Mr. Ariën van Beinum, Session Chairman

We would like to start the second part of this session. In the first part, we have seen and heard about enormous business opportunities and we still have to develop many things. In this part, we will go back to our own business. We will talk about cars, wire harnesses and wires and cables. It is more directly connected to us.

Our first speaker in this part is Mr. Sakai from Toyota Motor. He is Project General Manager of the Advanced Vehicle Engineering Division. His paper will deal with the development in the automotive technology and its consequence for wire harness. Here we will learn, what the automotive industry wants from international cabemakers. Mr. Sakai, please.
Thank you very much Mr. Chairman for your kind introduction. Today, I would like to give my presentation in 4 divided parts. I will explain the technical development trends of automotive technologies and give an overview of wire harness. Then I will talk about tasks of the harness industries and the requests to the wire industries. First of all, I would like to start with the development trends of automotive technologies.
I would like to start this presentation with the Toyota 2010 Global Vision. I think there may be not a big difference among automotive companies.

Four keywords are held up in Toyota:

“Kind to the Earth”: Toward a recycle-oriented society, to reduce the load of the cars to the global environment. We pursue the reduction of fuel consumption, exhaust gas and wastes.

“Comfort of Life”: Toward the age of ITS and Ubiquitous Networks. We pursue easy to use, peace of mind, pleasure to enjoy the life.

Other keywords are: “Excitement for the World” and “Respect for all People”.

Today, I would like to focus on the first two keywords in this presentation.
As regards the keyword “Kind to the Earth”, I will explain the environmental measures.

Environmental regulations in major areas are shown in this table.

In the USA, step-by-step strict exhaust regulations will be imposed.

In Europe, recycle regulations as well as exhaust regulations have become effective. Also, a carbon dioxide exhaust regulation, which means, a fuel consumption regulation is scheduled in 2008.

In Japan, especially diesel exhaust regulation has been tightened and car recycle regulation was enacted. Regulations on extremely low exhaust gas, low fuel consumptions and recycling have been started.

<table>
<thead>
<tr>
<th>Regulation Trends in Automotive Environment</th>
</tr>
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<tbody>
<tr>
<td><strong>USA</strong></td>
</tr>
<tr>
<td>LEV</td>
</tr>
<tr>
<td>LEV II</td>
</tr>
<tr>
<td>CAFÉ</td>
</tr>
<tr>
<td>SUV Exhaust</td>
</tr>
<tr>
<td>Freedom Project</td>
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<tr>
<td><strong>EU</strong></td>
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<tr>
<td>Recycle Directive</td>
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<tr>
<td>OBD II</td>
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<tr>
<td>Euro IV</td>
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<tr>
<td>08 CO₂</td>
</tr>
<tr>
<td><strong>Japan</strong></td>
</tr>
<tr>
<td>Metropolitan Diesel Regulation</td>
</tr>
<tr>
<td>Car Recycle Law</td>
</tr>
<tr>
<td>Diesel Exhaust Regulation</td>
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<tr>
<td>CO₂</td>
</tr>
</tbody>
</table>
Now, some remarks on automotive environmental measures:

Toyota promotes four basic technologies for the ultimate ecology car. They are improved gasoline engine, improved diesel engine, alternative fuel and electric vehicle. Combining these technologies, Toyota focuses on hybrid technologies on the way to the ultimate ecology car.

“THS” stands for Toyota Hybrid System. It is a combination of gasoline engine and electric vehicle (EV). The first mass production model was released in 1997 and the improved model was launched this year.

“FCHV” is a combination of Fuel Cell and Electric Vehicle (EV). That was introduced to the market as a trial.
This figure shows the construction of a hybrid vehicle.

The hybrid vehicle is composed of a gasoline engine, a motor generator and a voltage inverter. It travels by the engine and the electric motor, charges battery by the generator or it regenerates energy. This is a vehicle incorporating both the merit of an engine and the merit of a motor. For example, low speed acceleration is good for the motor and high speed acceleration is good for the gasoline engine. The selection of engine or motor will be made automatically by a central processor unit (CPU). When the car is decelerating or braking, the power is charged to the battery.
This year, Toyota launched a further improved THS II. The motor is empowered by increasing the motor voltage from 288V to 500V. The hybrid car not only improves fuel consumption, which influences the environment, but can get a comfortable acceleration feeling by combining engine and motor. We call this “Hybrid Synergy Drive”. This vehicle marked a good fuel consumption of 35.5 km per liter. I think it is the best in the world in this class.
Fuel cell hybrid vehicle as the future technology.

Toyota exhibited this bus (shown in the slide) at Tokyo Motor Show last year. “FCHV” is a hybrid technology, combining fuel cells and rechargeable batteries, and guarantees a high efficiency travel. The exhaust gas of this fuel cell battery is only water vapor.
This chart shows the flow of vehicle demolition during recycling. Recycling laws are enacted in each country and the material and the design of the vehicle have been changed to be more suitable for recycling.
Now I will talk about the keyword “Comfort of Life” and the influence to the trends of the vehicle technology development, especially on “Information Technology”, “Safety” and “New Packages”.

Let us start with the information technology.

Today, we are able to be connected to networks from our cars, while we are driving, thanks to the recent advanced and popular radio communication devices: Access to e-mail and internet, emergency services or information services by communicating with an information center.

We are also able to download the newest road map of the area, where the car is located for the navigation system equipped in the car.

You can access the security system of your residence or purchase the contents, you wish to get from an information terminal.

More and more such services will be available and it will assure us a more comfortable life.
Safety Technology:
Here you see a pre-crash safety system: It monitors in front of the car by millimeter wave radar, sounds the buzzer alarm to the driver or seat belt motion will occur, when there will be a danger of crash. This system pulls firmly the seat belt, when the crash is unavoidable. In the latest model this system can directly operate the braking system.
Monitoring Cameras:

Many cameras have started to be installed on board, to keep better visibility around the vehicle for driving safety. One of the reasons is that low cost but good quality cameras are available these days. The popularizations of cell phones with cameras is increased for the same reason.

There is a front camera for front view, a side camera at the passenger door mirror and a back camera at the rear license garnish area.

In the newest model of Toyota, a car is equipped with an intelligent parking assisting system using the back camera.
Blind Corner Monitoring System:

When we enter an intersection from a narrow road in a crowded residential area, it may be difficult to keep good visibility from the driver’s position. If we can check the left and the right side traffic, when we make a stop at the corner, we will be able to reduce potential traffic accidents.

This photo shows an image of the display on the instrumental panel of the car. As mentioned above, a future car will be equipped by many cameras to guarantee the safety.
From a different view point, I would like to mention the New Package. Customers want a compact body with good drivability and a comfortable and large cabin. You can see here many equipments on the panel. And inside the panel, there are many units like air-conditioning system, airbags and a lots of electronic units. In the back side of this beautifully designed panel, engineers are always struggling to make space available for electronic units and wire harness.

As the space for electronic components becomes narrower or smaller, car components must get smaller.
In the future, many of the mechanical systems of a car will be substituted by electric systems or by wire systems. It will be an evolution of actions by wire, which enables larger cabin space.
The car technology trends are summarized like follows:

Regarding “Kind to the Earth”: Electric power, weight reduction - of course, it is essential to reduce the fuel consumption - and recycling.

Regarding “Comfort of Life”: Information technology, safety technology and new packages.

Future cars will have more electric equipment in decreasing space.
Issue of car electronics:
Electronic equipment must be slim and compact to enable many kinds of electronic equipment on board.
Wire harnesses and its related components are facing the same issue as the electronic components.
Now I will give you an overview of the automotive wire harness.

What is the automotive wire harness?
It is delivering electrical power and signal to every corner of a vehicle, like blood vessels or nerves.
In compact class cars, the total wire length is 440 m and the weight is 12 kg.
In the case of a luxury car with full options, the numbers are considerably larger, the total length is 2600 m and the weight is 34 kg.
The annual copper quantity used in the world automotive industry is estimated to reach 500 k tons.

As I heard, the annual copper consumption in all industries is about 10 million tons, the automotive industry consumes about 5% of the world total consumption.
Wire harness manufacturers in the world:

Major companies in this field are: Yazaki and Siemens, Delphi, Sumitomo and Lear.

The global sales of vehicles are 57 million in the year 2002.
Features of automotive wires:

Automotive wires must have higher heat resistance and lighter weight with thinner insulation compared to other applications.

Automotive wires must withstand a severe abrasion resistance test.
Automotive wires come in many variations. The reason is as follows:
Many conductor sizes for various circuit currents,
many insulation colors for maintenance service
and heat resistant variations required for the installed locations
to get optimal cost and weight solutions.
There are about 1000 wire types.

<table>
<thead>
<tr>
<th>Conductor Size</th>
<th>Insulation Color</th>
<th>Heat Resistance Temp.</th>
</tr>
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<tbody>
<tr>
<td>0.22</td>
<td>Black</td>
<td>85deg.</td>
</tr>
<tr>
<td>0.35</td>
<td>White</td>
<td>100deg.</td>
</tr>
<tr>
<td>0.5</td>
<td>Red</td>
<td>125deg.</td>
</tr>
<tr>
<td>.</td>
<td>Green</td>
<td>150deg.</td>
</tr>
<tr>
<td>15 mm²</td>
<td>Yellow</td>
<td></td>
</tr>
</tbody>
</table>

= about thousand variations
The wire harness manufacturing process is as follows:

- Cutting wire and crimping terminals
- Sub assembly process
- Specified vehicle circuit wires are assembled in a main assembly line
- Taping and protective device attachment are processed
- Final test and shipping

It is a labor intensive industry with 500,000 workers in the world.
Wire harness is assembled on a plane board. When it is assembled on a vehicle, it is unfolded from the shipped form, then it is attached according to the vehicle's shape. The following slides show the change of the wire harness shape in the vehicle assembly process. (There were 15 slides to show the changing of the harness from simple one to the final shape. However, due to the limitation in the number of pages in the Congress Proceedings, ICF omitted these slides) Flexibility of wire harnesses are necessary in the vehicle assembly process. You can see, in the above photo, the difference in the shipped form and the shape before the installation in the car.
Now I will move to the tasks of the wire harness suppliers in accordance with the vehicle developments trends.

I will start from the keyword “Kind to the Earth” in the vehicle technology trends.
We have used 12 V as a main stream, however, a higher voltage is now needed. 42 V is the next generation standard for high power equipment. In hybrid vehicles, higher voltage is used to get higher efficiency. The new Prius-THS II utilizes a 500 V motor. High voltage requires dedicated specifications for the insulation and the noise shield.
Weight Reduction (Cu Wire):

Automotive wires become thinner and lighter with the times. Even the same capacity wire has thinner insulation by material improvement. Recently, a smaller diameter wire by compressed conductor is used.

The bottom figure of the above slide shows a comparison between old and new assembled 100 wires. There is a big difference between the old and new wires with respect to space efficiency.
Weight reduction (application of aluminum wire):

In hybrid vehicles and some luxury cars, the battery is located in the rear. Therefore long and thick wires to the engine compartment are needed. Though aluminum has higher resistance than copper and it needs thicker diameter, a drastic weight reduction can be achieved.

In THS II, 0.37 kg reduction is achieved and in Daimler Chrysler S-class 2 kg reduction is available.
This photo is an example for the improvement of the demolition work, using a dismantling belt on the wire harness as well as easy tear off ground terminals. The wire itself is recyclable as copper. However, if the wire is mixed into the shredder dust, it becomes an impurity of iron and lowers the value of the iron material. So it is worthwhile to be able to easily separate the wire harness from the vehicle, when it is demolished.
Wire dust, after taking out the copper, stems mainly from the wire insulation.

PVC is an excellent low cost material. However, the wire dust with the halogen content like chloride does generate toxic halogen gas, when it is burned.

The halogen gas will damage the incinerator and will create environmental pollution. Shredder dust from halogen free material can be used as shredder dust fuel.

Halogen free wire is thermally recyclable.
Year by year, Toyota increases the number of those vehicles using halogen free wires.
Now, I would like to move to the topics on the keyword “Comfort of Life“ related to the vehicle technology trends.
In-vehicle local area networks (LAN) are expanding due to the increase of electronic equipment and of advanced information systems. The Control Area Network (CAN) becomes popular today in automotive applications and is used with dedicated harness structures like twisted pair. Navigation systems or video signal equipment like Rear Seat Entertainment (RSE) are increasing and the number of video signal cables is also increasing. For the video signal exchange specifications, called IEEE 1394 or MOST, start to be used.

Recently, in some cars more than 30 units are connected to the onboard network.
A lot of radio wave applied products are mounted in the vehicles. Antennas are added for the radio, TV, satellite radio and digital broadcast. Cell phone, GPS and Electronic Tolling Card (ETC) need to be connected to outside systems. Furthermore, an obstacle-detection-radar is another example of expanding the radio wave application. Following the above trends, usage of radio wave cable and connectors are increasing and a recent example shows, that more than 20 pieces of radio connectors are used.
From the explanations, I have made so far, the tasks of the wire harness supplier are summarized as follows:

They must be well aware of the car technology trends and pay attention to their products. High voltage, weight reduction, halogen free, etc. are examples of the importance of the keyword “Kind to the Earth”.

LAN cables, optical fiber, radio frequency cables are the examples for the keyword “Comfort of Life”.

Cost and quality are always very important and the total system design capability is essential.
In the final chapter, I will talk about some requests to the wire & cable industry.

As I have explained above, electric wires suitable for automotive applications must be light weight, with a small diameter, tough, flexible, and low cost.

As the gasoline engine and the electric motor have a good hybrid synergy, I expect a hybrid synergy of electric wire and optical fiber for automotive wire harness.
I would like to conclude my presentation with these words:
“Hybrid Synergy of Industries All Over the World” and I also would like to add “Hybrid Synergy and ITS”.

Thank you very much for your attention.

Question by Mr. T. Nagasaka, Sumitomo Electric Europe
I enjoyed your comprehensive presentation. I have 2 simple questions. First question is on your hybrid car strategy. Do you have any specific plan for a hybrid car production and sales? Second question is, that environmental friendliness is indispensably important but do you think major customers like young folks can be attracted by the concept of Green issues?

Answer 1: In the near future, a hybrid car production of 300,000 cars per year is planned.

Answer 2: Obviously, only "Green" concepts cannot attract young customers. However, THS II is good in acceleration due to an empowered motor and attractive for driving and low fuel consumption.

Question by Mr. H. R. Al Zayani, Managing Director, Midal Cables
What is the Japanese industry thinking compared to the European industry about aluminum in wire harness instead of copper? I heard that Europe is much faster than Japan in using Aluminum wire harness.

Answer: Aluminum has two problems: Higher cost and it is not flexible. So, my request to wire manufacturer is to develop more flexible wires.