Up Close 1: Contributing Positively to the Environment through Craftsmanship



# From Birth to Reuse **Our Endeavors in Tire Making**

Before they hit the road, Yokohama Rubber's tires pass through the hands of numerous different specialists. In this section, we portray the life of a tire-from the moment it is conceived until it is recycled and reborn as a new tire-by showcasing the work of employees involved in each process.



Improved fuel efficiency = Reduced rolling resistance. Yokohama Rubber founded this concept and in 1998 released the very first eco-tire for passenger vehicles in Japan: the DNA series. Since then we have rolled out a number of products with high environmental performance in the categories of sports tires, studless tires, and tires for trucks and buses. We are spearheading the market for low-impact tires in Japan. having sent off into the world some 15 different types already. Yokohama Rubber's current idea of an environmentally sound product is one that performs these tasks: helps prevent global warming, recycles resources, conserves resources, and contributes to safety and comfort. After conducting a quantitative assessment of these four indicators and comparing them to the benchmark figures (1998 products), only those products that are on average 5% superior overall and do not perform worse in any one category are commercialized. In addition to environmental performance, in June 2010 we announced BluEarth, a new concept for tires that pursues greater user-friendliness. We have launched BluEarth AE-01 as the first in a series of future products based on the development concept "Eco + People-Friendly." By incrementally enhancing products with Yokohama Rubber's unique technologies under the BluEarth banner, we dare to go beyond positive contributions to the environment and provide the added benefit of a drive that is more comfortable and enjoyable. Making this type of tire a reality is a role we are committed to taking on as a member of the automotive industry







Data showing decreased rolling resistance

## Planning



IN FOCUS! **BluEarth Concept** = "Eco + User-Friendly" Achieved

As the product of numerous interviews with tire users, the new series concept BluEarth is all about achieving greater friendliness toward the global environment and people, hence "Eco + User-Friendly." Here we present a few keywords related to the concept.



#### Rolling resistance

The spinning tires of a moving vehicle encounter a force opposite in direction from that of the vehicle's movement. This is what is called "rolling resistance." If we can lower this resistance by making innovative modifications to the tire materials, structure, shape (profile), etc., less energy would be required to propel the vehicle, resulting in a considerable improvement in fuel efficiency.

#### Wet grip

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On the other hand, reducing rolling resistance as much as possible can also reduce the vehicle's breaking power (wet grip) on wet surfaces and thus compromise safety Maintaining high wet-grip performance while also reducing rolling resistancethis is a major key to realizing a fuel-efficient tire

Air pressure

This is surprisingly not well known, but the biggest thing that affects fuel-efficiency is the air pressure in a vehicle's tires Tires with insufficient air pressure not only bring down safety and riding comfort. but also lead to greater rolling resistance and thus poorer fuel efficiency.

### Identifying the world's needs and proposing fresh concepts for product development. The manufacture of tires starts in the planning division.

Tires are one of the most critical components of a vehicle. First of all, they have to satisfy our customers' requirements when performing all of the basic safety functions: driving, turning, and stopping. I think the key point to product planning is figuring out how to deliver additional value such as environmental performance and "user-friendliness" on top of these basic criteria. Even after a concept has been decided upon, we have to collect and coordinate opinions from numerous groups of people in and outside the company until the product is launched. Coordinating is a challenge because all the people involved are professionals in their field of expertise with their own uncompromising values, but they all share the desire to create great, popular products. After repeated discussions and pushing to reach that final product, when I finally see in the stores I feel like it was all worth the struggle.

Yokohama Rubber can take pride in being the foremost developer of eco-tires in the world. I want to continue to give society eco-tires that are adapted to the people who use them.



## "User-Friendly" Keywords

### Driving stress reduction

BluEarth seeks to achieve not only enhanced riding comfort and quietness, but also a environment in which drivers and non-drivers alike can live comfortably and stress-free. We are also conducting research to tone down the "passing sound" (vehicle exterior noise)-the noise heard by people around a moving vehicle-to a level much reduced from that of conventional tires

#### Maintenance-reducing technology

Once realized, comfortable and stress-free driving has the potential to create new stress if tire maintenance requires more time and energy that of conventional products. With the BluEarth concept, we aim to dramatically reduce gradual air leaks and are working on the development of "AIRTEX advanced liner," a product that minimizes air pressure adjustments and other labor required to maintain tires (already included in some tires).



Right now we're working on aerodynamic research. The goal is to increase fuel efficiency by lowering air resistance on not just the tires but the entire vehicle. Until now, engineers have focused their attention on just the tires, but now we're using simulations to elucidate the effect that tire design has by taking the unique approach of trying to improve the flow of air around the vehicle as a whole

With R&D there is no finish line. It is more about accumulating small achievements on a daily basis. I really want to help develop technologies and products by creating technologies that are unaffected by such variables as operating environments. (Koishi)

As part of our R&D activities directed at achieving the "Eco + User-Friendly" concept, we're conducting research on assessment methods based on "biological monitoring." Biological monitoring quantifies the stress and senses experienced by a driver by measuring a range of biological systems, including muscular and cardiovascular. It assesses what kind of tire is more user-friendly in a manner that is quantitative, not subjective. Technologies originally used in the fields of medicine and physiology are applied to the measurement of human senses from an "emotion engineering" standpoint. In order to incorporate advanced technologies from different fields, I try to keep my eyes and ears open in all directions. (Kuwajima)

# **Materials** Design

Materials are another factor that affects tire performance. The materials design people are on a never-ending search for materials and compositions that lead to greater performance.



One of the materials used in BluEarth AE-01 is "orange oil," an oil collected from orange peel. The impetus in using this material came from a project with a special mission to increase the proportion of non-petroleum raw materials to 80% or more. Although natural rubber is highly durable, it is also outperformed by synthetic rubber when it comes to grip. Mixing in petroleum-based oils is usually done to compensate, but they can't be used in this case because they'll increase the proportion of petroleum material. That is when we arrived at orange oil. It also dovetailed with Yokohama Rubber's policy of "environmental soundness," based on the fact that it reuses orange skins that are mass-consumed and typically discarded in the process of making orange juice. Using a new material often results in a performance level that, initially, is inferior to that of existing products. This was true for the orange oil. Through daily trial and error-after trying various new materials, and adjusting their proportions-we finally managed to raise performance to a level that surpasses existing products. Whenever we find a seemingly usable material, I have a "Eureka!" moment.

## Product Design



Masahiro Ebiko, Desi

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## Keywords for Achieving "Eco" + User-Friendly"

Working behind the scenes of the BluEarth series "Eco + User-Friendly" concept are the technologies and materials born from long, steady research. Here we present related keywords, including technologies still at the research stage that are planned to be used in future products.

Orange oil (technology that is used in AE-01)

In the tire manufacturing process, oils are added to rubber to adjust hardness. By switching from conventionally used petroleum-based oils to naturally derived orange oil, we achieve greater environmental soundness. Even in terms of quality, orange oil works to achieve a proper balance between low rolling resistance and high grip performance. Right now, the manufacturing process of some tire types can use as many as a couple of hundred oranges per tire.

### Aerodynamics

Another force that affects a vehicle's fuel efficiency alongside tire rolling resistance is air resistance. Yokohama Rubber engages in the research and development of aerodynamic performance not only to reduce air resistance on the tires, but also to address the fundamental question, "How do we bring down air resistance on the vehicle as a whole?"

### The job of the product design people is to combine developed and proposed materials and technologies and shape them into a concrete product. Their task is figuring out how to achieve the objectives set at the planning stage.

I've been working on tire design ever since coming to work here at Yokohama Rubber. In recent years I've mostly been in charge of designing eco-tires. Our task is to figure out what theoretical and practical approaches we can take in order to achieve the objectives set by the planning people. Success requires that we repeat a cycle of brainstorming, prototyping, characteristic testing, and test runs, which can't be done without collaborating with other departments, such as planning, research, and production.

When creating numerous prototypes, it's often the case that one type of performance improves at the expense of another. It's difficult striking a balance between opposing performances and still creating added value. Our goal, of course, is to keep performance as high as possible across the board.

Before marketing and mass producing a product, we also have to clear cost and scalability hurdles in addition to those for performance. Being able to pass those hurdles and supply customers with a tire they are happy with gives me the greatest satisfaction. Ultimately, my dream is to design a tire that is globally unmatched in all performance categories.



# AIRTEX future technology (as of August 2010, used only in DNA dB super E-spec)

Yokohama Rubber's "AIRTEX" is a newly developed material that, when adhered to the inner surface of a tire, reduces air leaks and prevents the loss of air pressure and, subsequently, fuel efficiency. In the future, we hope to engineer materials that completely eliminate air leakage, and link such performance with a reduction in the time and energy used to adjust air pressure, hence greater "user-friendliness."

## Biological monitoring

Biological monitoring is the science of measuring biological systems Properly applied, electromyography (EMG) and other technologies can allow us to quantitatively understand differences in the feelings and stress tires bring to a ride, experiences that are difficult to assess objectively and that until now have been evaluated only subjectively.

In the future we will use the results from biological monitoring to push forward with the development of tires that realize an even greater level of enjoyment and comfort for drivers and passengers alike

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Production

How much can we cut back on energy use without losing production quality and efficiency? Work on the shop floor tackles this question

> I'm in charge of managing the boiler and cogeneration system and making our facilities more energy efficient. I feel a sense of accomplishment when I detect technical problems before they occur and can resolve them without stopping the machines, which is a vital part of manufacturing tires efficiently.

Conserving energy is important, but everyone has to be involved and that won't happen if someone doesn't speak and act boldly. I want to be that "someone" and get more and more people involved as I work. I also hope that someday we can achieve tire production with zero net energy use. (Kuroshima)

My job is to conduct maintenance checks to reduce wasteful consumption of electricity. We set goals, create an implementation plan, and follow specific measures, such as making sure lights are turned off when they are not being used, and adjusting the motor rpm of various machinery. Increasing energy efficiency without sacrificing productivity is a challenge, and sometimes my efforts have unexpected results, but it's very important that I stick to it. Sometimes I get ideas from energy efficiency engineers at other plants or from operators on the floor. In the future, I want to work on increasing our relative inputs from solar and other renewable energies. (Koseki)

# **Distribution**

### After passing through the hands of various people, tires reach their completion. Our job at the distribution division is to deliver those tires to customers via our tire distributors nationwide.



Yokohama Rubber's greatest strengths are that we create better products than other companies, and our sales representatives have a firm understanding of what makes our products special. The tires that line a store front are the product of the passion and unceasing effort of countless people in and outside the company. That's the real reason why our products are so amazing. Our job as the distribution division is to convey that "passion" to our customers. I make it a point to visit stores to collect feedback from end users and relay that information back to other relevant people at Yokohama Rubber. I have many opportunities to hear critical reviews of our products compared with competing companies, but I know the advice I receive comes from Yokohama fans-it's a great stimulus. We also hold "Safety Education Campaign" events to teach customers about the proper way to manage air pressure in their tires. A surprising number of customers say to me, "I never knew the correct pressure." I think we need to put more energy into educating our customers through these events if we are going to make environmentally friendly products that are also used for a long time.

# Recycling

contribution to our environment.



# Keywords for Achieving "Eco + User-Friendly"

Here we present important keywords for achieving the concept of "Eco + User-Friendly" that are related to manufacturing plants and tires for trucks and buses.

## Cogeneration system

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A cogeneration system is a system that captures the waste heat that is created from fuel-generated electricity and uses it in plant steam systems, air conditioning, and water heating. Cogeneration is attracting attention because it improves energy usage efficiency. Yokohama Rubber's Hiratsuka Factory, Mishima Plant, Mie Plant, and Shinshiro Plant are all fitted with cogeneration systems. Yokohama Bubber has been awarded the "Japan Cogeneration Center\* President's Award" two years in a row since 2008.



## Retread tires

Retread tires are tires that are manufactured by reusing worn, used tires. Retread tires consume up to 68% less petroleum resources than new tires and produce approximately 60% less CO2 emissions during manufacturing and disposal.\* Right now, all truck and bus tires produced by Yokohama Rubber are designed to meet retreading requirements. \* Based on the Japan Rubber Manufacturers Association Tire Inventory Analysis." Total CO2 emissions are estimated using 11R22.514P tires.

(Source: Retre



Comparison of petroleum resources needed

## A "retread tire" is a recycled product manufactured from used tires. Popularizing retread tires is yet another important act of making a positive

Retread tires are used tires that have been put through a retreading process so that customers can use them again. In Japan we have four retreading plants delivering rapid service to customers throughout the country. In the system we recommend, we take our customer's used tires, retread them at one of our affiliate plants, and then give them back. From the perspective of net sales in our entire business, the retread tires business can be seen in a negative light because it subtracts from the number of new tires sold. Nevertheless, we live in an age when reducing environmental impact by actively using retread tires benefits both our customers and society as a whole. Rather than pursuing short-term sales and profits, I believe we have to put ourselves in the shoes of our customers and think about how we can give them value in the long run.

It made me happy when a customer once told me, "I feel safe using Yokohama's retread tires." Retread tires help conserve the environment and save people money. I want to continue providing such safe and high-quality retread tires, as well as get more people to use them.





to manufacture tires for trucks and buses

# HITES Tire Air Pressure Monitoring System

The HiTES tire air pressure monitoring system allows you to check in real time the pressure and temperature of the air in every tire all while sitting in the vehicle. Following the tire air pressure monitoring system's launch in 2003, an improved version was launched in 2009. When the system detects a drop in air pressure it immediately notifies the driver via sound and display. The system not only helps to prevent declines in fuel efficiency caused by greater rolling resistance, it can also lead to accident prevention by enabling drivers to promptly detect punctures and overheating in the tires. At the 6th Eco-Products Awards of Japan, HiTES was awarded the Eco-Products Awards Steering Committee Chairperson's Award in the Eco-Products category



HiTES display monitor

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### Developers in action

# How Did the High-Pressure Hydrogen Hose Come to Completion?

Yokohama Rubber provides society with a wide range of environmentally sound products. At the source of those products lies the work of developers tackling the challenges of research from day to day. Here we retrace the steps that led to the development of the high-pressure hydrogen hose, winner of the Environmentally Sound Products Award in FY2009.

Since 2006, Yokohama Rubber has implemented an internal environmental award program, the Environmentally Sound Products Award, to raise employee awareness of environmental protection and encourage excellence in eco-friendly activities. The product to receive the award in FY2009 was the high-pressure hydrogen gas hose "ibar HG70." The hose was developed for use in fuel cell vehicles, which are increasingly expected to reach commercial scale as global warming and resource issues become more serious.

Fuel cell vehicles run on electricity

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generated by the chemical reaction between hydrogen in the vehicle's tank with oxygen in the air. They have garnered attention in recent years because they are the "ultimate eco cars"-they emit no exhaust gases and are very energy efficient. Hydrogen stations are already operating in some locations, refilling cars with hydrogen gas for demonstration tests in the rampup to commercialization. A major hurdle in the move toward commercialization is the short distance fuel cell vehicles can travel on a single tank of hydrogen compared to their gasoline counterparts. Improving travel

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Iwatani

distance will require raising the pressure during fueling, thereby increasing the amount of hydrogen that can be stored in the same tank size. And in order to do that, a dispenser hose that can withstand high pressures is needed. Starting in 2003, Yokohama Rubber worked alongside Iwatani Industrial Gases Corp. under commission from the New Energy and Industrial Technology Development Agency (NEDO) to develop a high-pressure hose for hydrogen gas. The ibar HG70 hose was the creative outcome of this project.

The highest fueling pressure at most hydrogen stations is currently 35MPa. The aim of this project was to develop a hose that could withstand double this pressure, namely 70MPa. "From a pressure resistance standpoint, there were existing products from other companies, but those hoses all used steel wire and had trouble with hydrogen embrittlement, a problem in which hydrogen diffuses into and



weakens the steel. They also didn't meet the requirements of a hydrogen dispenser hose in terms of being lightweight for ease of operation and being flexible enough to handle repeated coupling and decoupling. To begin with, the very need for a highpressure hydrogen hose didn't even exist before the refueling of fuel cell vehicles with high-pressure hydrogen was imagined," says Mie Ookura, one of the principal people involved in the research and development of ibar HG70.

Yokohama Rubber did not undertake this project because it already had the knowhow needed for high-pressure hydrogen hoses. However, it did have experience with fuel cells, from a previous in-house project. Thus, participation in the project was decided based on the rationale that Yokohama Rubber could leverage previously developed technologies while also using this opportunity to achieve further

technological innovation. The endeavor started with the assembly of a roughly 10-person team, with Ms. Ookura at the helm and incorporating staff from materials development, testing, and other areas. How can a hose be created with adequate pressure resistance but without sacrificing flexibility and lightness? The team created a number of prototypes, modifying materials and construction in a continuous process of trial and error. Every day consisted of submitting the prototype to performance testing, and coming up with new ideas as new challenges were revealed. "Of course there were times when we reached a deadend. Still, I never thought to throw in the towel, because I had a strong awareness of the expectations of everyone around me, namely people in the companies and organization that were involved in the project," Ms. Ookura reflects. Ultimately, the key that led to successful completion was the adoption of a special synthetic fiber in the reinforcement layer where steel wire is conventionally used. This material allowed for unprecedented flexibility and lightness at the same time that it precluded hydrogen embrittlement. Ms. Ookura recalls, "When we completed the project, I was more relieved than happy."

A vital part of the process leading to the success of the project was partnering with Iwatani Industrial Gases. Capabilities that Yokohama Rubber lacks, such as high pressure gas handling, were undertaken by Iwatani Industrial Gases, which tested the hose's performance using actual hydrogen gas. Over and over, specialists at both companies held group meetings to figure out what testing methods would achieve the most accurate evaluation of





Mie Ookura Hoses and Couplings Technical Dept., Development Group

I've been developing hoses ever since I started working for Yokohama Rubber, but this was my first time participating in the development of a hose with an entirely different use. The advice I received from my teammates is what pulled me through this new challenge. I want to continue placing an emphasis on craftsmanship that will get customers to say, "What a great product!"

performance.

"This project was an extremely positive experience for us as well," says Koji Hasegawa of the Applied Technologies Section, Technology Dept., Iwatani Industrial Gases. "Iwatani Industrial Gases and Yokohama Rubber specialize in completely different fields. I hope we can take advantage of our respective strengths and collaborate in more projects to develop new businesses in the future too." Ms. Ookura, also speaking on the value of the partnership, comments: "Safety testing is an important part of development. We never would have developed this product successfully without Iwatani Industrial Gases' testing technologies.' The task that remains is to help in the commercialization and widespread adoption of fuel cell vehicles, first by scaling up production of the ibar HG70. "Sensitivity to the environment is one requirement that we have to consider in addition to safety. With that in mind, I want to continue to develop products that meet the needs of our various customers." says Ms. Ookura of her future ambitions.

Aiming to "assert world-class strengths in technologies for protecting the environment." The road that Yokohama Rubber travels to achieve its objectives is fueled by the passion and energy of individual developers like Ms. Ookura.