A Picture of Sumitomo Electric in Those Days

1911

Sumitomo Electric Wire and Cable Works (Foundation of the Company)

Factory of Sumitomo Electric Wire and Cable Works

Aiming to Achieve Domestic Production –Development of Wire and Cable Business

In 1897, a man visited a steelworks in the United States. Witnessing the technological prowess evident there, he felt impatient with the backwardness of his home country. His name was Kankichi Yukawa, and he later assumed office as the fifth Director General of Sumitomo, but at that time he was an officer of the Ministry of Communications*1, which had wide jurisdiction over transportation, communications and electricity. Yukawa was visiting the US on business as a member of the Universal Postal Union. In that era, Japan was not capable of manufacturing even basic materials for infrastructure, including steel sheets and electric wires, and thus had no other choice but to rely on imports. Seeing the situation of his country, Kankichi understood that the development of Japanese manufacturers was an urgent necessity. In 1905, he decided to join Sumitomo.

To achieve fully effective production of communication, electrical cables, Kankichi established Sumitomo Electric Wire and Cable Works in 1911 by separating the wire and cable business from Sumitomo Copper Rolling Works. In autumn of the same year, the new company succeeded in the practical application of lead-coated power cables for the first time in Japan. They were used as high-voltage underground cables in Kyoto City. While overcoming failures caused by technological immaturity one by one, Kankichi spared no expense in encouraging research. Subsequently, Sumitomo Electric Wire and Cable Works succeeded in the domestic production of communication and electrical cables, achieving a huge leap in technological expertise. In this way, Kankichi worked toward developing pioneering technology.

Kankichi Yukawa*2

*1 Present-day Ministry of Internal Affairs and Communications
*2 Photograph courtesy of Sumitomo Historical Archives

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OSAKA-KANSAI JAPAN EXPO2025

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Sumitomo Electric Group Magazine

vol.02

Innovative Development, Imagination for the Dream, Identity & Diversity

Feature article

Aluminum Wiring Harness: Key Factor in Change of Automobiles and Auto Future

SUMITOMO ELECTRIC GROUP

Mission: Reduce CO_2 Emissions to Fight Global Warming

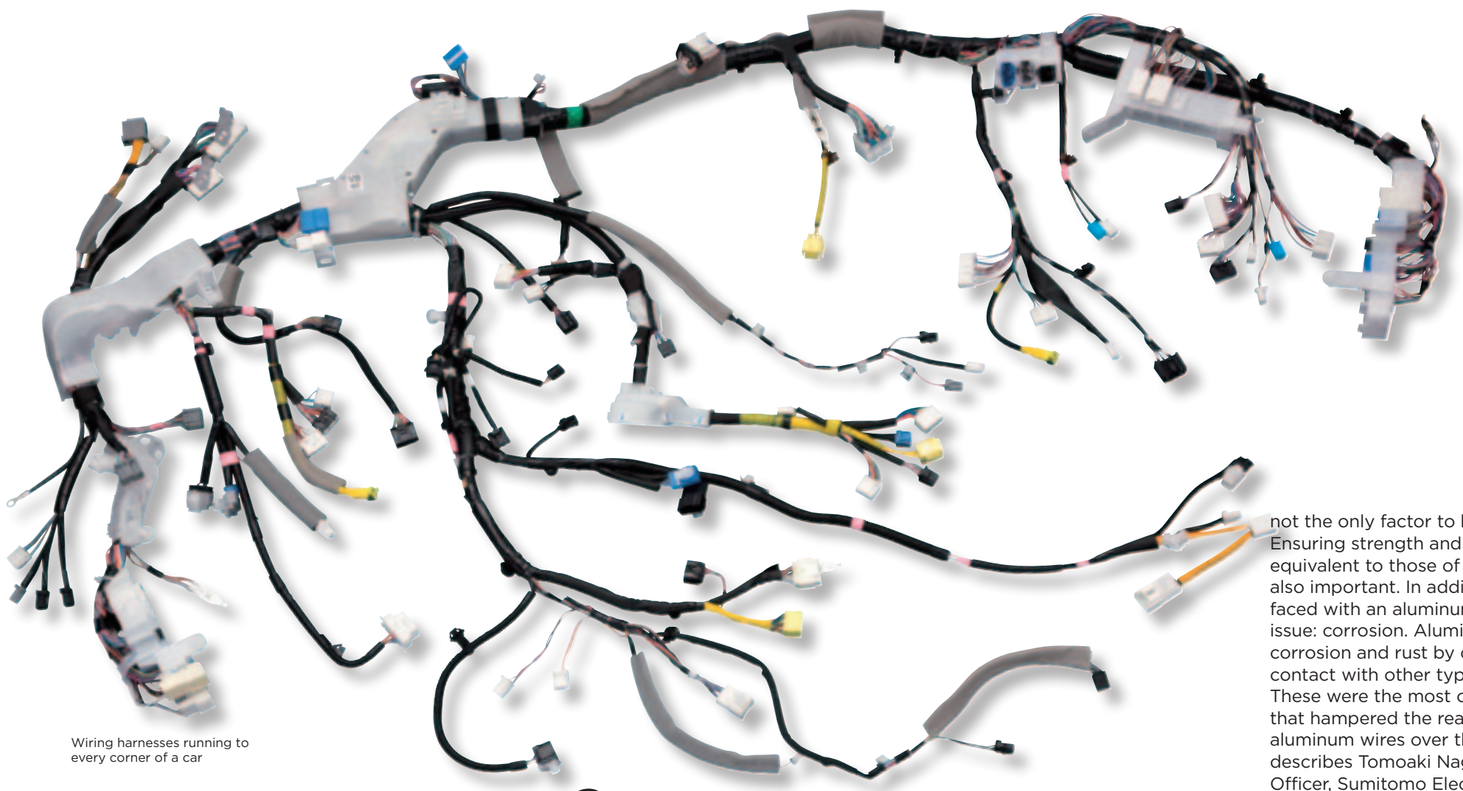
Challenge for the Realization of Aluminum Wiring Harnesses

Aluminum Wiring Harness: Key Factor in Change of Automobiles and Auto Future

Since the Industrial Revolution, people have been fostering economic growth by burning oil, coal and other fossil fuels. As a consequence, the concentration of atmospheric carbon dioxide (CO_2) has increased by about 40% or more since the Industrial Revolution. The increase of CO_2 and other greenhouse gases has brought about a serious environmental issue, namely global warming. The impact of global warming has already been embodied in various aspects: unusual weather events, sea level rise, disruption of ecosystem processes and decrease in food resources caused by adverse effects on agriculture and fishery. It is not a stretch to say that global warming is an issue of prime importance for human beings to address.

To deal with these situations, countries around the world have taken action: the conclusion of the Kyoto Protocol, an international treaty adopted in 1997 at the Third Session of the Conference of the Parties to the United Nations Framework Convention on Climate Change (COP3), comprising legally binding commitments to reduce the emissions of greenhouse gases by developed countries to fight global warming. This international agreement has forced various industries to make significant changes. In particular, for automobile and parts manufacturers associated with vehicles that use fossil fuels as their power source, the reduction in CO_2 emissions has become an urgent matter.

What the auto industry has pursued to reduce CO_2 emissions is improvement in energy efficiency to cut back on energy consumption. To achieve this objective, it has become a common consensus in the auto industry that vehicle weight reduction is indispensable, in addition to improvement in engine combustion efficiency. Under these circumstances, the Sumitomo Electric Group began to take on the challenge of converting conventional copper automotive wiring harnesses to those made of a lightweight material, or aluminum. This effort to reduce vehicle weight is also a challenge for the reduction in CO_2 emissions, which is considered a social and global issue, and by extension, for the prevention of global warming.



Wiring harnesses running to every corner of a car

Conversion from Copper to Aluminum

Wave of vehicle weight reduction to keep up with the times

Wiring harness, lifeline for vehicles

A wiring harness is an organized set of wires used to transmit electric power and information. Many wiring harnesses are installed in vehicles, relaying electric power and information by connecting various components, including the spark plug for engine activation and gasoline combustion, heater, air-conditioner, power windows, interior lights, audio system and navigation system. Automotive wiring harness can be compared to the nerves and blood vessels of the human body. The Sumitomo Electric Group launched the development and production of wiring harnesses shortly after World War II. During the 1960s, riding the wave of high economic growth and resultant motorization, the Group rapidly increased the production of wiring harnesses. Furthermore, since 2000, the Group has expanded its wiring harness business in an aggressive manner through M&A and other measures, so that the business now serves as the mainstay of the Sumitomo Electric Group. "The management judged that advance in globalization of the auto industry and the electronization of vehicles would enhance the added value of wiring harnesses in an unprecedented manner. This is why we embarked on an aggressive expansion policy," explains Kazushi Shimizu, Managing Executive Officer, Sumitomo Electric. Prior to the Sumitomo Electric Group's embarkation, however, there were already other wiring harness manufacturers, creating considerable product development competition.

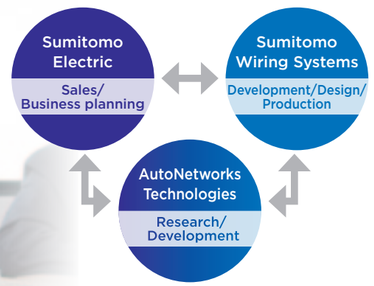
Meanwhile, the major challenge to be tackled by automobile manufacturers was improvement in fuel efficiency. To achieve this objective, vehicle weight reduction was essential. Thus, the use of aluminum for automotive components had already been under study. Aluminum is very light, having a specific gravity of one-third of that of iron or copper. In addition, with a higher strength per unit weight than iron and excellent workability, aluminum has been considered one of the most favorable materials to reduce the weight of transportation equipment. In fact, aluminum has been gradually applied to heat-exchange equipment, including radiators and air-conditioners, and the doors and bodies of some prestige cars.

As the next candidate for aluminum application, automobile manufacturers focused their attention on electrical components. Along with engines and alternators, wiring harnesses, clusters of copper wires, were one of the major factors in increasing vehicle weight. Therefore, the realization of aluminum wires was expected to make a significant contribution to vehicle weight reduction and improvement of fuel efficiency. However, the conversion to aluminum wires was not an easy project.

"Can aluminum ensure the same level of reliability as copper? This concern had long bothered us. Lightness was not the only factor to be considered. Ensuring strength and connectivity equivalent to those of copper was also important. In addition, we were faced with an aluminum-specific issue: corrosion. Aluminum may suffer corrosion and rust by coming into contact with other types of metal. These were the most crucial obstacles that hampered the realization of aluminum wires over the long term" describes Tomoaki Nagano, Executive Officer, Sumitomo Electric.

Tomoaki Nagano
Executive Officer,
Sumitomo Electric

Wiring Harness Business Structure Consisting of the Sumitomo Electric Group



Wiring harness layout

Launching the All Sumitomo Electric challenge

The realization of aluminum wiring harnesses, which had been at an impasse, was pushed significantly forward by the conclusion of the Kyoto Protocol. In line with the treaty, European countries began taking measures to reduce CO_2 emissions in unison, and the EU established controls over CO_2 emissions. For the United States, although the country did not sign the Kyoto Protocol, efforts to reduce CO_2 emissions began to be made in California and other states. Under these circumstances, the auto industry expedited the study for the realization of aluminum wiring harnesses.

Meanwhile, a steep rise in copper prices was a noteworthy change in the market environment. The rapid increase in demand for copper in China resulted in soaring copper prices. For automobile manufacturers, therefore, the realization of aluminum wiring harnesses became an inevitable mission. In this way, the realization of aluminum wiring harnesses with a view to a reduction in vehicle weight and production cost came under the responsibility of the Sumitomo Electric Group and other wiring harness manufacturers. In fact, aluminum wires were already used for aerial transmission lines and automotive battery cables. These wires, however, are for high current, having a large conductor cross-sectional area. On the other hand, standard aluminum wires used for wiring harnesses are for low voltage, having a small conductor cross-sectional area.

As other companies had gained a head start in terms of development, auto manufacturers claimed that the Sumitomo Electric Group had fallen behind in the race. "The Sumitomo Electric Group could not lose in the field of wire production—this pride of ours ignited our motivation" (Nagano). All the employees joined together to act as one.

To respond to requests from car manufacturers, the Group launched the development of aluminum wiring harnesses in autumn 2006, and the project took off in earnest at the beginning of 2007. From the outset of the development process, the Group made a concerted effort as "all Sumitomo Electric Group," namely Sumitomo Electric, Sumitomo Wiring Systems and AutoNetworks Technologies. The challenge for the realization of aluminum wiring harnesses was clear: ensuring reliability equivalent to that of copper wiring harnesses. More specifically, it was necessary to meet the following requirements: the high strength (tensile strength) of aluminum wires; high conductivity (conductivity is an index of the ease of electric flow); reliable electrical connection between the wires and the terminals; and the prevention of long-discussed galvanic corrosion.

For the development of aluminum wires, Sumitomo Electric Toyama, one of the Sumitomo Electric Group members, made a significant contribution. Serving as a center of the production of various types of aluminum wires, the company possesses a wide range of aluminum-specific expertise. The person in charge, who conjointly developed aluminum wires with Sumitomo Electric Toyama, was Yasuyuki Otsuka, an employee of AutoNetworks Technologies. "I started the development of aluminum wires with clear development targets. The most important task was to achieve compatibility between strength and conductivity. The two features trade off against each other. I was required to develop a new aluminum alloy with both high strength and good conductivity."

Aluminum Wiring Harness: Key Factor in Change of Automobiles and Auto Future

Kazushi Shimizu
Managing Executive Officer,
Sumitomo Electric

Working toward Ensuring Reliability of Aluminum Wiring Harnesses

Mission to achieve the compatibility between strength and conductivity

Throes of developing a new aluminum alloy

Aluminum has a lower conductivity than copper. To reduce electrical resistance to the same level as copper, therefore, it was necessary to increase the cross-sectional area of the wire, which in turn had an adverse effect on weight reduction. Otsuka and his team members conducted a study of the physical properties of materials that allow aluminum wires with a maximum cross-sectional area of 0.75 mm^2 to replace conventional standard copper wires for low voltage with a cross-sectional area of 0.5 mm^2. The realization of a new aluminum alloy that meets the abovementioned requirements can be achieved by adding optimally suited elements. The deliberate study made in collaboration with the Energy and Electronics Materials Laboratory of Sumitomo Electric found that adding iron (Fe) was effective in improving strength while controlling reduction in conductivity.

In tandem with the development of the new aluminum alloy, a study of mass production started. “In the first place, aluminum is a material with lower strength than that of copper when the same cross-sectional area is compared. I wondered if the achievement in the laboratory could be applied to actual mass production in factories. For the three steps of the wire production process, or wire-drawing, stranding and extrusion, we were principally concerned about wire breakage. We worked toward the achievement of high productivity in terms of copper wires by lowering tension and friction in each production step” comments on Osamu Okamoto, Exective Engineer, Electric Wire & Cable Group, Sumitomo Wiring Systems.

“Elemental wires used for electrical conductor wires have a diameter of 0.15 to 0.4 mm. These diameter values are extremely small for aluminum wires, resulting in an increase in the amount of added iron (Fe) for wire reinforcement. However, it turned out that increasing the iron content exacerbated workability during wire-drawing and stranding. Therefore, we explored potential materials for the second additive element that could increase the strength of the wires without hindering workability, when partially replacing iron” (Otsuka). Otsuka and his team members gave strength and conductivity, which trade off against each other, a second thought, determining that a decrease in conductivity was permissible to some extent. Comparative testing of elements revealed that magnesium (Mg) was the most suitable element. The optimum composition of aluminum (Al), iron (Fe) and magnesium (Mg) fulfilled both workability and performance, achieving tensile strength and conductivity exceeding the target levels.

One man had been patiently awaiting the completion of this new aluminum alloy: Hiroki Hirai, who was also an employee of AutoNetworks Technologies. Hirai took upon himself the responsibility of developing highly reliable terminals for wires made of aluminum, an element with which it is inherently difficult to achieve electrical connection.

Serration inside the terminal is the key

Wiring harnesses run throughout a vehicle. The number of wires used in such harnesses reaches approximately 2,000 in some vehicle models. Needless to say, it is necessary for wiring harnesses to be connected to each other at various points inside the vehicle. Wiring harnesses are connected by inserting connectors engaged with the terminals of wires through a technique called “crimping.” Crimping is a method used to connect wires to a terminal by physically applying pressure, ensuring electrical connection and wire retention. The establishment of a crimping technique to connect aluminum wires to a terminal was what Hirai focused on to expand the use of aluminum wiring harnesses.

“The material properties of aluminum were considered to exert influence on crimping. Aluminum is an inherently difficult material with which to achieve electrical connection because it is covered with a hard layer of electrically insulating oxide. Therefore, to ensure electrical connection, it was necessary to break this hard insulating oxide layer, which was the most significant challenge we faced. While tacking this issue, I focused my attention on serration of the terminals” (Hirai).

Serration is a series of notches formed on a crimp terminal in a portion where the terminal is connected to wires. Serration provides edges to prevent the disconnection of wires after crimping. It turned out that serration made a significant contribution to ensuring the stability of electrical connection between a terminal and aluminum wires by breaking the surface oxide layer. Hirai’s experiment was unique. He conducted simulation testing by employing a method that can be called “visualization” of the aluminum oxide layer: compressing a mock wire made of clay coated with paint, which serves as an oxide layer, by using a simulation terminal. The results of the testing showed that significant deformation of clay and breakage of the painting layer occurred in the vicinity of the serration. “Additional load application to this portion enables fresh metal surfaces of the wire and terminal to cohere (tin adheres to the aluminum wire), ensuring electrical connection.

In addition to simulation testing by using clay, we took various other measures, including computer aided engineering (CAE) analysis, precise analysis of the state of connection, and testing on more than 60 types of prototypes. Through these measures, we learned that, to ensure the required connection reliability, it was essential to increase the number of serrated edges at which the wires and terminals cohered. This finding was a key point in the development of the terminals” (Hirai).

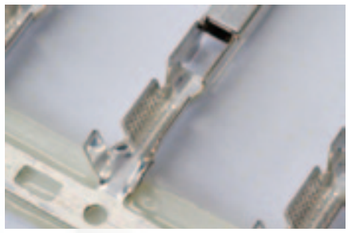
The newly developed terminals have an increased number of serrated edges and widespread fine asperities to improve electrical connection and wire retention, respectively. It is also worthy of note that the ensuring of electrical connection has been achieved by making changes only to the serrated edges. This allows conventional terminal production assets to be used, making a worthwhile contribution to cost reduction. For mass production, in cooperation with the Connection Technology Department of the Component Business Unit in Sumitomo Wiring Systems, Hirai succeeded in ensuring the quality of the serration and its reliability in connection, including crimping. This terminal development followed by Hirai came to serve as one of the major factors in achieving product differentiation.

Meanwhile, we cannot discuss the development of aluminum wiring harnesses without mentioning the development of technology to prevent aluminum corrosion. This technology development fell under the responsibility of Yoshiaki Yamano, like Otsuka and Hirai, an employee of AutoNetworks Technologies.

Hiroki Hirai
General Manager,
High Speed Communication R&D Division,
AutoNetworks Technologies

Yoshiaki Yamano
Senior Manager,
Harness Core Technology R&D Department,
AutoNetworks Technologies

Yasuyuki Otsuka
Senior Manager,
Electric Wire & Cable R&D Department,
AutoNetworks Technologies



Serration

When a mock clay wire is compressed with a simulation terminal, significant deformation and breakage of the painting layer occur in the vicinity of the serration.

Osamu Okamoto
Executive Engineer,
Electric Wire & Cable Group,
Sumitomo Wiring Systems

Aluminum Wiring Harness:
Key Factor in Change of Automobiles and Auto Future

Creating the Future of Automobiles

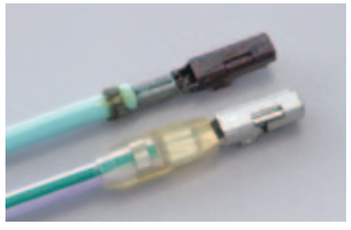
New automotive era conceived by Sumitomo Electric

Running automotive wiring harnesses (Image)

Step toward "complete replacement with aluminum wiring harness"

Before explaining the anti-corrosion technology developed by Yamano, it is necessary to describe the corrosion mechanism of aluminum. An aluminum wiring harness has a portion where aluminum wires connect with a copper-based terminal.For connections between copper and aluminum, the adhesion of salt water or other electrolytic solution causes galvanic corrosion, resulting in intense leaching of aluminum. This corrosion issue was one of the major factors that had long hindered the realization of aluminum wiring harnesses. Thus, to create aluminum wiring harnesses for vehicles, galvanic corrosion was a crucial issue to be resolved. To that end, Yamano launched a field research for vehicles used under severe environments.

"The largest environmental concern in terms of corrosion is the adhesion of salt water or other electrolytic solution. Therefore, I conducted surveys on aging vehicles used in regions where the adhesion of electrolytic solution is often observed, more specifically, the Middle East, where the adhesion of chlorides is a common issue; North America, where corrosion issues caused by the adhesion of snow-melting salt have come to the fore; and Southeast Asia, where the intrusion of water into vehicles often occurs due to sudden showers. By quantifying the concentration of salt, I clarify the relationship between the occurrence of corrosion and the concentration of salt" (Yamano).



Corroded terminal (upper) and corrosion-free terminal protected by a mold (lower)

Yamano's research has revealed another fact that vehicles have portions where the adhesion of salt water cannot be avoided, causing corrosion to terminals there. Corrosion occurs at the crimped portions of terminals connected to wiring harnesses. The challenge to be tackled became obvious: the establishment of anti-corrosion technology for crimped portions connecting wires to terminals. After thorough study, it turned out that, to prevent corrosion, complete protection needs to be applied not only to exposed aluminum conductors but also to the rear end of a terminal. Thus, a method whereby resin molding is applied to the whole, including the rear end of a terminal and the crimped portion, was employed.

This aluminum wiring harness, created as a "make-or-break product" for the Sumitomo Electric Group, came to be installed on automobiles in 2010. The Group was considered to enjoy superiority in its comprehensive technological prowess over its competitors due to its total manufacturing, which begins with the development of materials and ends with mass production. At present, Sumitomo Electric Group's aluminum wiring harnesses are delivered to many automobile manufacturers in and outside Japan, and used all over the world, including Europe and the United States. The product is highly regarded for its excellent reliability, making a great contribution to the achievement of the original objective, or the reduction of vehicle weight. Significant strides forward have been made in reducing CO_2 emissions.

Furthermore, the Sumitomo Electric Group developed a plan for the complete replacement with aluminum wiring harnesses at an early stage. Under this plan, the Group has conducted research and development on aluminum wiring harnesses of its own accord. One of the fruits of this effort is high-strength aluminum wires that were installed on vehicles for the first time in 2015. Before that, the application of aluminum wiring harnesses to the vicinity of an engine had been hindered by vibration issues. The Group strove to develop aluminum wiring harnesses that could endure vibration-induced bending, resulting in the realization of a product that was the same size as a copper wire, with excellent strength and conductivity, embodying the Group's high degree of engineering expertise.

When we cast our eyes to the foreseeable future of automobiles, it is expected that more wiring harnesses will be installed in response to further progress in electronization. In the near future, aluminum wiring harnesses, which can reduce vehicle weight, will become increasingly important. Meanwhile, aluminum wires are required to conform to application to electric vehicles, which will become the global mainstream. Electric vehicles require high current. As the next logical step, enlargement of the diameter of aluminum wires is inevitable. "The development of aluminum wires that conform to high current with a minimum diameter enlargement is also a significant challenge." (Otsuka). Moreover, as electric vehicles consume huge amounts of electricity, the development of aluminum wires that can cope with heating is another major challenge.

Masataka Inoue
Executive Officer,
Sumitomo Electric

Be a trailblazer and create new era of automobiles

The Sumitomo Electric Group has already begun taking measures with an eye to the automobile society to come. A strategic, cross-organizational task force has also been established. "Automobiles are entering a new phase, namely electrification observed in hybrid and electric vehicles, and intellectualization caused by progress in information and communications technology, lowering barriers to entry in the auto industry. As for users, ownership will be replaced by car sharing. The provision of new added value by new players and the creation of new business models may arise. Under these circumstances, we would like to tackle the challenge of creating an original added value conforming to a new era of automobiles in a timely manner" states Masataka Inoue, Executive Officer, Sumitomo Electric. He describes automotive services by comparing them to music services as follows: Today, music has become portable, and you can enjoy music services in the form of sharing. Greater importance is placed not on ownership, but on how to use services and what services can be provided. In the future, similar change is expected to occur in automotive services. Automobiles may serve as a mobile space where you can enjoy a wide variety of services.

Regardless of changes in the role and structure of automobiles, wiring harnesses, which transmit electric power and information in vehicles, will definitely continue to serve as "infrastructure deployed in vehicles" (Shimizu), even as their form changes. There is no doubt, however, that a departure from the present-day supply style, whereby suppliers deliver components to meet car makers' needs, will be required. "Although the Sumitomo Electric Group has run business as one of the Tier 1 automotive suppliers (prime contractor), it is necessary for us to aim to be a Tier 0.5 supplier. We should consider what changes we want and what proposals we will make. I believe that this is our mission: changing the role of automobiles on our own initiative" (Inoue).

One of the strengths of the Sumitomo Electric Group lies in the fact that the Group can work together not only with car manufacturers but also with businesses in various fields, including electricity and communications. By making the most of its strengths that these other companies lack, the Group intends to take the initiative in proposing and providing new added value and services. The Group's enthusiasm and attitude are creating the new future of automobiles.

Manufacturing Relying on Human Resources

Approximately 250,000 employees in about 30 countries around the world

Here, we introduce the production system of aluminum and other types of wiring harnesses that serve as Sumitomo Electric Group's bread-and-butter products. (The company in charge of production is Sumitomo Wiring Systems, one of the Group companies.) The Group's technological prowess is not the only reason for the high reliability of the Group's wiring harnesses in the global market. The reliability could not have been attained without the establishment of a manufacturing system in which quality products are handmade in a steady, consistent manner.
In addition, this article covers the present state of the newest location for the production of wiring harnesses in Paraguay (South America), or Sumidenso Paraguay S.R.L. (SDP).

SDP's production lines

G-STARS training

Global motto: Pika Pika Activity

The most distinctive feature of wiring harnesses in terms of manufacturing is the fact that they are mostly-handmade, labor-intensive products. At worksites, "human resources" play a central role in manufacturing. Therefore, people are the main determinant of product quality. It is no exaggeration to state that product quality hinges upon individual employee's skills. The Group has its production sites in about 30 countries around the world and approximately 250,000 employees in total. Under this production system, the Group is always aiming to achieve globally common best quality.

"Our basic corporate mission is to deliver products of the same high quality from every production site around the world. What underlies this idea is the philosophy that 'manufacturing relies on human resource development,' which serves as a driving force in the creation of a globally common best quality" says Akihiro Komori, Manager, Global PIKAPIKA Center, Wiring Harness Operations Planning Group, Sumitomo Wiring Systems. The philosophy is embodied in the Pika Pika Activity unique to Sumitomo Wiring Systems. This project has been well established as an activity to achieve "pika pika (brilliant) manufacturing" through "pika pika mind, actions, and skills" and "pika pika equipment and worksites." The term "Pika Pika Activity" now serves as a motto of the company's employees around the world.

The first step of the Pika Pika Activity is to measure and evaluate skills using the Global Skill Training and Recognition System (G-STARS). Skills are rated on a scale of 1 to 5 so as to motivate workers and improve their skills in terms of, for example, working speed and quality control. Another program of the Pika Pika Activity is the PK Evaluation to evaluate factory management levels. In recent years, judging from the fact that more than 90% of all factories score 80 or higher out of 100, high pika pika levels have been achieved on the whole. In addition, the Skill Olympic Games, in which employees around the world strive to participate, is held. Delegates from each country annually gather together in Japan to compete against each other to win first place in the skills required for each work process. "Although these programs are designed to evaluate skills, they all function as part of education, in other words, human resource development, providing the power to create a globally common best quality" proudly says Tetsuji Maruyama, Executive Officer, Sumitomo Wiring Systems.

Akihiro Komori
Manager, Global PIKAPIKA Center, Wiring Harness Operations Planning Group, Sumitomo Wiring Systems

Tetsuji Maruyama
Executive Officer, Sumitomo Wiring Systems

Struggle to achieve a globally common best quality

Located near the center of South America, Paraguay is one of the farthest countries in the world from Japan. Among Latin American countries, Paraguay has recently become a focus of attention. One of the reasons for its popularity is the country's economic policy, which provides tax exemptions for importing components and exporting products. In this country, the Sumitomo Electric Group launched the production of wiring harnesses in 2016. "Paraguay adopts a forward-looking attitude to attracting foreign businesses so that it can achieve resultant job creation and further economic growth. Meanwhile, having a high ratio of young people, the country provides businesses with the advantage of access to a large, young workforce. This attractiveness of Paraguay made the Group consider the country an optimally suited location for increased productivity and decide to establish a production site there" explains Masayoshi Morii, President, SDP. SDP was established as an affiliate of Sumidenso do Brasil Indústrias Elétricas Ltda. located in Brazil, by relocating part of the production lines from Brazil. The ceremony to celebrate the opening of SDP was attended by the President of Paraguay, major ministers, and the Japanese ambassador. The Minister of Industry and Commerce visited SDP three times in total before and after the ceremony. This indicates high expectations for SDP. At present, the company has created as many as 1,400 jobs, and is now one of the top-ranked businesses in Paraguay in terms of the number of employees and the amount of sales.

However, efforts made at the time of the factory's commencement of operations were far from easy. Looking back on those days, Vice President Hiroshi Kuroda described difficulties at that time as follows: "Most people in Paraguay are engaged in agriculture. Therefore, almost all SDP employees had no experience in working for a company. In cooperation with trainers who had acquired skills in Japan or Brazil, I educated workers patiently and earnestly. The penetration of education and the progress of on-site improvement activities have now brought a stable product quality." What measures were taken to achieve "globally common best quality" at the new factory in the early days of commencement of production?

"Wiring harnesses are mostly assembled manually. Thus, operational precision is a fundamental principle. As the basic management policy for Sumitomo Wiring Systems' manufacturing, three types of management are thoroughly implemented: managing compliance with standard operating procedures (operational compliance); checking changes in people, things and equipment (change point management); and checking abnormalities (anomaly management). We believe that the steady implementation of these three types of management and education leads to the achievement of a globally common best quality" (Kuroda).

Here are some stories of SDP employees. Noelia Diaz, Line Leader, joined SDP concurrently with the establishment of the company. "Previously I worked as a cashier at a supermarket. I am pleased to have taken this job. My persistent efforts were recognized and I was appointed as leader, which has allowed me to grow mentally. I share what I have learned from Japanese trainers with my team members. I teach them the importance of completing a job right to the end with due care." Noelia is immersed in training her subordinates.

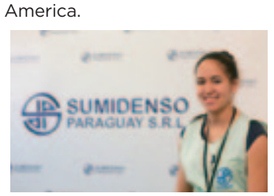
Minami Valeria, an operator, joined the company to take on a new challenge. She used to work as a babysitter and a nurse, but she wanted to have a steady job. "At the beginning, I was a slow worker, so I sometimes inconvenienced the people around me. However, as the leader and other operators encouraged me saying 'You can do it,' now I can do my job very quickly. I would like to acquire more skills and take on jobs other than that of an operator," said Minami enthusiastically. In this way, the location for manufacturing wiring harnesses functions as a place that provides workers with the opportunity to acquire skills and grow mentally.

At present, in Paraguay, in response to increasing demand for automobiles in South America, a new production project is about to be launched. "By utilizing our experience and making a concerted effort, we want to start a new project successfully. I expect that success in this project will further improve the performance levels of our employees" (Morii). The Sumitomo Electric Group's manufacturing philosophy has been passed down unbroken in a faraway land—Paraguay in South America.

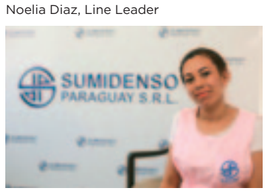
The opening ceremony was attended by the President of Paraguay, major ministers, the Japanese ambassador, and many other persons. (From the left, front row) Fourth: President of Paraguay / Fifth: Osamu Inoue, President of Sumitomo Electric / Sixth: Masayoshi Morii, President of SDP

Aluminum Wiring Harness: Key Factor in Change of Automobiles and Auto Future

Vice President Kuroda (center) and Japanese trainers



Noelia Diaz, Line Leader



Minami Valeria

Sumitomo Electric
The Professionals

"Manufacturing is a never-ending process. It is necessary to make consistent, step-by-step efforts to accumulate specialist knowledge and expertise and pursue the mission of manufacturing to an extreme. I believe that such tireless dedication serves as a driving force for further evolution of manufacturing."

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Featured person

Hideki Kitada

Hybrid Products Div.,
Electric Conductor & Functional Products Business Unit

1980: Entered Sumitomo Electric Industries, Ltd. Assigned to the Rubber and Plastic Products Div. (current Hybrid Products Div.)
1998: Manager, Vibration Control Products Group, Engineering Dept .
2007: Manager, Manufacturing Dept. of SEI Hybrid Products, Inc.
2010: President, KTS High-Tech Rubber Co., Ltd.
2013: Chief Engineer, Hybrid Products Div.
2016: Recognized as a Fellow*

* Sumitomo Electric selects several employees as a Fellow every year as a means for recognition of those equipped with high levels of rare specialized knowledge, skills and expertise. In 2017, the title of Fellow was awarded to eight employees, including Kitada, who was selected for the second consecutive year.

Keep on Going and Never Give Up!

Air springs that serve as the backbone of the evolution of the Shinkansen

After graduating from university with a degree in mechanical engineering, I entered Sumitomo Electric with a strong desire to play an active role as an engineer in supporting fundamental manufacturing technology. Since then, I have dedicated my efforts to the development of air springs. An air spring, consisting of rubber reinforced with tough fibers and metal components, refers to a suspension system to suppress vibration by taking advantage of air compressibility. Air springs employed for railroad vehicles, for instance, are an important security component to significantly alleviate vibration transmitted from wheels to the vehicle body and improve ride quality.

In the 1980s, further increases in the speed of the Shinkansen bullet train were a challenge to overcome in order to win a competitive battle with aircraft for passengers, and were, at the same time, a strong demand from a society with invigorated economic activity. To achieve this, it was essential to reduce vehicle weight. For train bogies into which air springs are incorporated, it was also an important challenge to eliminate the heavyweight bolster. The bolster installed between the bogie and the vehicle body is responsible for buffering the lateral motion and recovering the relative displacement when traveling on a curved railway. We worked on a new structural design and finally developed a bolster-less bogie featuring an air spring that functions as a conventional bolster (Fig. 1). Moreover, many of the metal components of the air spring were replaced with aluminum alloy to reduce the bogie weight. Our design to optimize spring characteristics depending on traveling conditions also enabled Shinkansen trains to provide a truly comfortable ride. Since then, bolster-less bogies have been employed for Shinkansen vehicles.

Development of an industry-standard air spring

In 1993, we were requested to develop a new air spring technology to improve ride quality when Shinkansen trains travel on curved railways at higher speeds. The Japanese archipelago is made up almost entirely of steep mountain areas with very few plains. This means there are a lot of curves on railway tracks. On the curve of a railway, a certain level of cant (the difference in height of the inner and outer rails) is created, so that the vehicle body can be tilted inwards due to its weight to offset the force by which the body tilts outwards on a curved railway due to centrifugal force. When a train passes through a curved railway with an insufficient level of cant at a higher speed, excess centrifugal force is generated, pushing the carriage outwards to its maximum possible position. To prevent this, lateral bumpers (stoppers) were installed between the vehicle body and the bogie. However, such bumper collisions led to a significant decrease in ride comfort (Fig. 2). We needed to develop a new technology to eliminate bumper collisions caused when trains pass through curved railways.

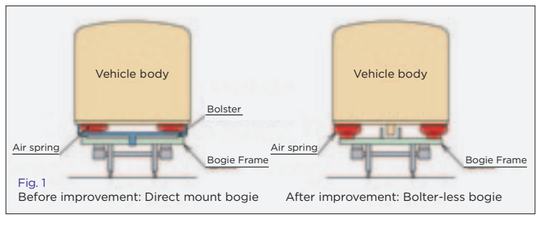


Fig. 1
Before improvement: Direct mount bogie After improvement: Bolter-less bogie

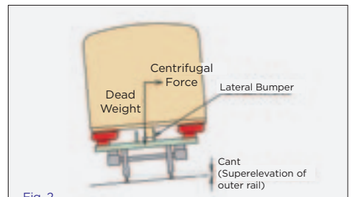


Fig. 2
Vehicle body tilting when traveling on a curved railway

Our challenge was to develop an air spring whose reaction force is equivalent to the centrifugal force. We repeatedly visited our customer and made technological proposals, but we were not able to get to the point where our proposal was accepted. We, together with our customer, made steady efforts through a lot of trial and error. We faced various hardships, but we never gave up. As a result of tenacious efforts, we finally succeeded in developing an air spring that can react to the excess centrifugal force created by increased speeds. This technology improved ride quality without bumper collisions even when trains pass through curved railways at higher speeds. A full five years were spent on the development and introduction of the new air spring technology, but this gave me, as an engineer, a lot of valuable experience and a great sense of achievement.

This technology became the standard structural technology for Shinkansen air springs. Later, further increases in speed when passing through curved railways were achieved by developing a body tilting system that makes optimal use of the characteristics of air springs. For a series of new Shinkansen models introduced later, we made steady efforts to improve air springs to ensure better safety and comfort of passengers.

Advancement into the Chinese market was an landmark event for me. In 2010, I was transferred to China to establish a plant from scratch, together with two local staff members, and then I was able to put local production of air springs for China Railway High-speed (CRH) on track. After my return to Japan, air springs saw a drastic increase in sales and grew to a core product of the Hybrid Products Division. Our products have been employed for about half of the CRH trains.

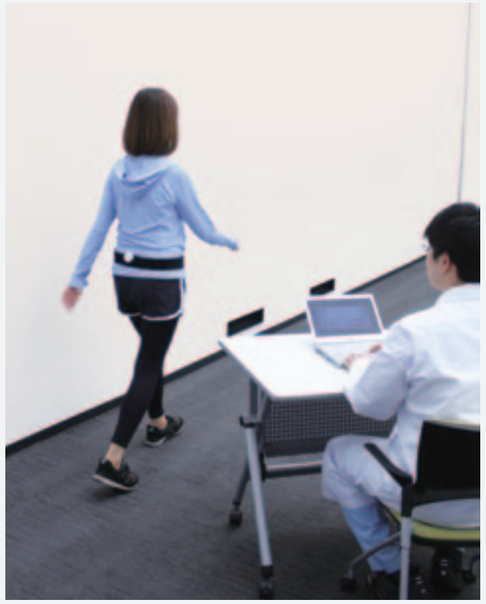
Sumitomo Electric's engineer DNA handed down from one generation to another

I feel incredibly lucky to have been able to develop air springs into a successful business with the help of colleagues and other people around me. In retrospect, it was a tough road. The history of air spring technology goes back half a century, and air springs went through many improvements. I myself diligently persisted in efforts to repeatedly improve the structural design of air springs. I believe that my strong desire to play an active role as an engineer in supporting fundamental manufacturing technology was materialized in the form of the air springs that serve as the backbone of the evolution of high-speed rail trains.

The air spring has kept evolving in line with the times and social needs. With the advancement of system integration including control technology, we need to respond to new challenges, such as increasing running speeds, ensuring security and reliability, and improving environmental friendliness and ride comfort.

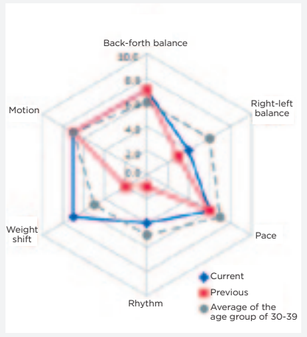
Based on the knowledge and experience acquired so far, I have also engaged in the nurturing of young engineers. I believe that my mission is to pass on the knowledge and skills imparted from my predecessors to younger engineers, and to aggressively pursue universal themes in manufacturing. Manufacturing is a process of efforts to pursue thorough optimization, and there is no end to the efforts. "Persistence and enthusiasm" is my creed as an engineer and, I believe, is also "DNA" handed down in Sumitomo Electric.

Promoting Health by Visualizing Your Walking Style



A wireless wearable motion sensor collects walking data

Sensor



Walking radar chart (measurement sheets)

Locomotive syndrome (locomotive syndrome)–a condition of reduced mobility (limitations in standing, walking, etc.) due to impairment of locomotive organs, including bones, joints and muscles–has attracted a lot of attention recently. As part of its efforts to help people have a longer healthy life expectancy*, Sumitomo Electric has developed and launched "Q'z TAG™ walk," a device that measures and evaluates walking, a most fundamental movement and regarded as the first step to prevent locomotive syndrome.

This walking monitoring device features simple operations: install dedicated software on your PC and walk 10 meters there and back with a 15g sensor on your waist. Since the sensor is connected to the PC through Bluetooth, you can use the device anywhere and anytime. Measurement results are converted by our unique analysis technology into a numerical form under six categories, including pace and balance of walking. This system also enables users to compare the past three walking measurement results and print out such results.

Since the release of "Q'z TAG™ walk" on June 20, 2017, many nursing homes for the elderly have been considering its use. On a local government level, Mishima City in Shizuoka Prefecture was first to introduce the device. As part of its efforts to promote the good health of residents under the "Smart Wellness Mishima" program, the city established a health and wellness facility called "Mishima Kenko-Juku," with the aim of providing health-related support, disseminating health information and promoting interactions among local people. As one of the events to mark the second anniversary of the establishment of the facility, the city decided to introduce the "Q'z TAG™ walk." In August 2017, a project was launched to provide firsthand experience of the device. "The program was so popular that the admission capacity is reached quickly whenever we invite people to join the program," a city official says. This shows people's high interest in their health.

Sumitomo Electric continuously strives to promote the development of health-enhancing products, including the upgrading of "Q'z TAG™ walk" and ICT device cooperation, aiming to provide solutions to the problems faced by our customers and help people improve and maintain their health.

The health and wellness facility "Mishima Kenko-juku," located in the city center of Mishima, is alive with people (once featured on a TV program).

* Healthy life expectancy refers to the number of years an individual can be expected to live in good health.

QUARTERLY

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Topics from the future-shaping Sumitomo Electric Group

From Tohoku to the World: Contributing to Manufacturing by Offering High-Quality Cutting Tools

Steel tools

Cemented carbide drills

Tohoku Sumiden Precision Co., Ltd. will go into full-scale operation in November 2017. The company, located in Miharu-machi, Tamura-gun, Fukushima Prefecture, will serve as a major cutting tools production site in the northern Kanto and Tohoku regions. With the promotion of the restoration of the Tohoku region affected by the Great East Japan Earthquake, many plants are being constructed, thereby causing a growing demand for cutting tools.

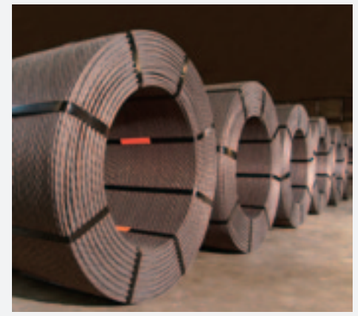
Tohoku Sumiden Precision produces cemented carbide drills and steel tools, which are used for drilling and milling*1 machines for metal processing. The company also has the Tohoku region's first plant for repolishing drills, which help shorten the lead time for drill re-polishing for local customers. On the same premises, Tohoku Tool Engineering Center (My-TEC)*2 will be established to reinforce customer support services in the Tohoku region by providing individual technical consultations and demonstrations of machining work using the latest tools and equipment. In response to a rapidly growing demand for cemented carbide drills on a global scale, highly efficient production lines–which enable the automation of manufacturing processes and a smooth connection between processes–will be introduced.

With "Working Together in Pursuit of Development to Become a Globally Active Company" as our motto, we strive to contribute to manufacturing industries around the world by pursuing finely tuned manufacturing in more depth here in the town of Miharu of the Tohoku region.

*1 A machining process of using a rapidly rotating steel tool with multiple cutters to perform surface processing
*2 Its customer services include demonstrations of machining work using the latest tools and equipment.

Supporting the Development and Upgrading of Social Infrastructure in the Southern US

PC strand



Texas plant

The building and upgrading of social infrastructure is a huge challenge around the world. The southern part of the US, where the population is on the rapid increase, saw a boom with a rush of infrastructure development and improvement, such as the construction of expressways and housing, thereby generating a growing demand for building materials.

In this region, where the ground is soft, the slab*1 construction method, in which prestressed concrete (PC) strands*2 are laid and then set in concrete, is often employed for the foundation of a residential house.

In this context, Sumiden Wire Products Corporation*3 constructed a plant in the city of Dayton, Texas, to respond to a growing demand for PC strands in the southern part of the US. The plant enhanced productivity and quality by increasing production capacity and introducing a welding quality judgement system.*4

The plant, located in an area characterized by frequent rains and high humidity, has secured stable production by raising the ground level and effectively utilizing an air conditioning control system.

We will continue to serve as the backbone of social infrastructure development in the US by further expanding our PC strand production capability and reinforcing our stable supply system.

*1 A foundation for supporting the load of the ground floor of a reinforced concrete building
*2 Steel utilized for the development of infrastructure, including buildings and bridges
*3 Established in 1979 as Sumitomo Electric's first subsidiary in the US. Engages in the production and sales of PC strands and stainless steel wire. Already has two production sites in the states of California and Tennessee. The Texas plant is its third production site.
*4 A system to detect welding defects at the time of connecting wires