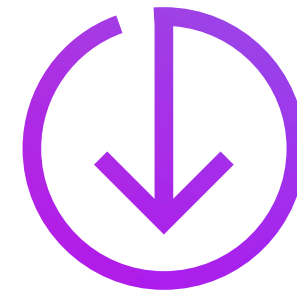
In the next few years, we will see the in-car HMI transform into an intelligent, proactive medium, with the user assuming a new role as an 'approving' consumer. Embedded AI will lead inexorably to an organic relationship that's also hyper flexible, adjusting to the individual user in context—a truly My(H)MI.

Two People on The Move in 2035

Both Anna and Haruki have moved on. In-car HMI is not only central to the driving experience for both of them. It's also reshaping their lifestyles.

Anna now centers all of her mobility needs around a Personal Companion Service as offered by most OEM brands. Her companion makes switching between different vehicles and brands a whole lot easier for her - making her feel at home instantly, no matter the type of car she's using on-demand. The van she's using this week to help her daughter move into a student dormitory is as intuitive to use as the convertible she enjoyed last weekend on a trip to the mountains. The AI of the companion knows her preferences and takes over all relevant tasks aside from the (occasional) driving. It connects seamlessly to any car she gets into, adjusts settings, navigation targets and connects to her digital periphery.

Anna's car brand of choice is known for a strategic partnership with a large insurance brand, offering secure financial services tailored to in-car applications. This has built trust and Anna lets the companion take care of payments via her digital wallet while driving.

Thanks to the companion, which she trusts like an old friend, Anna's shared-car time is no longer digital detox but quite the opposite: it's the time when she feels most connected and cosseted by digital services and comfort features, almost independent of the actual car she's driving. But most surprisingly, Anna is now really fond of a certain car brand and its promises – something she didn't care about in the past, as cars themselves did not mean much to her.

Haruki is still a techie and can't wait for the streamed introduction of the next-generation OS for his type of car. The joy of anticipating the next big update reminds him of waiting for the big Apple events of 20 years ago, with all the announcements he is so eager to see. Haruki has recently become disloyal to his long-term favorite European car brand. Three years ago, he switched to a brand that co-operates with a tech player that not only stands for superior interior and infotainment experiences but also enables Haruki to fully celebrate his passion for digital upgrades.

Haruki continuously 'grows' his car and increases its value, just like others do with gaming characters that become more powerful and valuable the longer you play. Being a huge fan of consumer media in his car, Haruki has every available sensor on board and connects the car to all his wearables and other devices. He allows the car to access all of his data so that he can enjoy tailored micro-interactions which make the vehicle a true extension of himself. Haruki perceives his car as something that almost gives him super-powers, enabling him to do things like seeing through objects and anticipating the actions of objects around him ahead of time.

His car has become a truly immersive and highly empowering microcosm, fully integrated with his connected lifestyle.

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Having led game-changing interface design projects for automotive clients globally, Werner now drives strategic business development for mobility and cross-industry clients. As creative head, consultant and manager he benefits from 20 years of experience in the broad field of HMI. With a passion for transforming strategies and ideas into innovative and meaningful solutions, he advises the industry on the digital transformation of their products and services.

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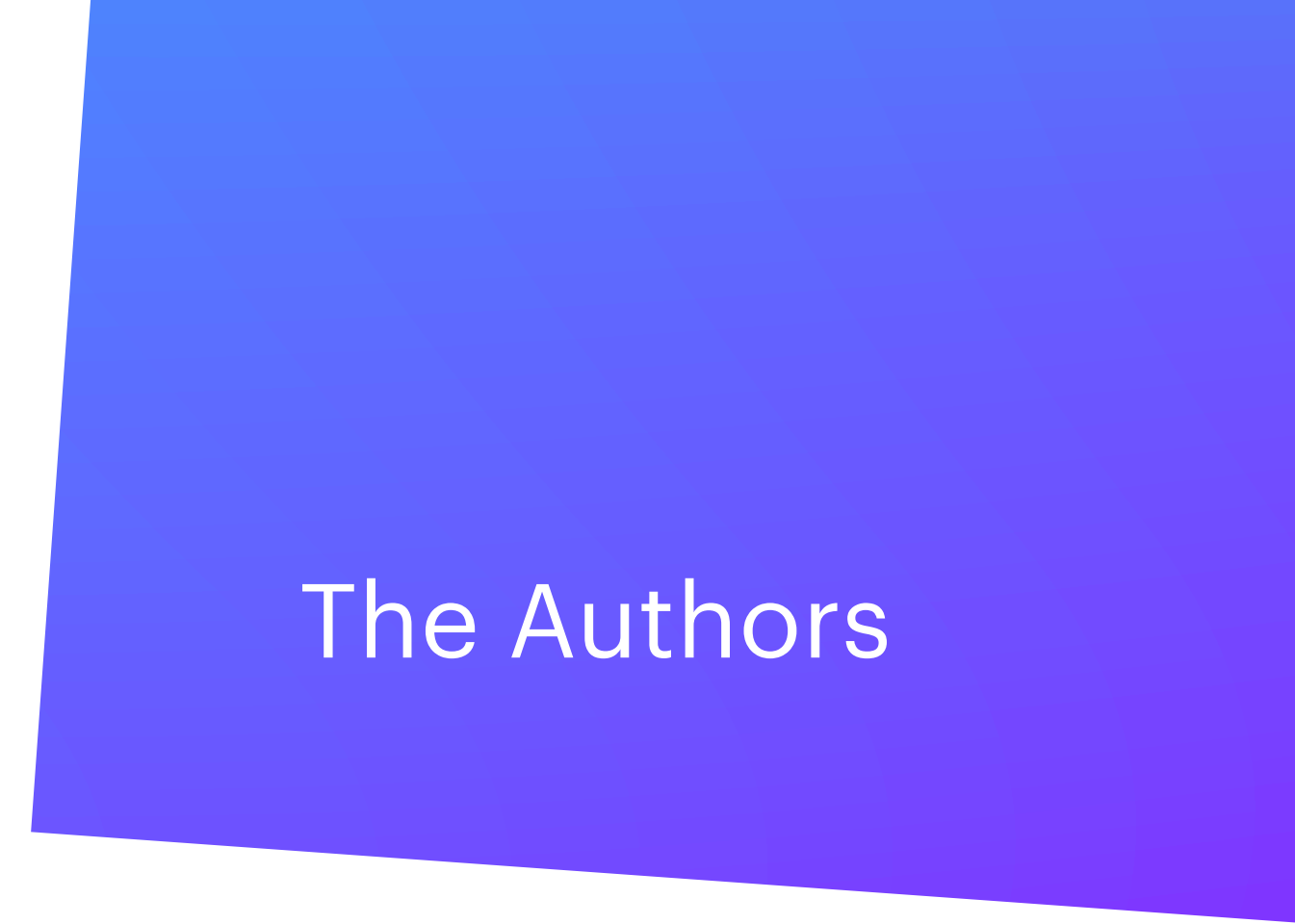
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