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/ CONNECTIVITY AND ELECTRIFICATION IN FUTURE VEHICLE DESIGN

INTRODUCTION

We depend on vehicles every day. From the car that takes us to work to the truck that delivers our groceries, modern vehicles are critical to the global economy. These vehicles are constantly being developed, offering new features and improved capabilities. However, the automotive industry is on the edge of a revolution that will see changes not just in the technology that vehicles use, but also the way in which they are manufactured.

This rapid rate of change in vehicle technology is the result of several key innovations that are all maturing at the same time. The level of sophistication that we will see in future vehicles is forcing the manufacturers to re-evaluate how they design and build their products.

At the very heart of the changes in the automotive market is the interest in electric vehicles (EV). Consumers around the world are seeking alternatives to conventional fossil fuels, and there has been a rapid growth in demand for electric and hybrid vehicles. The advances in battery technology, along with the latest battery management systems, mean that electric vehicles are delivering new standards of reliability and performance.

However, the growth of the EV market is just one of the changes that is revolutionising the field of car design. The automotive industry is benefitting from developments in other fields to deploy new and exciting functionalities into our vehicles.

Vehicles will also provide a new standard of connectivity as they share information with other road users in a network that is known as V2X (Vehicle to Everything). Using the latest 5G wireless communication network, vehicles will be able to transmit information about their location, road conditions and intentions to other vehicles, as well as smart phone-carrying pedestrians and even the city infrastructure. This information will allow other road users to build a complete picture of their local environment, thus enhancing road safety.

HOW ARE EVOLVING VEHICLE ARCHITECTURES AFFECTING THE NEED FOR CONNECTIVITY?

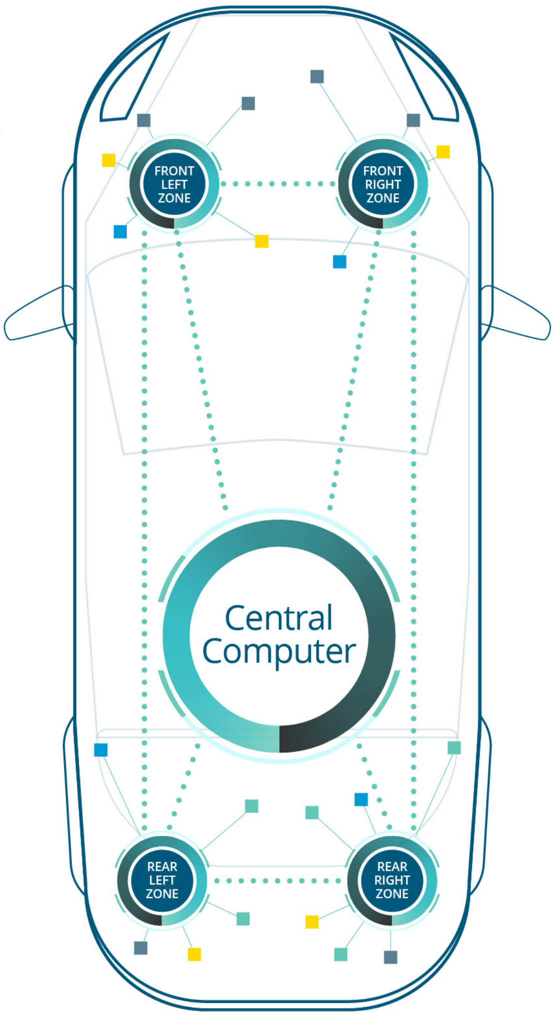
Despite all these advances in automotive technology, the way in which cars are designed and manufactured has changed little over the last decades. The installation of sophisticated components has happened gradually over many years, and vehicle cable harnesses have grown in complexity as a result. When new features are added to the existing vehicle wiring, each is controlled by its own module, known as an electronic control unit (ECU). Each ECU is provided with its own dedicated wiring that connects it to the rest of the vehicle.

The result of this approach is that modern vehicles can now be fitted with as many as 150 ECUs, along with the associated wiring harnesses. This means that manufacturers are running out of space in their vehicles for new technologies, and their wiring requirements are approaching the point of saturation.

Modern cable harnesses are tasked with delivering power, data and signals all over the vehicle, and their complex shape means that they are costly to make. Despite the adoption of highly automated production lines, cable harnesses are one of the few systems of any vehicle that are largely made by hand. Manual assembly of any component is expensive.

There is also a significant impact on quality. Robots are poorly equipped to manufacture or install vehicle cable harnesses due to their complexity and pliability. Wiring harnesses are designed to flex, twist and move freely, making them difficult for a robot to handle.

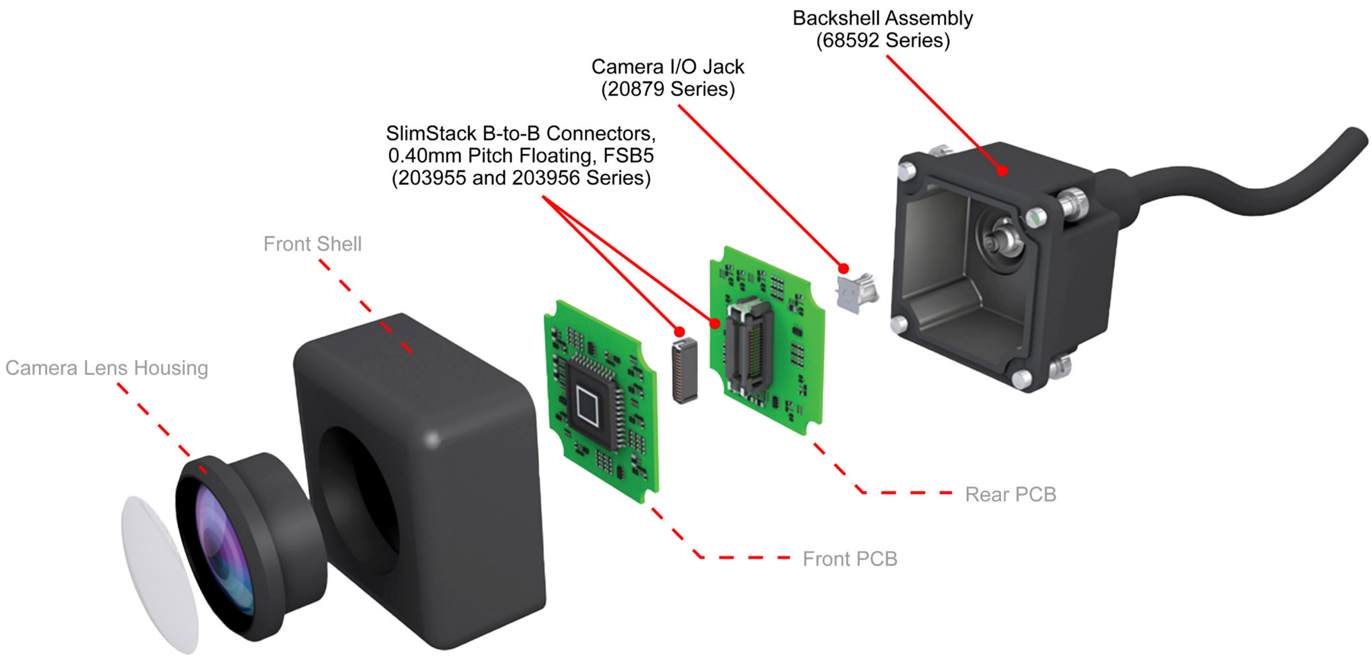
The profusion of ECUs and the complexity of the cabling that connects them makes it difficult to integrate the next generation of technology without changing how vehicles are designed. This has led to a new concept known as Zonal Architecture.



The electronic systems within the modern vehicle often represent over half of its value, with new features constantly being added. Here is a conceptual overview of what zonal architecture could look like in future vehicles.

Zonal architecture is the name given for the new structure of vehicle electronics. In contrast to a traditional vehicle in which systems are grouped by function, zonal architecture offers a more efficient solution. The functions within a vehicle are grouped by location into several zones.

Each zone is responsible for the devices that are installed in a particular section of the vehicle and is connected to a locally installed zonal controller or gateway. Because a zonal gateway is close to the devices it controls, the cable lengths required to connect them are relatively short.



Intelligent design enables robotic assembly and meets small space requirements, critical to achieving miniaturisation in cameras, radars and LiDARs. Shown: Molex Slim Stack Floating FSB3 and FSB5 Series

Each zonal gateway is connected to the central computing cluster at the heart of the vehicle. The communication between zonal gateways and the central computer resembles that of a computer network rather than an automotive harness. As a result, this inter-zonal communication can take place over small, high-speed networking cables that greatly reduce both the quantity and size of the harness that must be installed around the vehicle.

This new approach leverages the latest developments in computing power and high-speed communication, both of which will be essential due to the huge increase in data that this next generation of vehicle must process. The array of sensors that will form the eyes and ears of the latest Advanced Driver Assistance Systems (ADAS) and autonomous systems will create an unprecedented volume of information that must be processed at high speeds. The vehicle network of the future will see speeds of 10 Gigabits per second (Gbps) and greater. Cars equipped with zonal architecture will require computing power equivalent to several of the best desktop workstations, a "data centre on wheels."

Although the move to zonal architecture will be led by software, the physical structure will play a huge part in making this concept a reality for manufacturers. Easier assembly, reduced weight and advanced modularity are just a few of the advantages that a zonal structure will bring to the task of building tomorrow's vehicles. Connectors will be critical to these designs, and Molex is already developing the solutions to deliver both high power and high speed in this new automotive environment.

Of particular interest is the development of connectors that can be assembled by robots. Despite the advances of zonal equipment, the installation of cables and connectors will remain a manual process unless connections can be adapted for automation. Molex is taking its decades of experience in automotive connectors and applying it to the problem of robot handling. The result will be a range of connectors that is designed from the outset for automated assembly.

Meet the Molex HS Family

The "Connected Vehicle" industry has seen the rapid proliferation of in-vehicle cameras, digital high-resolution displays and 24-bit colour imagery. This has led to a sharp increase in bandwidth requirements for automotive and commercial vehicles. The next-generation HSAutoLink interconnect system addresses these ever-increasing requirements by providing a robust, sealed and cost-competitive system with data rates up to 13.5 Gbps. Supporting multiple high-speed communication protocols such as LVDS (8 Gbps – 4 GHz per lane), USB 2.0, USB 3.1 (5 Gbps) and DisplayPort, FDP-LInk4 (13.5 Gbps), the HSAutoLink interconnect system has the bandwidth to support advanced infotainment, telematics and camera devices across the automotive and commercial vehicle industries.

The dependable HSAutoLink interconnect system brings a proven, USCAR-30 compliant solution for point-to-point in-vehicle connections, complete with multiple keying options and full-length cable shielding for superior signal performance and reduced electromagnetic interference (EMI).

Along with superior bandwith and signal integrity, cable solutions must be able to operate across multiple systems and automotive protocols. Shown: Molex HS Autolink and typical automotive cockpit applications.

HOW ARE INNOVATIONS IN THE AUTOMOTIVE WORLD INFLUENCING OTHER INDUSTRIES?

Just as the vehicle design can benefit from technologies developed for other markets, trends in the automotive world have huge influence over many other industries. The development of high capacity batteries, rapid charging technology and advanced connectivity has found a ready audience in a wide range of applications.

Battery technology is at the heart of the next generation of vehicles. The widespread adoption of electric vehicles will depend on their performance and convenience. Petrol and diesel are such useful fuels for vehicles because they provide a high energy density. They can deliver a lot of energy from a relatively small volume and weight. Modern family cars might carry around 60 litres of fuel at a mass of just less than one kilogram (kg). This will be sufficient to take the car nearly 1000 kilometres. When the time comes to fill the tank, it will take less than 10 minutes at any of the thousands of service stations on our roads.

The battery of an equivalent electric car is several times the mass of a 60 litre fuel tank, and it will struggle to provide the same range. The manufacturers of today's highest-performing electric vehicles state that they can reach just 500+ kilometres. The appeal of electric vehicles will depend on drivers being able to recharge their vehicle quickly. Manufacturers understand this, and so battery technology is constantly being refined. Fast charging is being delivered in the form charging stations, capable of providing an electric car with 300 kilometres worth of power in just 15 minutes.

This improvement in battery performance is being welcomed in applications beyond conventional road cars. A wide range of industries are interested in the use of electric propulsion to reduce their environmental impact and to improve the flexibility and reach of machinery. Even military forces around the world are actively exploring the possibility of all-electric fleets to reduce their dependence on long and complicated supply chains.

Beyond the battery, the sensor and computing technology that is enabling self-driving vehicle to become a reality will also find use in other industries. For example, in the use of robots in domestic appliances such as robotic vacuum cleaners and lawnmowers. Sensor and computing technology will become heavily used in harsher environments too.

The world of agriculture is facing a daunting array of challenges as the global population is predicted to reach nearly 10 billion by the middle of the 21st century. The use of autonomous vehicles, both land-based and airborne, will be welcomed by farmers around the world.

This self-driving machinery will use the same sensor suites as road-going cars to provide the vehicle with a real-time representation of its surroundings. Advanced computing systems will use edge computing to assist the farmers' decision-making process, effectively enabling them to be in several places at once. Farmers will use this technology to produce more food whilst using fewer resources.

The automotive industry has always been at the forefront of new developments. The latest generation of vehicle design is delivering new innovations in batteries, computing power, sensors and connectivity. We will see the benefits of these developments far beyond our driveway or the parking lot.

HOW WILL IN-VEHICLE FUNCTIONALITY CHANGE DRIVING EXPERIENCE FOR THE NEXT GENERATION?

As consumers, we are more familiar than ever with modern technology. Touchscreens and Bluetooth connectivity have changed mobile phones into smartphones, and the same technology has found its way into almost all other markets. Inside the home and outside, we expect our devices to provide the same immersive experience. This includes our relationship with our car.

The increasing use of touchscreen displays has combined with new methods to provide data to drivers, including head-up displays (HUD) and the use of augmented reality (AR). As a result, the in-vehicle experience has changed beyond all recognition. This has led to the car of the future being described as the "third living space," as drivers begin to enjoy the same level of functionality that they might experience in the home or the office. Part of this new in-car experience takes information from the next key area of development.

The use of Advanced Driver Assistance Systems (ADAS) has become more common recently. These systems are designed to augment the driver's skills to make the roads safer for all users. What began with a simple reversing camera has evolved into an integrated system that receives information from an array of sensors.
This information is collected and processed in real time, allowing the car to identify potential hazards in the environment around it. From lane-departure sensors to traffic-sensing LIDAR (light detection and ranging), vehicles are able to take action to avoid accidents.

Standard FAKRA is being replaced by smaller, intercompatable and fully-shielded systems that deliver higher data speeds and allow more connections in vehicle architecture. Shown: Molex HFM

To fully realise the goal of the driverless vehicles, this same suite of sensors will be crucial to detecting and identifying hazards. However, the computing power required to analyse the data collected by these sensors, decide upon a course of action and safely navigate around the obstacle is beyond that currently seen in road-going vehicles. The next generation of automotive computers will use artificial intelligence (AI) and machine learning (ML) to provide the speed of response required.

These same technologies will also change how we use our cars. While more mature customers still want to buy their own vehicle, younger generations will be more interested in transportation-as-a-service (TaaS) models that reduce the emphasis on vehicle ownership and promote alternative solutions to mobility. The in-car experience needs to be flexible enough to optimise vehicles for each customer type, from full ownership to a pay-as-you-travel model.

These latest innovations will see our relationship with vehicles change enormously. Whether we choose to drive ourselves, or enjoy the benefits of autonomous transport, how we interact with the in-car environment will be driven by the technology.

WHAT DOES THE FUTURE HOLD FOR VEHICLE MANUFACTURING?

The introduction of zonal architecture will represent the greatest change in vehicle design for decades. Instead of being hardware-driven, software will provide the method by which new features are integrated into the vehicles we drive. Their layout will take more inspiration from computer networks than previous generations of car design, and the zonal structure of new vehicles will make the integration of new features simpler.

Cars that employ zonal architecture will require less wiring, saving weight and cost, and as a result will be more capable. The improvements in battery performance will allow electric vehicles to rival the utility of their conventionally powered equivalents, and the dynamic controls will adapt to a wide range of usage models, from traditional ownership to on-call TaaS.

These benefits also present challenges for connector manufacturers. Designers will need to find methods for connecting power and high data speeds in the tough automotive environment, while still delivering the high reliability that we all expect from today's cars.

Hopefully this guide has given you some useful insight into the broad range of factors affecting connector development for electric vehicles, the capabilities of Molex's various solutions and how to employ the right connectors in your designs.

If you're ready to take the next step, our team of FAEs works closely with Molex to provide you with the highest level of engineering support for your design. You can get in touch with them in your local language at **avnet-abacus.eu/ask-an-expert**

Alternatively, if you need more time to explore Molex's solutions for vehicle electrification, find out more at **avnet-abacus.eu/molex-ev-solutions**