FORMULA E RACING MAKES AN IDEAL REAL-WORLD PLATFORM FOR DEVELOPING NEW TECHNOLOGIES

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Formula racing has long been a testbed for automotive technology. Today, Formula E racing—all-electric cars capable of 0 to 100 km/h acceleration in 3 seconds and top speeds of 225 km/h—are important platforms for developing battery technology and electric powertrains.

But racing is not the only endeavor where these technologies can be applied. Engineers from the worlds' best solutions providers have developed partnerships with race teams to create synergies where technologies that help win on race day can be transferred to a broad range of applications. Military and commercial aerospace, military ground vehicles, industrial automation, appliances, and automotive are among the industries that will benefit from the lessons learned about withstanding harsh environments characterized by tremendous shock and vibration, extremes in temperatures, and chemical exposure.

Formula E racing provides a testbed for developing sensor and connector technology having a wide range of applications.

Making Sense of Performance

An electronics-first approach is changing the design of racecars. As more sensors deliver more data to monitor, control, and communicate car performance, packaging and interconnection of electronics becomes ever more challenging. The harsh environment, coupled with the ever-present need to save weight and make efficient use of constrained space, makes autosport an ideal real-world platform for development engineering.

Sensors measure just about everything on the car that can be measured: pressures, speeds, temperatures, displacements. A Formula E car can have 200 data channels providing information that must be collected and logged—creating gigabytes of data. The data is used three ways. Some is directed to the driver's display. Other data is sent by telemetry to the race team for real-time analysis that will allow adjustments to be made during pit stops. Finally, all the data will be analyzed after the race. The data forms a treasure trove of information about the car's performance to allow adjustments to the mechanical and aerodynamic setup. The sensors must be connected to the computers logging the data by cable assemblies.

Saving Weight in Interconnections

Weight reduction is critical to competitive advantage. A few grams saved here and a few more saved there can add up to significant savings overall. There is also a developing trend toward high-density packaging of electronics parts. As the electronic content of cars increases, the natural drive is to miniaturize the package to gain maximum efficiency in the use of space.

The wiring harnesses and interconnection systems offer opportunities for weight and size reduction. The first requirement for connectors and cable is a rugged design that can withstand extreme temperatures, vibration, and exposure to fluids in general and brake cleaner in particular. The evolution of autosport-specific connectors demonstrates how important miniaturization has become in the sport. Smaller connectors typically weigh less, so attention was paid to higher density connectors. Stainless steels shells gave way to lightweight aluminum, with even lighter composite versions available. Features like coupling rings became smaller as well.

Autosport connectors were originally developed from military counterparts, evolving to become smaller, lighter, and easier to handle. Today, a shift is occurring where autosport connectors are being adapted to military and commercial aerospace applications to solve similar challenges. Space and weight savings are increasingly important in aerospace, even as the use of electronics means more data being transmitted throughout the aircraft. As military applications move to using or adapting commercial off-the-shelf products, autosport connectors are being increasing considered as alternatives to custom parts.

As connectors shrink in size, attention must also be given to usability issues, such as redesigned knurls to make it easy for a gloved technician to quickly and accurately connect and disconnect the connectors.

Composite-shell connectors offer an attractive alternative method for reducing weight. When the industry first looked at composite connectors, many did not live up to expectations for rugged performance in the autosport market. In particular, the composites did not withstand exposure to brake cleaner. As a result, designers moved away from their use. Composites, however, are evolving. They have improved dramatically, with the next generation believed to soon meet the needs of auto racing fully. Composites deserve a fresh evaluation of their ability to save weight and meet the mechanical and environmental needs of autosport.

Autosport connectors have evolved from military-style connectors to meet the specific needs of auto racing.

While both the commercial auto industry and the military are starting to use aluminum wire and cable for weight savings, they do not yet find widespread use in autosport. Aluminum wire is seen as hard to work with. Its bend radius is not as tight as copper’s and there are concerns over reliably terminating it due to cold creep. Yet contacts that counteract cold creep to form a reliable, gastight connection are available. Aluminum has only 60 percent of the conductivity of copper so a larger conductor is needed to achieve the same current-carrying capacity. Even accounting for this, aluminum will be about half the weight.

Technology Transfer: Applying the Lessons Learned

While winning races is the primary goal for the engineering partnerships. Formula E racing makes a good testbed for transferrable technologies. It is a fast evolving industry, where new things are tried and adopted if they work and discarded if they don’t. Racing cannot tolerate the long development cycles found in industries such as the military. In addition, the harsh environment is a great proving ground for assessing reliability and ruggedness.

The obvious area in adapting autosport technology, is in the automotive industry in general and electric powertrains in particular. On the horizon are autonomous vehicles, where sensors and data analysis will play an even bigger role than they currently do in driven cars. An autonomous car must not only monitor its own systems, but also needs to sense and react to the surrounding environment in real time. As car networks become more capable and sophisticated, interconnections must be able to handle the bandwidth requirements.

The autosport industry is looking at adding sensors to a driver’s clothing. The hot, bumpy environment provides a platform for evaluating wearable technology. What we learn in the cockpit of a racecar can have important implications for wearables in consumer, military, and industrial applications. Wearables need not only to offer small size and light weight, but also to accommodate the wearer’s movements without restricting them.

The Internet of Things

Wearable electronics are a subset of the Internet of Things (IoT). In simplest terms, IoT is the migration of the Internet beyond people; IoT can function without human intervention. Autonomous cars, smart homes, wearable electronics, and factory automation are all examples of IoT. The key ingredient in IoT is the use of the internet protocol (IP). IP is a communications protocol used by Ethernet and by the Internet to control the flow of information. Every attached device has an IP address. Every device with an IP address has the capability of communicating with every other IP device. (Of course, we have firewalls, passwords, and other security measures to control what devices can actually communicate with each other.)

One advantage to being part of the IoT ecosystem is that a device does not have to exist as a standalone system. Data sensed in an autonomous car can be used to control the vehicle's operation. But it can also communicate with a wider network, reporting about local traffic conditions to other vehicles and gathering information about remote traffic conditions. This interconnectedness will allow cars to reroute themselves to avoid traffic jams, road construction, and other hazards.

The electronic systems of Formula E cars, with their sensing, data gathering and logging, and telemetry capabilities are increasing our understanding of designing complex systems with sophisticated real-time interactions. And how to build them into challenging, space-constrained, weight-sensitive environments. Compared to a Formula E car, a passenger car is spacious.

Sensors are becoming smarter, with built-in intelligence that allows analysis to be done locally with only results transmitted back to the computer. Sensor packages with integrated electronics significantly lower the data load. For example, a temperature sensor can be set only to transmit data when the temperature rises above or falls below defined levels. An intelligent sensor can even become an IoT node with its own IP address.

Autosport is also driving the packaging of sensors: smaller, lighter, more rugged, and physically matched to the space. In other words, you don't have to design your space around the sensor. The sensor can be custom designed to fit the space. While autosport is a low volume application that makes custom designs relative costly, high-volume consumer and automotive applications will benefit from the economies of scale. A custom design will, at high volumes, become an off-the-shelf item.

TE sensor and connector technologies help partners like Andretti Technologies enable smarter, faster Formula E racecars.

The Cutting Edge Slices Both Ways

Formula racecars are at the forefront of technology. It's easy enough to think that the cars push the performance envelope only in speed. But there is a whole lot of cutting-edge technology behind that speed. Racing has long been a way for auto manufacturers to develop and prove new technologies. Automakers use the insights gained through racing to design and build better cars. For engineering and solutions providers, a technology-development partnership can provide insights that will benefit most of the industries they serve. And with formula racing, the technology seems to evolve as fast as the cars move.

ABOUT THE AUTHOR

Paul Webb is the sales and marketing manager for Autosport for TE Connectivity's Global Aerospace, Defense and Marine business unit. With more than 15 years of experience in the global motorsport industry, Paul has developed the TE DEUTSCH products from a small demand from Formula 1 to the market leader in interconnection solutions on all professional racing series. As TE continues to expand its racing presence, the insights and voice of Paul Webb continue to add value to the conversation of this growing focus, as he has been working with and watching these products evolve for many years.

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