



Automotive White Paper



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Synopsis

This report is intended to give a general overview of the global automotive market, and provide information about how Nexans is serving this market.

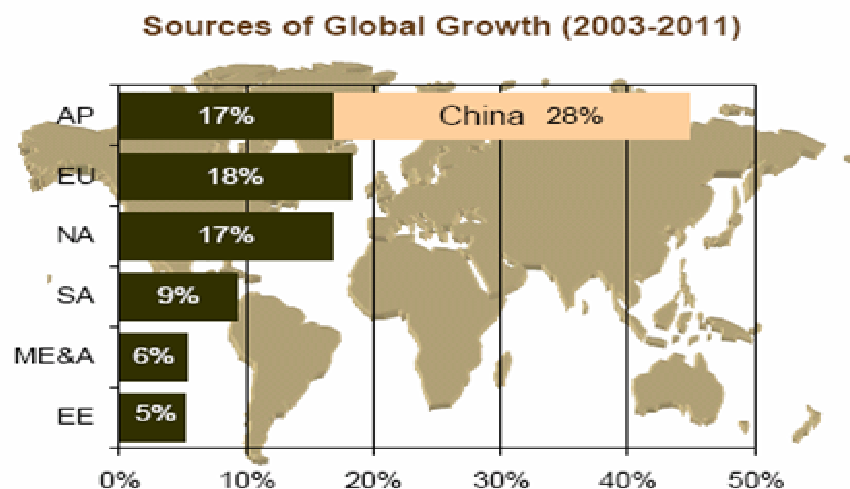
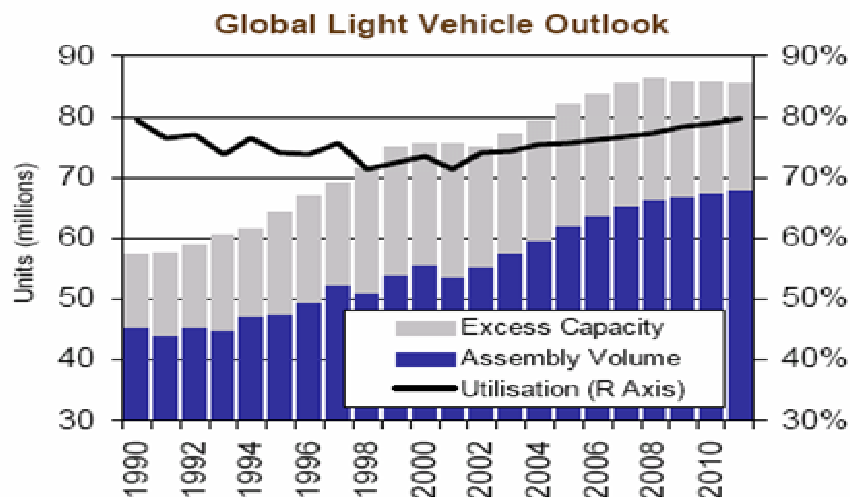
It opens with a brief introduction which explains the trends affecting the automotive industry worldwide, especially in terms of assembly volume, growth, sales and continuing consolidation. This is followed by specific trends in the industry and especially the automotive cable business. After exploring challenges and the “push-pull” factors transforming car manufacturing, it concentrates on Nexans’ four strategic strengths which also correspond to the concerns of auto and harness makers, themselves: metallurgy, standard and special cables, recycling, and an ability to serve customers in emerging automotive-assembly countries. Finally, the White Paper explains the Nexans approach to innovation, which is driven by technology, new production methods (“lean manufacturing”) and strategic outsourcing. The final chapter explains Nexans service solutions in practical terms, and emphasizes the importance of partnership in finding solutions for an increasingly synergized industry.

I. DRIVING CHANGE IN THE VEHICLE ELECTRICAL MARKET

“There are two main factors driving change in the vehicle electrical market. The first relates to the cost pressures that are inherent in the industry. This is driving us to offer more creative solutions, providing added value for the customer. The second aspect is consumers’ insatiable demand for added features.” Tom Russell, VP of Advanced Products, Lear

Global trends

Global light vehicle assembly is expected to grow from a total of 57.6 million units in 2003 to 68.1 million units in 2011, representing an increase of 10.5 million units worldwide. Among the contributors to assembly growth, the Asia Pacific region will lead the way (45%), while the EU (18%) and North American (17%) regions benefit from incremental capacity investments by foreign automakers. South America will recover somewhat to contribute 9% to global growth, while Eastern Europe (5%) is losing key vehicle manufacturing centers as part of their entry into the EU (2004). The following charts, compiled by CSM Source show the evolution of the industry until 2011.



Although light duty vehicle¹ demand is growing in France and elsewhere in Europe, vehicle assembly is down as a result of assembly relocation outside the EU, mainly to Central Europe and North Africa. Even though assembly has declined in some new EU member countries, it is bound to increase significantly in Slovakia, the Czech Republic and Poland as automakers transplant manufacturing capabilities in search of both cost savings and local demand for growth.

Globally seen, the two catchwords in the automotive industry remain **overcapacity** and **consolidation**.

It is a widely recognized fact that serious overcapacity exists in automotive manufacturing worldwide, especially in developed countries (nearly 25%). However, the good news is that global capacity utilization will improve from 74% to 80% by 2011.

It looks as though consolidation, too, will continue as companies look at ways of rationalizing production through collaboration. Thus key decisions affecting domestic markets are often being taken at Pan-European and even global levels. According to Peter Lemagnen, senior director of Oxford Intelligence,² there are likely to be around 30 major automotive players, with investments being made in developing markets, especially Eastern Europe, South America, China and South-East Asia. Western Europe's share of these investments will naturally slide as a result. Thus opportunities for North America, Western Europe and Japan are going to lie in "high value-added facilities" for technically advanced vehicles. Cost-driven new investments also mean that there is a trend among vehicle producers to transfer critical activities to their suppliers, with a knock-on effect. Suppliers will have to increase their own investments significantly. Lemagnen suggests that they will need to create 3.3 million new jobs worldwide by 2015 just to accommodate growth.

The American Environmental Protection Agency (EPA), also recognizes the seemingly unstoppable move from independent manufacturing towards consolidations and alliances. Originally it classified groupings according to a market segment approach (using Domestic and Import categories). Given the growing transnational and transregional evolution of the automobile industry, it has now squeezed the core companies into 8 major marketing Groups, plus a ninth "Others" category:³

- 1) The General Motors Group includes GM, Opel, Saab, Isuzu, Suzuki and Daewoo
- 2) The Ford Motor Group includes Ford, Jaguar, Volvo, Land Rover, Aston Martin, and Mazda
- 3) The DaimlerChrysler Group includes Chrysler and Mercedes Benz
- 4) The Toyota Group includes Toyota, Scion and Lexus
- 5) The Honda Group includes Honda and Acura
- 6) The Nissan Group includes Nissan, Renault-Nissan and Infiniti
- 7) The Hyundai-Kia (HK) Group includes Hyundai and Kia
- 8) The VW Group includes Volkswagen, Audi, SEAT, Skoda, Porsche and Bentley
- 9) Others (largely independents)

¹ According to the US Environmental Protection Agency (EPA), Light duty vehicles include four categories: cars, vans, sport utility vehicles (SUVs) and pick-up trucks. For a review of the trade-off between fuel economy and technology, consult "Light-Duty Automotive Technology and Fuel Economy Trends: 1975 through 2006," July 2006, which is available at www.epa.gov/OMS/fetrends/htm

² See "Steady shift to the east," available at www.fdimagazine.com

³ See EPA's study referenced above, p. 67.

The growth figures in China are truly remarkable, in keeping with recent highway infrastructure upgrades and expanded manufacturing. According to one industry specialist:

The figures behind China's car boom are stunning. Total miles of highway are more than double what existed in 2001, and second now only to the United States. Number of passenger cars on the road: about 6 million in 2000 and about 20 million today. Car sales are up 54 percent in the first three months of 2006, compared with the same period a year ago; every day, 1,000 new cars (and 500 used ones) are sold in Beijing. The astronomic growth of China's car-manufacturing industry will soon hit home for Americans and Europeans as dirt-cheap Chinese automobiles start showing up for sale here over the next two or three years.⁴

The final prediction has already materialized, since the Chinese-built Landwin SUV is now available in France at the cost of 15,500 Euros.⁵

In short, the global picture reveals projected high growth worldwide with a shift eastward in both manufacturing and consumption, a refocus of priorities for western manufacturers, continued cost-driven investment both at home and abroad, and unstoppable automotive consolidation.

All of these major trends have consequences for harness makers and cable manufacturers, who will be obliged to take on new responsibilities, including R&D, local production, and even recycling.

Automotive trends

Concentration among the big eight or nine Groups just mentioned has had several important effects. Since there are fewer major manufacturers serving a widely-scattered public, synergetic efforts are needed to unify products, so that cars can be serviced wherever they are, whether in Europe, the US, South America or the Far East. This calls for global presence; but it also means **standardization** and a unification of parts numbers. This especially applies to cables which serve a dual energy/data function in an automobile. Whatever the system, they are generic elements and need to be easily interchangeable.

As was just mentioned, manufacturers are outsourcing what is not a core competence in many areas. A growing percentage of the value added to any car is coming from suppliers, who are involved even at the initial design stage. In fact, it is unlikely that any major OEM could build a complete car without the input of the entire supply community, who are expected to take responsibility for research, design, testing, and assembly line processes. We are moving away from a product approach to an **integrated systems** approach in which R&D, customized services and logistics are important. Today's door or front end is no longer merely "assembled." It is a geometrically closed unit (system) incorporating cables, contacts, motors, etc. A brake system is no longer perceived as the

⁴ John Robb's Weblog, 3 July 2005, available at www.fdimagazine.com

⁵ See: "Ne ratez pas le 4 x 4 chinois" in LE PARISIEN, 9 September 2006.

wheels, but includes the brake pedal, the leads, the sensors, and onboard computer with a harness stretching through the entire car. Once again, cables play a key role in making these modules and systems work. According to Nick Cassudakis, Director of Engineering at Delphi Corp, "Our OEM customers are looking for a low cost, highly reliable electrical system that is easy to build in their vehicle assembly plants. They also want strong engineering support. Reliability is critical."

There is also the second demand driving change in the automotive market: the consumer's insatiable demand for features, like memory seats, GPS and digital instruments and equipment. They also expect **choice**. They no longer want basic models with a change of color to differentiate them; they expect an extremely wide selection of models from every manufacturer (minivan, full-sized van, large van, hard-top, convertible, etc.) They also want to customize their car in terms of conveniences and comfort. Thus, in seeming contradiction to the trend towards standardization, there is a real move towards splitting up the product into niches to create highly individualized automobiles.

In fact, according to the Financial Times' *Special Report* on the motor industry, there are now more than three times the number of car models already on sale across the world compared with a decade ago!⁶ This is due to what has been called **mass customization** by using standardized components that can be personalized at the very end of the production chain. Intelligence is often added to the component so that it can be personalized to the car model in question. Today, a car engine can be re-used across various car models by setting the power and torque differently for each model.⁷ This has a high impact on the production process and logistics. For example, when a car is being built with a sliding roof, followed by one with a solid roof, or with or without climate control, customized cables and harnesses have to be delivered in-line and in the right sequence.

The ultimate product differentiation is the so-called "reconfigurable vehicle"⁸. By using Internet Reconfigurable Logic (IRL) the automotive manufacturer will build variety and upgradeability into a single car. For example, it would be possible to upgrade or enhance the performance of the family car for the weekend by paying for the engine management system to be "race-tuned" to enhance performance, thus transforming it into a de facto sports car for the weekend. At the end of the prepaid period, the car's "personality" could be changed back to its original settings. The same approach allows an automobile to be regularly upgraded, the way software packages are periodically improved through patches provided via the Internet. Once again, flexible, modular cabling will play a key role in making the new world of automotive electronics systems, computer, and software applications a reality. All of this high technology will ultimately depend on the sophistication of the harnesses and cables used.

If standardization, integration and customization are the *basso continuo* of recent automotive developments, recent trends marking 2006 led one automotive analyst to talk about a renaissance of the automobile in glowing terms:

⁶ See 28 September 2006 Financial Times Special Report (FTSP).

⁷ See Yves Rombauts' "Applying 'mass customization' manufacturing principles to solve technical communication problems," 2005, at www.cherryleaf.com/news-masscust3.htm

⁸ See Karen Parnell's article "Reconfigurable Vehicles" at www.xilinx.com

This year [2006] has seen the rebirth of the car, as we saw a two percent increase in the segment's market share, while SUV market share decreased by nearly the same percentage. We expect this trend to continue as manufacturers will be launching new hybrids, subcompacts and other fuel-efficient products.⁹

In point form, these impinging trends could be summarized as follows:

- Record-level gas prices due to crises in the Middle East and elsewhere have led consumers to turn away from gas-guzzling, V8-powered SUVs to fuel-sipping, 4-cylinder economy cars¹⁰. Hybrid sales nearly tripled last year, and the compact car market has made a comeback since the disastrous '90s when they were dropped by nearly all automakers. Gone are the Festiva, the Metro, the Colt and the Tercel. Enter the Aveo, the Accent, the Rio and the Reno, and a host of subcompact models: the Fit, the Versa, and the Yaris. With the rediscovery of the compact car (especially in the US), market share is now over 16%.
- Global warming has become a serious preoccupation. In little more than six months, and following summer heatwaves in many countries, the public mood towards the issue of carbon dioxide emissions appears to be changing from skepticism to the widespread acceptance that "something must be done." Motor vehicles are on the front line, with consumer interest in the issue heightened by the quantum leap upward in fuel prices mentioned above.¹¹
- Technological change is transforming the sector from all points of view: environmental concerns, engine emissions and safety, voiced by the public and legislators. Meanwhile consumers are eager for a host of electronic onboard devices which touch nearly every aspect of the driving experience: real-time traffic navigation, hard-disc drives for audio and other systems, new radar-detection technologies, digital radio, airbag control modules, adaptive headlights, onboard Internet services and entertainment, sensors, etc. The list is virtually endless, and consumer demands are likely to steer technological innovation in the near and distant future.
- The trade-off between weight, performance and fuel economy is still a live concern as well. After a rapid increase from 1975-85 in efficiency, a slow increase into the late 80s, followed by a gradual decline until the mid-1990s reaching a constant fuel economy today which averages 21 miles per gallon or 9 km per liter at its best. Fuel economy is once again related to energy security since light-duty vehicles account for approximately 40% of oil consumption, and much of that oil is imported. Secondly, fuel economy is directly related to the cost of fueling a vehicle. Thirdly fuel economy is directly related to emissions of greenhouse gases, mentioned above. In the US, light-duty vehicles contribute about 20% of all CO₂ emissions. This does not mean that today's cars are lighter. Vehicle weight has increased; however performance has improved, while fuel economy has remained constant (more horsepower, faster acceleration, more comfort and safety).¹²

⁹ Quote by Jesse Toprak, executive director of industry analysis for Edmunds.com in "Edmunds.com looks back at 2005 and forecasts 2006 automotive trends" at www.edmunds.com/help/about/press/108914/article.html

¹⁰ See ConsumerGuide Automotive, May 2006 issue available at www.auto.consumerguide.com

¹¹ See 28 September 2006 FTSP.

¹² See "Light-Duty Automotive Technology and Fuel Economy Trends: 1975 through 2006" at www.epa.gov/OMS/fetrends/htm

All of these impinging trends – gas hikes, environmental concerns, technological change, and the weight/performance ratio – have implications for both cable manufacturers and harness makers manufacturers since every trend has an impact on how harnesses and cables are made.

Harness and cable trends

There is a **high volume** of wires, cables and harnesses in cars, and the amount is still growing. In 1960, the wiring loom of an upmarket car contained about 200 connectors. Today the figure is nearer to 1,800. In 1960, the same car contained about 200 meters of wiring. Now it is more like 2.5 kilometers with over 800 wires. Depending on the model and the conveniences under the hood and in the cabin, the amount of cable can even attain 3.5 to 5 kilometers. A tremendous array of cables exist for control and monitoring vehicle behavior; guidance, navigation and telematics; and driving assistance, automation, comfort and entertainment (infotainment).

There has also been a trend towards **weight reduction**. Wiring looms are heavy. The average loom per vehicle carries around 80 pounds of copper wire and insulation. And that could easily 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. In fact, some 40% of the wiring harness in a midrange car is located in the cockpit.

The encapsulation of engines and new applications are giving rise to requirements for cables that can operate in smaller engine compartments for longer periods of time. This means cables and harnesses that can handle **higher temperatures**. This requires new insulations and designs, not only for technically advanced vehicles, but for low-cost vehicles, as well.

The production of a wire harness is also **labor intensive**. Wire harnesses used to be produced at plants near vehicle assembly lines. However, in a bid to reduce production costs, Japan's Yazaki Corporation led the shift to overseas production by using low-cost labor in South-East Asia. North American and European manufacturers soon followed suit by relocating production in nearby developing countries, like Mexico, Morocco and Eastern Europe.

Furthermore, with external forces acting on the business, there is a shift in cable requirements which is evident in the following graph:

EXTERNAL FORCES ACTING ON THE CABLE AND HARNESS BUSINESS

TODAY	TOMORROW
<ul style="list-style-type: none"> • Incremental technological innovations based on copper • Fairly flat cost curve 	<ul style="list-style-type: none"> • Increased high-temperature capability • Aluminum penetration (due to high copper prices, and the onboard weight issue) • Eventual standardization
<ul style="list-style-type: none"> • Growth in all producing areas • Medium switching costs 	<ul style="list-style-type: none"> • Growth only in emerging areas (a strong delocalization effect) • High switching costs
<ul style="list-style-type: none"> • Patents/licenses are a significant entry barrier • Car manufacturer fidelity long and expensive to acquire 	<ul style="list-style-type: none"> • Zero-halogen a must • Stability in other areas

Not only is Nexans capable of handling the high volume of various kinds of cable under the hood, in the cockpit and elsewhere, it is also continuing to reduce weight, improve temperature performance, support local production initiatives, and do the kind of research and development needed to make the transition from today to tomorrow's automotive cable environment. Its global approach extends from initial copper procurement and insulation development through to recycling.

II. CHALLENGES AND DRIVING FACTORS

Challenges

This new automotive environment, driven by consolidation, increased outsourcing, customization, niche products, and advanced IT-based technologies has give rise to a number of challenges.

First, **cost pressures** will continue to be strong in developed markets for both OEMs and their suppliers. As with other consumer products, buyers will continue to want to get more technology for less money. On the other hand, in the developing market, sales will strongly depend on the surplus income of the buyer, which will be lower than in the developed world. Bringing down costs will not be easy if the number of variables continue to explode (due to model differentiation). However, the industry is going to have to keep cars affordable, if they are to continue to sell them worldwide. Rather than think in dollars or euros, it is important to reason in terms of how many hours a person in the developing world has to work to afford a car. If we want to maintain mass motorization, and sell 500 million vehicles worldwide, we will have to have access to this market, and that means keeping costs at minimum.

Secondly, since the market is increasingly international and consolidated, major players in the industry are going to need a **local presence** to be competitive. Suppliers will have to follow the OEMs wherever they choose to go. Sometimes, this will mean strong supply chain management with the ability to keep inventories low, while delivering to far-flung points from multiple sources of provisioning. This can be achieved by new Internet-based supply management platforms (e.g. SAP) which will eventually incorporate planning, distribution, warehousing, manufacturing, quality control, purchasing, plant maintenance, etc. in one consolidated system. In addition, since local presence and technology transfer are important matters for governments in the developing world, first, second and third tier suppliers must have resources on the ground, including production facilities, to serve their customers.

Thirdly, customers will expect equal **quality and performance** from a car, wherever they happen to live. Even though they may have to work more hours in order to purchase it, they want to experience the pride of driving the same automobile that is used in Europe, or elsewhere. This is the prestige factor. Thus, automakers and their suppliers are bound to find ways of keeping quality uniform, even though production is done in countries where labor conditions and costs can vary greatly. In addition, quality standards and certification are essential if uniformity and consistency are to be achieved, especially in the key area of automobile service and repair. In the past, the industry has worked according to QS9000 standards. Today, the new (2002) ISO/TS 16949 standards, which were developed to unify European, American and Japanese production, are being increasingly applied. Product quality and performance require that we move away from country-specific to truly universal quality standards if tapping into the new developing markets is to be achieved.

Fourthly, **integration** is a must. It starts with vertical integration in the securing of vital raw materials, like copper which has risen by about 60% overall since the end of 2005. Then there is integration in terms of product, i.e. having the biggest range of interchangeable, standard productions possible. And finally, there is integration in terms of cooperation among suppliers, and between suppliers and automakers. As mentioned earlier, there is a definite move from parts and products towards modules and systems. This more flexible approach requires an increasing exchange of information among the automotive community, and means getting everyone involved early in the engineering and development process, long before serial/series production takes place. Supplier-OEM integration is based on shared databases, Computer Assisted Design (CAD), and integrated supply-chain management systems. It will require a new spirit of cooperation among companies who may have previously seen themselves as competitors.

The fifth challenge is **innovation**. Few sectors have been as creative as the automotive sector, in terms of manufacturing processes, logistics and product. It has long been recognized that (like clothing) automobiles make a strong appeal to taste and preference, and these tend to change regularly. Innovations in areas like IT, the Internet, and new satellite technologies are having a tremendous impact on the industry, as well. Today's advanced technologies are already pointing to a new form of "sustainable" car travel in the future, which will reduce needless delays and traffic jams, save precious resources, and safeguard people and the environment.

Transport is the key to our social and economic life. We spend six entire years of our lives doing it, and 16% of our income on it. Instead of hard fixes that generate noise, pollution and waste, the automotive world is moving towards soft, data-based solutions, in which information-rich and energy-efficient cars are seamlessly integrated with Intelligent Transport Systems. In biological terms, cables provide the blood (energy) and nervous system (data) that makes this happen.

Push-pull factors

Cable producers and harness manufacturers have a number of push-pull factors, as well, which are driving them to exploit the "white space" in marketing, i.e. areas where strategy and authority are vague, and where useful entrepreneurial activity (drawing on directed research & development) can flourish.

PUSH	PULL
Cable producers	Harness manufacturers
Looking for increased sales in mature market (Western Europe)	High temperature cable increase
Excess capacity in standard T1/T2 standard products	Aluminum penetration (due to copper price level and weight issue)
Looking the next hit product (margin or volume) as T3 Zero Halogen	Strong delocalization effect
Fear of losing out in sector, or not obtaining best cost	Standardization potential

Moreover, there are technically-driven demands which both have to face:

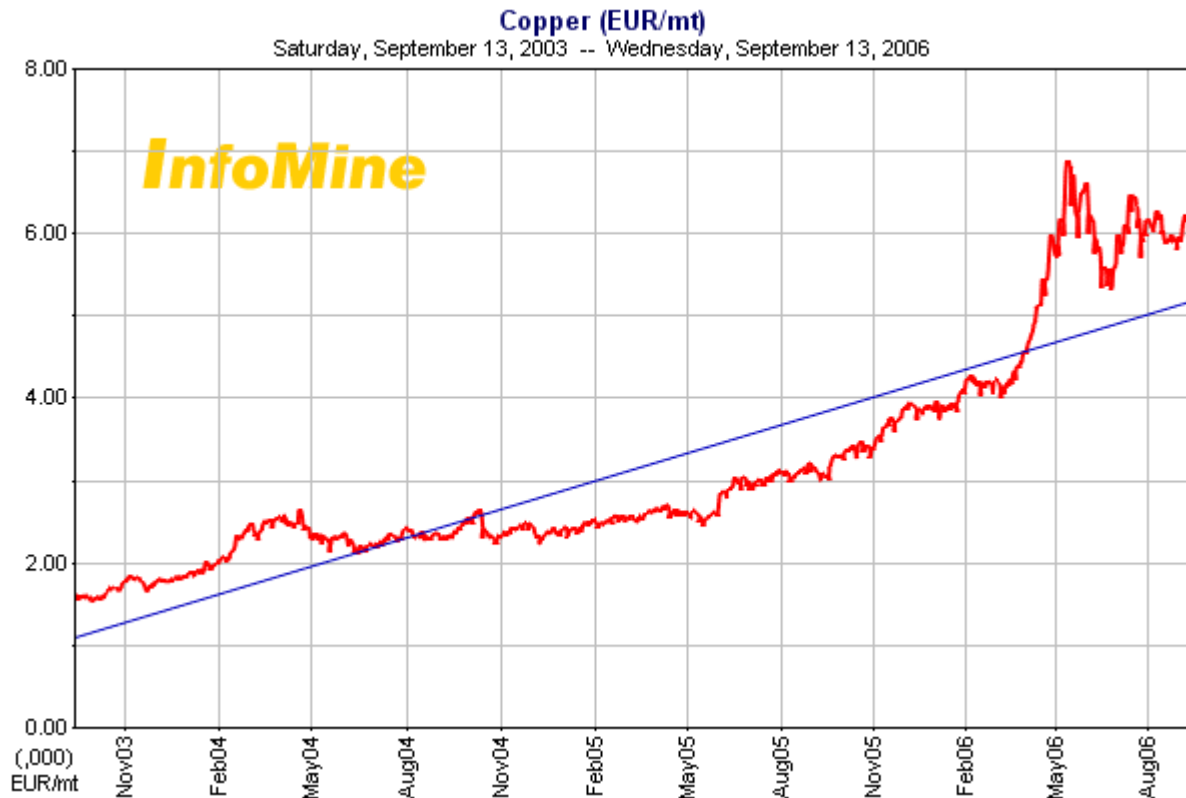
- increased electrical/electronic capability to handle multimedia, drive-by-wire, safety features, and conveniences
- lighter cables: every reduction of 100 kilos of weight equals one less liter of fuel; it also reduces wear on equipment, and improves engine performance
- thinner insulations
- smaller diameter cables: more space for passengers and equipment
- more heat resistance: quieter cars means more insulation and thus more heat; today's standard is 105°C, tomorrow's will probably be 125°C
- environmentally-friendly products
- onboard and roadside radio and broadband solutions

III. NEXANS: A GLOBAL LEADER IN THE INDUSTRY

Nexans manufactures a wide range of low-cost standard automotive cables, and special cables, including high-temperature, halogen-free versions. Its innovations and expertise have won the approval of major manufacturers, and it is already serving delocalized harness manufacturing countries. Nexans vertically-integrated metallurgy division guarantees a steady supply of metals, while its knowledge of car-specific insulations is unsurpassed in the automotive industry.

i. Metallurgy

Nexans is a world player in the copper market, giving the auto industry, and especially harness makers, what they need and want. The first thing is the high quality of the raw copper itself which guarantees the purity of all wires, rods and conductors, and ultimately the performance of all finished cables. Secondly, a steady supply of vital primary and secondary copper materials. In recent years, some rod and conductor providers actually ran out of copper, seriously putting at risk their own automotive production. Thirdly, Nexans provides counseling on the financing and purchase of copper. Fourthly, in the highly innovative automotive sector, Nexans provides an important source of innovation in both new materials (aluminum substitutes, alloys) and cable designs. This touches not only the product, but also the processes to make production more efficient. Planning is focused a decade ahead, so as to meet the automotive challenges of tomorrow. Finally, Nexans is a real partner in the development of new concepts. Even though the migration to a 42-volt energy system has yet to be widely adopted by the industry, it is already in position to follow this kind of upgrade – if and when it comes – often drawing on experience acquired in other market sectors, like power utilities, rolling stock, shipbuilding, and aeronautics.



In a context where copper is priced at over 6,000 Euros (US\$8,000) per metric ton, the full mastery of copper supplies is thus essential to production line continuity and indeed car production, itself. Nexans is the biggest copper broker in the world with purchases worth 2,800 million Euros in 2004.

Nexans processes over 820,000 tons of copper annually, which is equivalent to 5% of the world's yearly consumption. In addition it has the capacity to produce 70,000 ton of aluminum in France, Vietnam, Brazil and Morocco. Finally, its European recycling center, RIPS, recycles 18,700 metric tons of cables yearly, metals which become re-available to the industry.

The sheer mass of the yearly copper purchase is what gives Nexans the leverage needed to obtain the best quality copper for itself and its customers. The procurement of copper is a double advantage: Nexans buys the copper, securing a seamless and adequate supply for the foreseeable future; and it hedges the price, assuring price stability for the cables its customers buy. This helps customers control what could be a volatile unknown in a complex production budget.

Another Nexans strength is that it is the only cable manufacturer to have vertically-integrated production from early metals procurement to final value-added products. Its four continuous casting plants, located in Lens and Chauny (France), Montreal (Canada) and in Bramsche (Germany) produce 820,000 tons of rod every year, by far the largest output in the world. These rods are then drawn into finer mono-wire conductors or twisted into stranded wires especially adapted to automobiles. Nexans has production capacity in Morocco, Romania and Korea, and numerous other plants around the world, where the platform can be redesigned to handle automotive products. In addition, a new project is being installed in Lorena, Brazil. Standard Cables are largely produced in low-

cost countries, while Specialty Cables are largely manufactured in Europe at Nuremberg (Germany), Grimsås (Sweden) and Paillart (France).

To further assure quality, all wires, rods and conductors are carefully inspected to assure a perfect and stable product, using non-destructive testing equipment and electron microscopes. In some cases, copper is plated with tin, or aluminum is plated with copper to achieve precise characteristics.

Nexans Metallurgy Competence Center, located in Lens (France) is an important contributor to innovation. Not only does it provide support to all company metal plants, it has direct technical contacts with suppliers and maintains an extensive network of contacts worldwide. The MCC has numerous priorities: developing next-generation drawing machines, sharing industry information, qualifying new materials, designing new conductors and processes, and training engineers and operators. It is especially concerned with exploring new alloys for the auto industry, and uses a special "pilot line" to produce new prototypes, often jointly with its customers and development partners.

To resume, Nexans copper activities have the following strong points:

- Supply of all metallurgical products thanks to applications other than automobiles
- Mastery of all copper technologies through continuous casting capabilities
- Copper alloys to economically replace pure copper
- Both hot and cold techniques: rod drawing, but also rolling of flat wires
- Control of the coating process: tinned, nickeled, silvered, etc.
- New solutions through expertise in energy and data transmission
- Lighter and cheaper cables (e.g. copper clad aluminum)¹³

¹³ ¹³ For more detailed information about Nexans copper activities, please consult the CD-Rom, Cabling Insight [Copper] available at no cost from the Nexans Communication Department: 16 rue de Monceau, 75008 Paris, France.

ii. Standard and Special Cables

In the industry, **Standard Cables** are usually singlecore cables of the lower thermal categories, and are used for the transmission of data and energy for control and power applications (wipers, signalling, motor functions). Nexans manufactures Standard cables of from 0.22 mm² to 6mm² from category A to F according to ISO 6722 (85°C–250°C). Temperature performance is indicated either using A–F or T#:

A = T1 – 85°C (PVC insulation)	
B = T2 – 100°C (PVC insulation)	
C = T3 – 125°C (PVC or halogen-free insulation)	

D = T4 – 150°C (halogen-free or fluorinated ETFE insulation)	
E = T5 – 175°C (FEP insulation)	
F = T6 – 200°C (PTFE – PFA insulation)	

Nexans considers the boundary between standard and special cables (according to temperature performance) to be between C (T3) and D (T4). Most cables of this type used in automobiles still belong to the A, B or C category, with PVC insulation. While Nexans' familiar PVC versions offer quality, low cost, reliability and flexibility, its T3 cable comes in two zero-halogen versions: T3ZH irradiated is a fully-finished XLPE cable manufactured in Nuremberg, while T3ZH silane achieves cross-linking through a chemical process, making it ideal for local production. These moderately priced T3 zero-halogen versions thus allow automakers to accommodate higher temperatures under the hood, with the added bonus of safety and environmental friendliness.

Of course, manufacturers would like to have only one standard singlecore cable, offering the highest temperature performance at the lowest price possible. However, zero-halogen cables are still relatively costly to produce. Also, cables are not the only PVC element in car interiors; there are also seats, fixtures, instruments, roof linings, etc. An all zero-halogen automobile would thus require solutions for these elements also.

Nexans not only meets the ISO 6722 standards mentioned above, it also conforms to each car manufacturer or harness makers standards as well in terms of ability to endure heat, cold, salt, oil penetration, etc. Since conductors can have different cross-sections and various kinds of insulation (thick wall, thin wall, ultra-thin wall) the tests are many and complex. However, they make it possible to find exactly the most appropriate cable for any given automotive application.

Special cables are virtually all the other kinds of cables used in an automobile. Among the most important are:

Multicore cables often used in Antilock Braking Systems (ABS) and for airbag release. These, too, come in a full range of materials, cross-sections and cores. Their main advantage is that they are less encumbering since two cores can be accommodated in a small insulation. They can also be customized to very specific requirements. For example, multicore cables used by many truck manufacturers have a double insulation to provide enhanced vibration resistance, which once again contributes to reliability and safety.

Nexans **battery cables** can range from 7mm² to 100mm² and like singlecore cables fall under various temperature classes to meet the heat problem in the extremely confined motor compartment. Battery cables run from the battery to the starter, and usually the battery has been located in close proximity. However, some automakers, in order to make space gains under the hood, have been studying the feasibility of placing the battery in the trunk. This raises the weight-performance-fuel economy tradeoff (mentioned on p. 6). A longer cable is, of course, a heavier and more expensive cable if made out of copper. Nexans is currently developing lighter stranded aluminum battery cables and copper-clad aluminum cables. The latter has the added advantage that, apart from being cheaper than copper, it is easy to connect.

Flat cables offer space-saving command and control functions in an easy-to-install flat ribbon. Resembling the wide and flat cables used in computer printers, these cables are often used in doors, roof liners, dashboards and bumpers (for radar detectors), wherever tight space is a factor.

Other types of **special cables** include coaxial for communications; wires for gear boxes and oxygen sensors; polyurethane solutions for vibration and flexibility; high-temperature, zero halogen (Class D T4 to Class F T6); and specially protected cables against snow and ice, etc. Nexans also designs, engineers and produces **harnesses** of up to 500 wires linking information and energy systems for lights, air conditioning and dashboard intelligence.

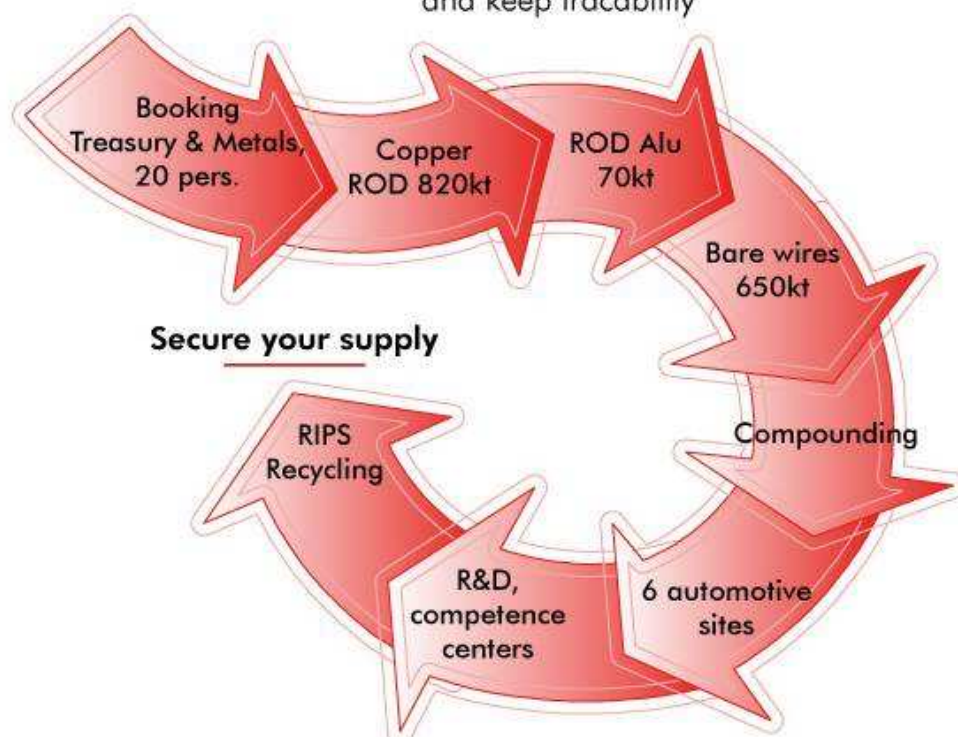
iii. Recycling

We have talked about copper and metals procurement and the various process stages from drawing through to stranding, and alloys. As part of Nexans vertical-integration and mastery of the entire value-chain, Nexans is also boosting profits and promoting environmental-friendliness by cost-efficiently recycling cable “scrap.”

In fact, Nexans is the only cable manufacturer that can fully recycle cables, based on a profound knowledge of evolving cable technologies (see graph below). Its recycling approach is founded on a “customer-supplier” concept, meaning that Nexans sells harness manufacturers cables initially; then it pays to recuperate, recycle and re-introduce the recuperated cable into the supply chain. By controlling costs at each stage it is thus able to reduce overall purchase cost and increase competitiveness for the automotive industry which does produce waste, but wants to keep it to a minimum and recuperate it wherever possible. Nexans has 30 years of experience in cable recycling, which is the exclusive activity of its subsidiary, RIPS, based in Calais, France.

METALLURGY

We do master the entire value of chain, to secure your supplies and keep tracability



Recycling begins with purchasing off-cuts, discards and retrieved cables not only from Nexans' own customers, but also anyone who has used cable to recycle. Nexans recycling guidelines take into account current regulations (ISO 9001 and 14001 certification) and are designed to generate a quick response time by first listening to the customer and then customizing service. Customers seldom have waste storage space on their own production sites, and non-ferrous metals require quick recycling. Pick-up is done using the most appropriate solution: crane trucks, skid containers, bins, or even plastic bags. Customers receive maximum lead times, plus a checking procedure which gives them a comprehensive vision of the procedure, including traceability, transparency and statistical feedback. In France, Nexans has five trucks serving 500 sites throughout France. Often road and rail transport are combined.

Not all cables are alike; each requires a customized recycling solution. The sheer range of Nexans primary and secondary production ensures that the right treatment will be applied. Once the old cables arrive on the RIPS recycling site in Calais, all batches are visually controlled; then, each batch is assigned a number. Thus, it is easy to consult all relevant batch data: date, weight, composition, and choose a suitable grinding methodology. The final step in the process is returning the tracking form to the client to show that the batch conforms to the quality of treatment. Satisfaction rates have been approximately 95%.

Apart from retrieving copper and aluminum, RIPS is working closely with the Nexans Research Center to recycle the various polymer layers to be found on cables, mainly PVC, polyethylene, and elastomers. The Research Center assists in technical analysis, finding

the best recycling solution, and valorizing plastics for even easier recycling tomorrow. It is constantly coming up with new processes for separating materials, including polymer/metal separation.

A Research Center test lab has been set up to produce prototypes to increase the feasibility of recycling. Moreover, recycled polymers have been increasingly finding uses beyond the automotive industry, for example in traffic beacons, PVC pipes, and industrial flooring. The ideal would be to recycle an even larger proportion of the polymers in cables and accessories without altering their quality or final properties. For insulations, it is evident that some of the characteristics that cable makers are looking for are precisely those features (ruggedness, heat resistance, high fire performance) that make it hard for them to be broken down.

Finally, aside from waste control and cost cutting, another important reason that harness manufacturers are interested in recycling is that every year environmental laws are evolving. In some countries, many critical materials are already being placed on a “red” list, which could compromise new automotive solutions. While cables are not usually classed under electronic equipment recycling regulations, some Scandinavian countries have taken this step. Obligations for manufacturers are bound to increase rather than decrease. By integrating recycling and environmental friendliness in its overall automotive strategy, Nexans is contributing to the principles of sustainable development, by making your business sustainable, as well, in terms of available and approved materials.¹⁴

iv. Local production

Because Nexans’ direct clients are car manufacturers and harness makers faced with fierce competition, it is important that Nexans respect and follow their migration to emerging second-tier supplier zones in Europe, North Africa and elsewhere. Traditionally, they were located near production lines for speed and convenience. However, because harness making is labor intensive, today approximately 70% have a presence in low-cost areas, even if they are shipping much of their production to established European manufacturers.

In a first phase, it was felt that only standard cable plants could be set up in low-cost areas, providing singlecore cables for basic car models. However, it is now evident that the industry is in a transition phase. Due to the growing skills of the local labor force and experience acquired in close cooperation with locally-installed manufacturers, there has been a trend to move upwards in terms of cable sophistication. In other words, there is an ongoing transfer of “specialties” to these offshore plants, as they increasingly upgrade equipment and resources. This trend is also supported by local governments and business interests since it represents a widening of the industrial base, which can strengthen the economy and have a positive knock-on effect for parallel industries, e.g. shipbuilding, and even eventually aerospace.

¹⁴ For more detailed information about Nexans recycling activities, please consult the CD-Rom, Cabling Insight [Recycling] available at no cost from the Nexans Communication Department: 16 rue de Monceau, 75008 Paris, France.

Strengthening and upgrading both standard and special cable production in emerging zones is thus a top priority for Nexans. At present, Nexans is focusing on T3 Zero Halogen cables, and has a presence in three emerging zones: Morocco, Romania, Korea.

- In Morocco, **Nexans** has a capacity of some 350,000 kilometers yearly of T1, T2 and T3 cables (which will expand to 700,000 by 2007). Note that competence includes both copper and aluminum cables, and especially the production of leading-edge copper-aluminum battery cables.
- In Romania, **Nexans** has a capacity of some 250,000 kilometers yearly of T1, T2 and T3 cables (which will also expand to 700,000 kilometers by 2007). Competence is in all-copper cables
- In Korea, **Nexans** has 700,000 km of capacity in the three lowest temperature categories. Nexans Korea is already poised to supply the booming Chinese market with all-copper solutions.

Tomorrow, Nexans will be involved in automotive line integration in three “agile” new plants: **Brazil, Russia and Turkey**, offering for the first site copper/aluminum solutions, and the latter two, all copper solutions. In short, Nexans is maintaining and extending its capacities to keep up with the customer demand for T3 PVC and T3ZH high-temperature cables in both established and emerging countries:

T3: the transitional automotive cable

Type/insulation	Key features	Site
T3 PVC	Low cost, reliable	Grimsås, Sweden (for Scandinavian market); Morocco, Romania, Korea
T3ZH irradiated	ZH, high temp, fully finished	Nuremberg, Germany (for Central Europe)
T3ZH silane	ZH, high temp, local production	Romania, Morocco, Russia, (Tunisia); Turkey (for new emerging zones)

IV. MASTERY OF INNOVATION

As Marshall McLuhan once remarked, people tend to “wear” their cars, and that is why a change in models in the automotive business is as inevitable as in the fashion industry. However, in recent years the notion of innovation has gone far beyond mere aesthetics and design.

Factors mentioned earlier (see pp. 6 and 7) reveal genuine concerns about issues like high-fuel prices, the environment, and safety. Moreover, accustomed to the computer environment in the home and office, potential car buyers are looking for new technology and gadgets throughout the car, like GPS navigation, Internet access and onboard video for passengers. Also, cars are becoming sensor-rich, with new devices like motion detectors in bumpers (to signal animal or human presence behind the car) and operational feedback sensors to control motor efficiency, etc.

There is also the ongoing hybrid revolution.¹⁵ With hybrids expected to get up to 75% better mileage per liter of gasoline when compared to conventional vehicles and emitting up to 90% less pollution, it is no wonder that hybrids are expected to jump from being 0.5% of the market to being 3.5 percent in the next few years. In fact, after the peaking and present decline of the gas-guzzling SUV, hybrid cars seem to be the wave of the future.

Finally, although the car industry has been very conservative about introducing electronic driving systems (“drive by wire”) into automobiles, such systems have been operating safely and successfully in passenger aircraft for over 20 years. Most manufacturers have been working on electronic braking and steering technology. Meanwhile, fuel-cell propulsion systems are reaching the point where mass production is becoming feasible.

The dramatic shift from “style and look” to the technology mentioned above has a high impact on harness makers and cable manufacturers, since every one of these developments is cable-related. Lighter cars mean lighter cables; more features mean more cables; the twinning of thermal and electric power trains requires harnesses which can handle both high energy and information.

Technical innovation is at the very core of Nexans’ cable products. It has special automotive teams at its Research Centers in Lyon (France) and Nuremberg (Germany), and a Competence Center dedicated to metallurgy in Lens (France).

The Research Centers have the responsibility for working on materials and processes for all markets and for very different applications. This is how a breakthrough in rolling stock, shipbuilding or aerospace could finally provide a new solution for the automotive business. They are fully equipped to do basic research, develop and test a new prototype, and then find a way to produce it on the plant floor in the most efficient way possible.

The Competence Center is more vertically focused, concentrating its expertise on the development of metallurgical solutions for one product family only. For example, Nexans

¹⁵ For information, see the article “The Future is here and it is called the hybrid available at www.cross-car.com/date/2006/03/

metallurgy experts are continuing to experiment with new, lighter and more efficient alloys, while chemists are doing groundbreaking work for insulations in areas like thinner insulations, plastic optical fiber, flame-retardant halogen-free compounds, oil and high-temperature resistance, fluoropolymers and cross-linking. Automotive customers also benefit from the wide network of 450 researchers and experts located around the globe.

V. SERVICE SOLUTIONS AND PARTNERSHIP

Nexans provides service solutions and partnership in ways which are both organizational and interpersonal. Quality, reliability and supply chain logistics are also a big part of this organizational transformation.

First, Nexans supports new lean automobile manufacturing methods, designed to eliminate waste and lower costs (recycling and offshore manufacturing). By eliminating non-value-added activities, it allows its customers to reduce the time it takes to deliver products to their customers, and narrow the cost difference between a domestic manufacturer and an offshore supplier.¹⁶

Secondly, Nexans has responded to the growing trend to outsource non-core capabilities, and does so, itself, wherever feasible, so that it can concentrate on production design and development, building customer relationships, branding, marketing, position, communication and selling.

For automotive customers, the introduction of a Customer Technical Interface (CTI) person fulfills this important function. This technical person, with overall Nexans expertise, interfaces directly with a harness manufacturer to push development in harmony with ongoing automotive projects and real customer needs. Instead of project teams going directly to Nexans R&D experts and plants, the CTI, familiar with all Nexans R&D resources in areas as diverse as metallurgy, chemistry and industrial process, provides one point of contact.

This new strategy, built around eight work streams (concentrating on aluminum, insulation, compounds and supply chain, etc.) is more than just product innovation; it is "living with the customer," allowing harness makers to divest himself of cable research which is beyond their core competences, and move R&D far upstream to a supplier who is capable of controlling everything from raw materials, processes, product design, production and on-time delivery.

Thus, customers are more constantly in contact with Nexans production floor, and this varies from customer to customer. Nexans is thinking beyond products, themselves, and concentrating on service solutions, including logistics, new manufacturing methods, and modular systems. It wants to be integrated in the design process, itself, to find the best way of optimizing production. In fact, our transversal groups, along with the customer, are already planning a minimum of three years ahead.

¹⁶ See "Lean manufacturing can save American manufacturing" at www.searchmalaysia.com/news/lean/2006_01_01_archive.html

Practically speaking, Nexans ability to provide solutions and develop partnerships can be shown in three concrete examples:

- It can make high temperature cables locally for harness makers located in emerging countries (e.g. Romania). Its competitors are in France, Spain and Germany. Nexans offers its partners an equivalent, more available product at lower cost.
- In Romania and Morocco, Nexans has platforms for delivering all types of cables. However, if a client wants a Nuremberg special cable in Morocco, Nexans can have it rapidly delivered and “just in time,” but with only one local invoice, to save paperwork.
- Nexans secures the supply of copper, and thereby assures the continuity of its customers’ production, while protecting his medium-term production costs.

In the final analysis, it is Nexans’ global experience in all kinds of cable that is its force, one which can be rapidly applied to the automobile environment. Nexans is not only immediately responsive to customer demands; it is also highly proactive to future and even unexpected needs. With dual competence in both power and data transmission, Nexans can advise the automotive environment about both new features and parallel hybrid solutions. Most competitors offer one material and one technology; Nexans offers all materials and various technologies, not only on its own home ground, but also at the local level in emerging auto-producing countries worldwide.

As this White Paper has argued, there are a complex number of trends driving change in the automotive market globally through high growth, new markets and further consolidations. Meanwhile, a number of intermediary factors, like record-level gas prices, global warming, and technological change are impinging on the purchasing decisions of the consumer. Recently, there has been a dramatic fall in the sale of “gas guzzlers” in many countries, which has been counterbalanced by the revival of compact cars and the introduction of evermore efficient hybrid cars. Harness and cable manufactures have their own set of trends as they position themselves to adjust to consumer and carmaker demands. There are more cables in automobiles than ever before, and they must be lighter, safer, and capable of handling higher temperatures. Also, new factors are driving changes in manufacturing: cost pressures, the need for a local presence, quality and performance. Increasingly, a new “white space” in marketing is demanding new entrepreneurial effort.

To answer this complex and evolving situation, Nexans has concentrated its strengths in four key areas:

- **Metallurgy**, by securing continuous supplies of vital metals
- **Standard and Special cables** by widening and upgrading its product range
- **Recycling** by assuring that materials are recouped, and the environment protected
- **Local production** by following carmakers and suppliers into new emerging areas

Behind this four-fold strategy is Nexans long-term commitment to innovation, service and partnership to support its customers' strategic strengths, so as to assure that the world's consumers get the kind of sustainable transportation they want and deserve.