Vehicle electrical wiring systems: A global market review - forecasts to 2007

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Chapter 1 Introduction

Has the conventional wire harness had its day?

The basic function of an electrical distribution system is to provide the electrical interconnections necessary to distribute electrical power and signals around the car. Electrical distribution systems consist primarily of wire harness assemblies, terminal and connector products, fuse boxes and junction boxes. This electrical network extends to virtually every part of a vehicle, including powered comfort/convenience accessories, lighting and signalling, heating and cooling systems, powertrain, chassis, safety restraint systems, audio systems and other devices.

The wire harness itself consists of raw, coiled wire that is cut to length and terminated. Wiring assemblies are a combination of round wire, flat wire, ultra-thin wall cable and connection systems bundled together to distribute power throughout a vehicle. Flat wire provides a low profile, flexible option to round cable and can be designed with or without printed circuits. Flat wire reduces bulk, can incorporate electronics (eliminating the need for separate electronic control devices) and enhances interior design control.

Report coverage

Continuing our series of component niche market studies, this just-auto.com report reviews the key market drivers for automotive wire harnesses. Chapter two determines major trends in supply, sourcing and design of wire harness technologies. It will also provide you with market value estimates and forecasts of vehicle wire harnesses in Western Europe, Japan and North America through 2007. The use of electronics in vehicles has seen a considerable rise over the last few years. In fact the power demands of a mid-sized saloon have increased by between 25 to 40 watts per year. As new technologies appear on the horizon, the amount of electronics within vehicles can only rise significantly through this decade. Can the current wiring and multiplexing harnesses within today’s vehicles cope with so many electrical components? Has the traditional wire harness loom had its day? What are the alternatives? This chapter looks at some new electrical technologies, weighing up the pros and cons of these solutions to engineers and designers for the harness structure and power requirements within vehicles. Chapter three will provide you with brief profiles of the major wire harness full system integrators, including Delphi, Lear, Sumitomo and Yazaki.
Chapter 2 The market

Market trends

Although conventional round wire harnesses continue to evolve to support additional electronic content in vehicles, the technology has remained much the same over the last 50 years. Molex’s director of automotive marketing, Bob Fuerst, told just-auto.com: “One reason why existing harness makers have not embraced flat wiring is because it impacts all facets of their operations from design to manufacturing, thereby obsoleting huge amounts of installed capital.”

Car electrics have become extremely complex. In 1960 the wiring loom of an upmarket car contained about 200 connectors. Today the figure is nearer 1,800. In 1960, the same car contained about 200 metres of wiring – now it is more like 2.5 kilometres with over 800 wires. Many vehicle functions that had previously been hydraulically or mechanically activated are being replaced by electrical/electronic activation. For example, a top-of-the-range 1993 model year Ford Explorer had 963 electrical circuits while a comparable 2000 model year model had more than 1,800 circuits.

Wiring looms are heavy, too. The average loom per vehicle carries around 80 pounds of copper wire and insulation. And that could double over the next five years as the avalanche of multimedia and safety devices descend on tomorrow’s car. A great deal of the vehicle’s electrical systems and wiring are positioned within the cockpit area; some 40% of the wiring harness in a mid-range car is located in the cockpit.
A cable network can include 800 conductors with a total length of 2.5 kilometres in a modern vehicle.

Source: Hella.

For manufacturers, the increase in the content and complexity of electrical and electronic components requires a broader overall design perspective. This shift in design philosophy is, as Lear Corp describes it, ‘moving from the wire itself to the wire ends’, reflecting a view that design should include both the wiring and the electro-mechanical and electronic devices to which they are connected.

Further challenges confront the electrical circuit designer as a result of the growing number of sensors carried by vehicles, particularly since the data produced by the sensors may be required by several systems operating in real time, e.g. safety and emission control. Other challenges include harness runs over door hinge lines, higher power and current requirements and electro-magnetic and radio frequency interference.

But there are alternative solutions to the traditional wire harness loom emerging, such as multiplexing, fibre optics and flexible printed circuit boards.
Multiplexing

Multiplexing is a possible solution, separating power and signal requirements, and the simplification of the signal wiring. In other words, multiplexed systems need fewer wires, thereby reducing bulk and weight. Manufacturers claim that multiplexing cuts the amount of wiring by 20% over conventional wire harness designs. Information is shared rather than duplicated, improving service repair, diagnostics and the flexibility to change options.

In this system each component needs an electronic relay to receive the signal and switch the power supply accordingly. Cost and the fear of introducing radical innovation sooner than necessary confined multiplexing to door applications throughout the 1990s. Instead of hundreds of wires running between electrical parts, switchgear and the power source, each major component is given a degree of intelligence. In this way, the component – be it an electric motor, instrument cluster or lighting unit – can be operated by sending instructions to it along just one or two wires. Multiplexing enables a lot of different modules to communicate with one another through one or two wires. Without multiplexing, a bundle of wires is necessary to transmit information from module to module. Signals from a host of switches are encoded, either in analog or digital form, and transmitted over a single wire. This requires some form of node or smart connector at each end of the wire, to split the signals to their intended devices.
There are three classes of multiplexing, as follows:

- **Class A** — (low speed communications): used for seats, doors, windows and lighting;
- **Class B** — (data communications): sharing of information between communications; and
- **Class C** — (high speed): used for real-time control functions.

Initially, high costs limited multiplexing to premium cars. But as costs fall the system is starting to appear in family cars too. In 1999, Chrysler introduced multiplexing on its least expensive vehicle, the Neon.

Given that fewer cables and connections are needed in a multiplexed car, this saves both space and weight resulting in reduced fuel consumption and improved reliability. For example, the wiring inside Citroën’s Picasso multi-purpose vehicle has been reduced by around 20%. In fact, multiplexed wiring allowed Citroën to offer a number of high-tech refinements on its C5 model, including tyre pressure sensors, light and rain sensitive headlamps, sunlight sensitive air conditioning and an auto-find facility for locating the car in a car park. Volvo’s S80 is another example of a highly multiplexed vehicle. Also, Mitsubishi Motors’ Airtrek SUV features a so-called smart wiring (multiplexing) system that is used to control all functions of electrical equipment related to the body. The system links the steering column switch, power window main switch, front ECU, electronic time and alarm control system, sunroof motor assembly and the security system. The BMW 7 Series uses both multiplexing and networking technologies incorporating some 1,000 copper circuits, 20 optical fibre circuits and several wireless modules, the latter for keyless entry and mobile phones. Without multiplexing, BMW’s flagship vehicle would require about 4,000 circuits for the equivalent features and controls.