

## Pressure points and the Bugatti Veyron

The **Bugatti** Veyron 16.4 may be the world's fastest road-going car, but it has one thing in common with even the lowliest, oldest, slowest of cars—or, more precisely, four things: the contact points of its tires with the ground. Sudden tire pressure loss can be a major safety hazard at any speed, but minimizing any risk in a car capable of 400 km/h (249 mph) is plainly essential.

Cross-fertilizing exotic Formula One (F1) motor racing technology into regular production applications is not a common event. But **Beru** F1 Systems has achieved it with DigiTyre, its tire-pressure-monitoring system (TPMS) for the new Bugatti. With a power output of 736 kW (987 hp), a top speed of about 400 km/h (249 mph), and all-wheel drive, the exotic Veyron is hardly an example of mass production (about 50

units per annum), but it is a road-going car, and Beru is optimistic that its system will receive wider use within the motor industry and that other F1-derived technologies will find production-car applications.

The Veyron's enormous performance potential creates a challenging and sometimes hostile environment for any component. Internal temperatures of its tires reach higher than 100°C (212°F)—a combination of air temperature and heat soak from the brakes—at maximum speed, with forces exceeding 2900 g; most OEM TPMSs would struggle to cope. However, such environments are Beru's speciality; for more than 12 years, the company has been supplying durable electronic devices to all forms of motorsport, often using military specification components and developing novel solutions to fulfill particularly demanding weight, package, size, and environmental criteria.

The rapidity of motorsport product development has also created a flexible and responsive culture in the company; the TPMS DigiTyre program for the Bugatti took 20 months from concept to validated parts. Used in F1 by four teams (Beru will not specify which), it is also found in Rally Raid vehicles, where exposure to sand and long periods of high loads makes it one of the toughest of all motor sport environments.

"The Bugatti Veyron 16.4 is the system's first OEM application and a rare example of direct technology transfer from F1 to road car," said John Bailey, Managing Director of Beru F1 Systems. Components of the DigiTyre system comprise wheel electronics, an electronic control unit (ECU), and an antenna system. The wheel electronics contain a military-grade battery, absolute pressure sensor, temperature sensor, accelerometer, microcontroller, and radio transmitter/receiver, all housed in a very compact and robust PEEK (Polyetheretherketone, a high temperature resistant engineered thermoplastic with excellent chemical and fatigue resistance and thermal stability) wheel housing.



The Bugatti Veyron uses a Beru tire-pressure-monitoring system.



Beru's tire-pressure-monitoring system comes in this electronics assembly.



A Beru sensor is positioned on each wheel rim.

"By mounting this lightweight—35 g (1.2 oz)—component onto the rear of a modified valve, there are no rim modifications and the installation becomes very straightforward," said Bailey. "Getting the weight down was critical. The tire is, of course, part of the vehicle's unsprung weight. Also, once the wheel is turning, the forces are very significant."

The ECU, mounted in the cockpit, is responsible for processing wheel data messages, which are then available on the vehicle's CAN (controller area network) data bus.

Beru F1 Systems uses the pressure and temperature sensors together to identify a puncture, cross checking values with preset parameters defined at the factory. There are two levels of alarm: Soft Warning if the tire has lost a small but significant amount of pressure over time, and Hard Warning, if pressure has dropped below a minimum level or the rate of loss is rapid. With the nominal tire pressure set by a CAN data bus message at the factory, the system works by compensating each wheel pressure and comparing this to its stored nominal pressure to calculate any pressure changes. This approach avoids potential false alarms due to natural heating and cooling of the tires.

"The Veyron installation represents a severe application, with the strain conditions far exceeding those we witness in F1," said Bailey. "On a production sedan, the system normally experiences 2000 g, but with 21-in wheels, the Veyron 16.4 exerts over 2900 g of centripetal force on the wheel electronics, their 35 g weight in effect becoming over 80 kg. For the Veyron, the fixing strategy is enhanced, combining the traditional mechanical fixing with an adhesive. A loose unit inside the tire could cause a major weight imbalance and induce handling difficulties, further exacerbated by the high speeds the Bugatti can achieve."

System development has not stopped at the product itself. Beru F1 Systems is

also providing wireless diagnostic equipment for end-of-line testing and dealer applications. Technology from the race track will also make life easier for technicians, said Bailey. "In a race, when wheel/tire combinations are changed, the system almost immediately automatically learns when a wheel has been swapped—without time-consuming software downloads. A greater understanding of road car development programs, coupled with our experience of their data buses, means that we will be able to transfer more of our technologies to the road to improve safety, reliability, and performance attributes."

Bailey is well aware of the growing importance of tire-pressure monitoring as a significant road safety tool. "In response to deaths and injuries attributed to tire failures in the U.S., Congress enacted the Transportation Recall, Enhancement, Accountability and Documentation (TREAD) Act in 2002. Beginning in October 2005, and over the next two years, the act will require a pressure-monitoring system for all passenger vehicles and light trucks sold in the U.S. that will indicate up to a 25% pressure variation from values specified by the National Highway Traffic Safety Administration (NHTSA)."

Surveys by NHTSA revealed that about 56% of passenger cars had at least one under-inflated tire. "We are expecting more and more manufacturers to look for turnkey, robust solutions. We are now talking to other OEMs, both high- and low-volume, to offer a rapid, reliable solution to those selling to the U.S. and other markets adopting the legislation," added Bailey.

NHTSA estimates that, when all new vehicles are fitted with the tire-pressure-monitoring devices, some 120 lives a year will be saved.

*Stuart Birch*

## Three for the Road

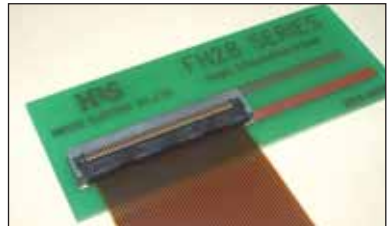
**W**ith so many critical applications in your design, Hirose knows that protection of an electronic system can only come from using the right connectors.

### GT17- USB



This connector has been developed for connecting various types of mobile electronic equipment, such as those that use a USB standard. The connector features 4 contacts with a 2mm pitch. The built-in lock is secure and verifiable. In addition to the locking mechanism, the connector has a polarized interface. Any attempt at incorrect insertion is impossible and damage will not occur to the contacts in the receptacle. Four polarizing options are available.

### FH28



The FH28 Series are robust and reliable. 0.5 mm pitch, ZIF type connectors for Flexible Printed Circuit (FPC) and Flat Flexible Cable (FFC). The connector is currently available in 40, 50, 55, 60, and 80 contact positions. The FH28 is designed for 0.3mm thick FPC/FFC and has a 2.55mm height with the actuator in the closed position.

### GT5



Designed for automotive applications requiring reliable and cost-effective "one-step" crimp termination of coaxial cables with transmission speeds up to 2GHz. The GT5 series offers a reliable latch, in a wide variety of contact positions and mounting styles. Interface polarization, color coding, and application designation meet the requirements of SAE/USCAR-19 specification titled: "Coaxial Cable Interface-Square Outer Conductor." Typical applications: GPS connections, AM/FM audio, cell phones and Tire Pressure Monitoring Systems (TPMS).

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For more information, go to:  
**[hiroseusa.com/autoad.htm](http://hiroseusa.com/autoad.htm)**

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## Saving time with software

**Mentor Graphics** has significantly extended its automotive offerings and is launching a comprehensive set of electrical and electronic (E/E) design solutions for the automotive market. With Volcano automotive networking solutions, and SystemVision, a new modeling and simulation tool for automotive mechatronics subsystems, Mentor now has tools for design and analysis of the electrical distribution system and its associated harnesses for embedded system/software and in-vehicle network design. And the company is now a premium member of **AUTOSAR**, the standards organization working to create an open standard for automotive electronic architectures.

virtual prototype and use simulation to perform the critical analyses of electrical, mechanical, thermal, and hydraulic subsystems needed to help ensure successful automotive system design. SystemVision is based on a mixed-signal modeling language, VHDL-AMS, which as a vendor-independent standard language enables very efficient information exchange between OEMs and suppliers, reducing communication problems with the concept of executable specifications.

SystemVision is fully integrated with Mentor's electrical systems design solution, Capital Harness Systems (CHS), and complements CHS' electrical analysis tool, Capital Analysis.

and Tier 1 suppliers, and CHS is now being deployed as the next-generation solution for many of these companies.

Mentor Graphics completes its comprehensive automotive solution with its "design to deployment" embedded software products. The Nucleus family of embedded software products offers an integrated developers' toolkit, ranging from UML high-level design tools through to the royalty-free real-time operating system (RTOS) and middleware specifically targeted to automotive applications and processors.

Additionally, Mentor continues to strengthen strategic alliances and relationships with other key suppliers to the automotive industry such as **UGS**, **The Mathworks**, and **Dassault Systèmes** to address the industry need for a complete design environment.

**Magneti Marelli** Powertrain has integrated Mentor Graphics tools into its application-specific integrated circuit (ASIC) development flow to achieve a reduction in design and simulation time. The company is using SystemVision for mechatronic system simulation (including safety function simulation) to design and simulate the core of a new digital ASIC. SystemVision provides a virtual lab, which supports industry-standard languages VHDL-AMS, SPICE, and C, for creating and analyzing analog, digital, and mixed-signal systems.

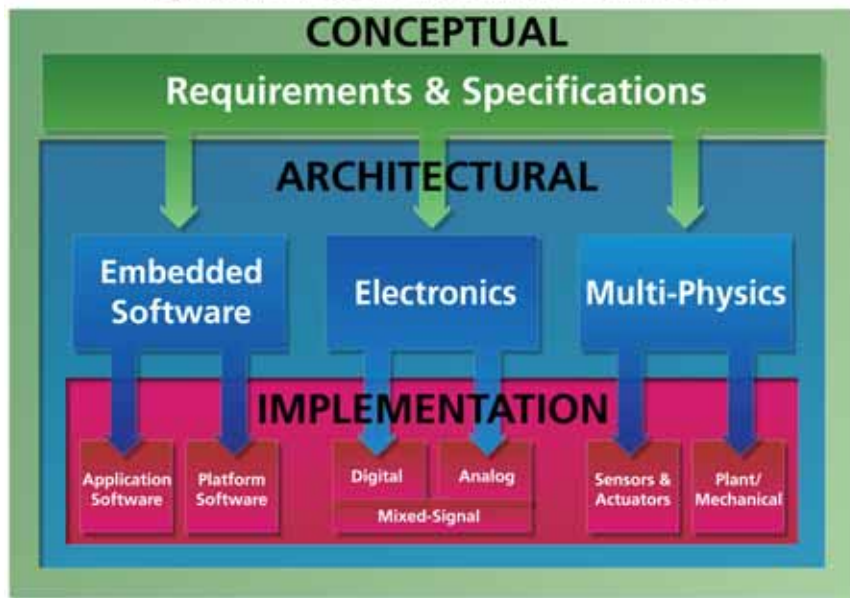
"Our Powertrain Division reduced development time for its engine control custom design flow by 30% using SystemVision and ModelSim, and achieved a full running component in the first release," said Edoardo Martelli, Methodology Manager of R&D Hardware Development at Magneti Marelli.

Magneti Marelli is also using Mentor Graphics products HDL Designer for design entry and ModelSim for digital simulation. These tools facilitate ASIC development across distributed design teams and enable practical design reuse through easy deployment of intellectual property.

The Mentor Graphics solution will be deployed in the Magneti Marelli Powertrain R&D site in Venaria Reale near Torino, Italy.

*David Alexander*

### SystemVision Mechatronic Flow



Mentor Graphics' SystemVision is being used by Magneti Marelli Powertrain to design and simulate the core of a new digital ASIC.

Mentor's strength in electrical systems and harness design was extended to in-vehicle network design with the recent acquisition of **Volcano Communications Technologies**. Volcano is an industry leader of networking and data communication solutions that support the development of in-vehicle networking systems. Customers include **Audi**, **BMW**, **Bosch**, **Visteon**, and **Volvo**.

SystemVision enables the designer to model systems and components with a

Mentor's CHS product suite captures and allocates all system devices into the vehicle topology. Merged with option and variant definitions, the entire electrical distribution system (EDS) is synthesized and stored centrally for reuse across the enterprise. CHS design tools are fully supported by analysis, view synthesis, and enterprise integration tools for correct-by-design outputs that minimize warranty exposure. Mentor is a leading supplier of EDS and harness solutions to major OEMs

## Programmable buttons mean fewer switches

Along with the ever-increasing number of electronic systems found in today's automotive vehicle interiors—entertainment systems, climate controls, seat adjustments, and mobile phone controls, to name a few—a multitude of operating switches and knobs have followed.

The sprawl of these switches in the car's cockpit is frustrating to drivers, who must search for the desired button to push, some of which are not within easy reach. In the unsightly welter of switches, the driver has to take his or her eyes off the road in the hunt for the right button, making driving more hazardous.



When the air-conditioning function is selected, circulation icons appear on buttons of Preh Automotive's freely programmable button (FPB) concept.

This problem remains even with the use of custom soft keys or a central operating display system with a touch screen that is difficult to mount ergonomically in the driver's line of sight.

A possible solution to this problem is **Preh Automotive's** freely programmable button (FPB) concept, which couples proven switch technology with intelligent multiple function button assignments to drastically reduce the number of required switches for a variety of electronic functions.



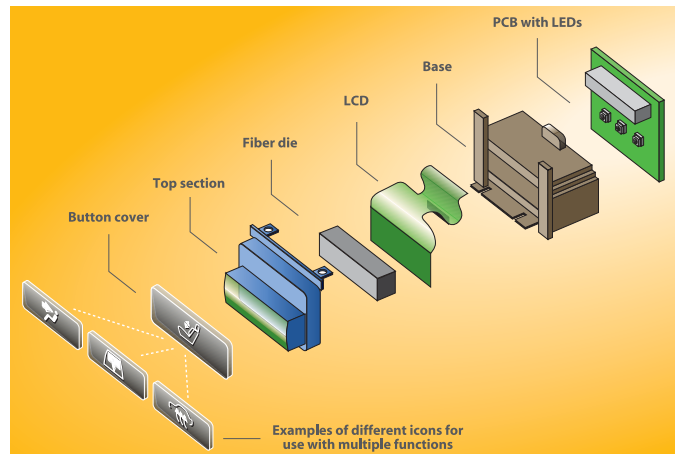
If the seat function is chosen, seat position icons appear on the buttons.

Preh's FPB array is contained in a control display configuration that can be located on a vehicle instrument panel or center console. The FPB system objective is to provide an ergonomic focal point where a large number of functions can be controlled using a very small number of button switches.

In the example shown, four fixed buttons indicate major system functions: telephone, seat position, climate control, and audio. Once a function button is pressed, the six blank buttons above reveal icons, as rear-projected by color LEDs, first onto a LCD and subsequently focused in high resolution through an optical fiber die onto the rear of the blank button.

When a different function is selected, the FPB button array displays the corresponding function icons, and the individual control buttons can be pressed accordingly.

Through the use of processor programming, even animated icons can be displayed—slow- or fast-turning fan blades, for example, corresponding to slow or fast blower speed; or moving seat



The programmable button structure can show multiple icon displays, depending on the selected function.

icons for seat position adjustments.

Although the FPB concept could conceivably permit a large number of buttons for controlling a single function, Preh's focus has been to provide the highest level of operating comfort while limiting the flood of switches. Theoretically, the button array can be assigned any number of programmed functions.

One undeniable advantage of the concept, however, is that convenience functions that previously could only be selected via display menus now can be activated more directly by way of switches.

At present, visual information is shown on display systems in vehicles equipped with them. FPBs offer interior designers a possible alternative for this role, assigning some buttons critical functions, and placed in the driver's optimal visual field to ensure minimal distraction.

Preh has already patented its FPB concept, which has been developed to series-production standards. The company says that it is continuing to further advance its rear-projection technology, using a variety of different approaches.

*Barrett Kalellis*



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