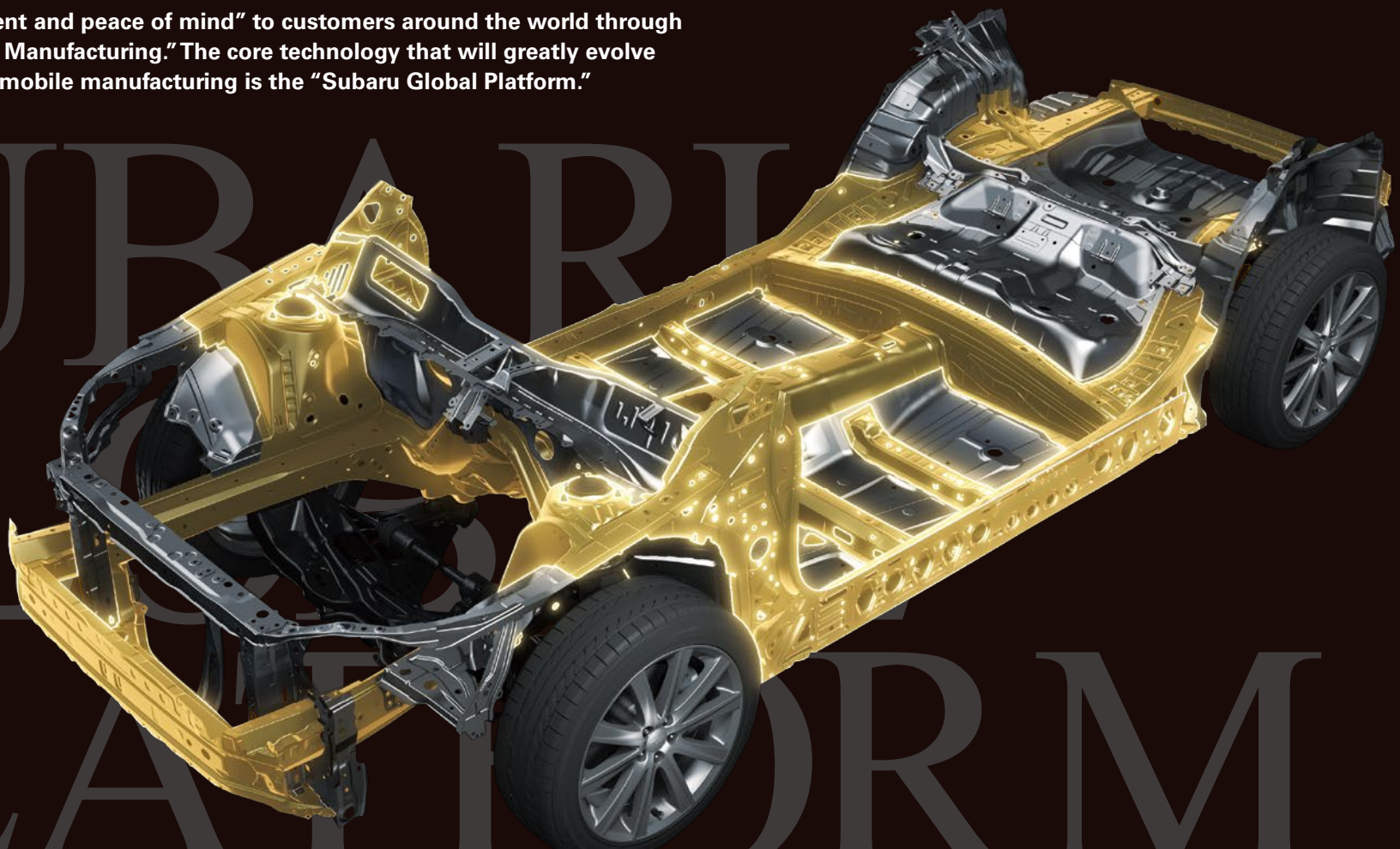
# Innovativeness of the Subaru Global Platform that will Serve as the Backbone of Next Generation Automobile Manufacturing

**Subaru has provided "enjoyment and peace of mind" to customers around the world through "Human Centered Automobile Manufacturing." The core technology that will greatly evolve Subaru's next generation automobile manufacturing is the "Subaru Global Platform."**

SUBARU GLOBAL PLATFORM

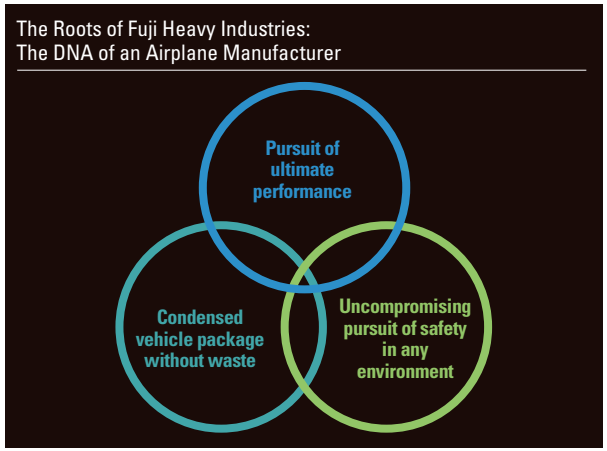


# The DNA of Subaru that Underlies the Subaru Global Platform Facilitates "Enjoyment and Peace of Mind"

Naoto Muto
Director of the Board
Corporate Executive Vice President

The roots of Fuji Heavy Industries lie in the Nakajima Aircraft Company as an aircraft manufacturer. Founded in 1917 makes next year our 100th year anniversary. A great number of airplanes were developed and produced in the days of the Nakajima Aircraft Company. The uncompromising pursuit of safety performance and rational design that had developed because of the fact that we were an airplane manufacturer has been passed down over generations as the car making DNA of Subaru.

The "Subaru 360" is a mini vehicle that was released in 1958 but, regardless of being a mini vehicle, it was the first time anyone had adopted a monocoque body in Japan to realize a revolutionary package that fit four adult passengers comfortably while keeping the vehicle compact and lightweight. The "Subaru 1000," that was released in 1966, adopted an all-aluminum horizontally-opposed four-cylinder engine and a front-engine front-wheel-drive system, putting it at the forefront of a global trend to switch to front-wheel-drive on compact vehicles.



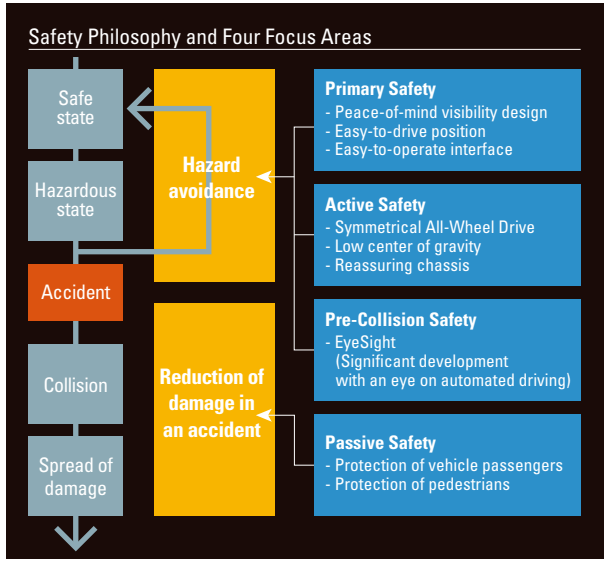

In Japan, frontal crash safety standards started to be applied in April, 1994 but if we take a look back 29 years prior to this, Subaru had already been working on frontal crash safety testing voluntarily on the "Subaru 360" since 1965. Following this, based on a safety concept to protect not only the driver but also the passengers as well as pedestrians, crash safety data in various forms such as rollovers and rear end collisions has been accumulated as we have continued with development of unique safety technologies to where we stand now.

In this way, here at Subaru, where we have worked on safety for over half a century, we currently view safety for car making from four angles: "Primary Safety," "Active Safety," "Pre-Collision Safety," and "Passive Safety." "Primary Safety," "Active Safety," and "Pre-Collision Safety" are technologies that have the purpose of avoiding an accident before it happens and "Passive Safety" is technologies that have the purpose of minimizing damage in the event of an accident.

In "Primary Safety," we develop vehicles with evaluation criteria in designing such as excellent visibility, driving positions that make driving easy, intuitive interfaces, etc. so that driver fatigue is reduced, allowing the driver to concentrate on driving with peace of mind.

"Active Safety" features the low center of gravity design of the body that takes advantage of the horizontally-opposed engine and symmetrical AWD that makes sure-footed driving possible in a wide variety of road surface conditions. Having a low center of gravity makes it easy for anyone to drive straight with peace of mind and corner smoothly.

In terms of "Pre-Collision Safety," the core technology is




"EyeSight." It is a system that recognizes what is in front of the vehicle with two cameras that function similarly to human eyes to provide safe protection with the car in front, pedestrians, and bicycles. Last year, actual market results were released showing a 61% reduction in accidents resulting in human injury or death for vehicles equipped with EyeSight. Subaru will continue to evolve "EyeSight" greatly going forward and focus our efforts on protecting the lives of Subaru customers around the world.

In terms of "Passive Safety," even if a crash was to take place, with the key concept of protecting the integrity of the cabin by smoothly crushing the front zone of the vehicle in an extremely short amount of time in mind, we develop a collision system that can adeptly cope with the actual market. Subaru has continued to research crash safety performance independently since the days of the "Subaru 360" and has garnered the highest level of rating in all safety performance tests performed by third parties in countries around the world.

Synchronized with the making of cars built with a safety concept as reliable technologies as the fundamentals of the vehicle, we follow the "Human Centered Automobile Manufacturing" concept so that the customers that use our vehicles feel the enjoyment, we have placed importance on the "feelings" of customers in the developments. We have improved "enhanced dynamic feel" of the vehicle so the enjoyment and how great it feels to drive straight and take turns intuitively could be felt with the senses.

To have the user feel a sense of security the moment he/she steps into the vehicle, sits downs, and closes the door. To have the user feel a solid rumble when turning the engine on and feel that smoothness as he/she steps on the accelerator pedal and starts to pull away from a stop. The vehicle runs so straight that the customer forgets about the existence of the steering wheel and when cornering, the vehicle turns exactly in line with the image that the customer has in mind when a turning maneuver is made on the steering wheel. To have the car move linearly interlocked to what the customer has in mind. This kind of relationship with the vehicle is what we have prepared in our vehicles so that the enjoyment can be truly felt.

Moreover, to expand extend the enjoyment of customers further from the perspective of making "living life" for our customers richer, we eliminate or avoid unnecessary packaging, pursue and utility, and have developed a vehicle that will be able to work in various situations with customers.

In addition to the development of new small displacement turbo engines that realizes significant fuel economy efficiency and hybrids (HV) that many of our current customers still use, we are also developing Plug-In Hybrid Electric Vehicles (PHEV) that can also be charged at home that is now under development for the US market and Electric Vehicles (EV) that aiming for a market launch in 2021.

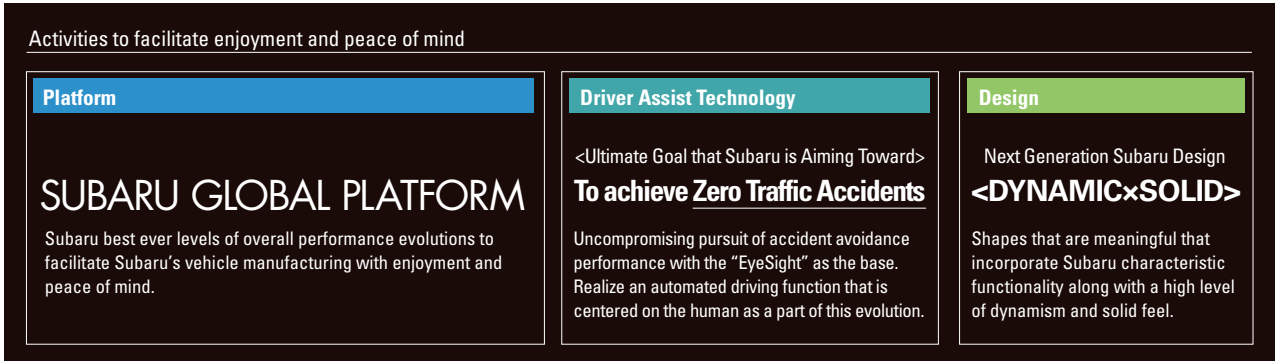
The EyeSight that has been well received by customers for safety will also continue to improve safety levels going forward. The EyeSight will also react to and stop for bicycles that are encountered in intersections, and provide automated driving that can also cover lane changes on expressways on a mass production vehicle. Of course, automated driving for Subaru does not mean unmanned driving; it is automated driving that is centered on the customer. It will also be fun and safe automated driving.

All of the functions described above have been incorporated on vehicles with the Subaru Global Platform.

It is a platform that polishes up on the world's highest level of safety performance, realizes safety performance that anticipates 2025 that not only will have high performance but have a performance feel of movement that fits the human senses that can be understood by users the moment they step into the vehicle and that point in time that the car takes off. This platform will also be able to accommodate electrification as well as electric vehicles that will be key for future environment requirement compliance and furthermore will also be incorporated into automated driving.

The Subaru Global Platform will be equipped on the next generation Impreza that will be released for sale this fall, then it will be adopted on all independently developed vehicles by Subaru.

Designs of cars that express these functionalities are designs that exude the "enjoyment and peace of mind" of Subaru. Integrated under a concept called DYNAMIC×SOLID that comes with a lively and solid feel that has the Subaru touch, all Subaru vehicles will have the unified design to be brought to our customers everywhere.




# A New Platform that Anticipates the Year 2025 that will Realize Subaru's Best Ever Overall Performance Evolutions

Tetsuo Onuki
Corporate Senior Vice President
Chief General Manager of Subaru Engineering Division 1

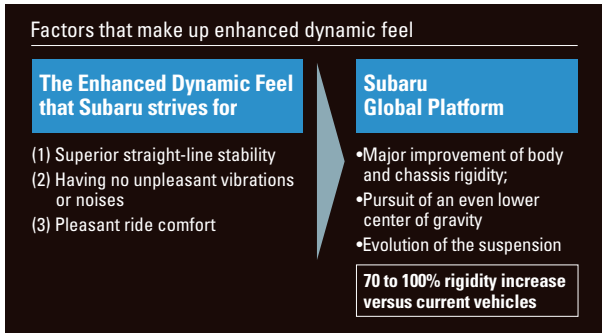
## Do not stop with just raising performance and specs and pursue "enhanced dynamic feel" that resonates with human senses.

The "Subaru Global Platform," that was developed as a far-sighted technology in the year 2025, is a new platform that will be adopted on all forthcoming Subaru vehicles that we independently developed starting off with the next generation Impreza. A major aim of introducing the Subaru Global Platform is to realize significant evolutions in overall performance, that would have been difficult as just an extension of conventional technologies, by executing a complete overhaul of the platform, which is the basic structure of an automobile, and to facilitate "enjoyment and peace of mind" which is the greatest appeal of Subaru vehicles. To accomplish this, the element that the development team poured all of their efforts into was simply the pursuit of "enhanced dynamic feel" that resonates with human senses beyond high performance and "safety performance" at the highest levels in the world.

So what is "enhanced dynamic feel?" It is the performance feel that a person driving or riding a car feels, such as operation feel and drive feel while driving, as well as ride comfort. At Subaru, this "enhanced dynamic feel" is captured as a combination of three factors [1] performance feel that is felt when operating the steering wheel and pedals, [2] performance feel that is felt audibly, [3] performance feel that is felt from the movement of the vehicle and as has been done in the past we have pursued a high level of quality that delves into the realm of human sensations such as "smoothness" or "how great it feels." Furthermore, in the development of the Subaru Global Platform we have attempted to visualize "enhanced dynamic feel" that had been difficult to capture as physical values till now.

For example, when a driver is driving a vehicle, following the operation of the steering wheel, the forces trying to turn the vehicle is transmitted from the front wheels to the body and there is normally about a one tenth of a second delay that occurs until the vehicle actually starts to change its orientation. Reducing this slight delay is what leads to smooth and stable vehicle behavior and improvements in steering feel. Here at Subaru, we have developed our own original sensors, measured suspension inputs in 1/1000 second unit intervals and measured strain in 200 locations on the vehicle body to quantify the movements of each part of the vehicle. Furthermore, bench testing equipment that reproduces the movement of the suspension on actual roads was developed and development of vehicle elements has also progressed.

Taking this kind of fundamental research and elemental developments into consideration, Subaru has established three factors to pursue "enhanced dynamic feel" which are (1) being able to drive straight (straight line stability), (2) having no unpleasant vibration or noise, and (3) pleasant ride comfort. In order to realize these factors in the Subaru Global Platform development, the work



was focused on "significant increases of body and chassis rigidity," "pursuit of an even lower center of gravity," and "evolution of the suspension system."

For example, comparing the Subaru Global Platform to current vehicles, improvements have been made to the front body lateral rigidity, body torsional rigidity, front suspension rigidity, and rear sub-frame rigidity, by 90%, 70%, 70%, and 100%, respectively. Moreover, Subaru cars have traditionally had the characteristic "low center of gravity design" but on the Subaru Global Platform, an even lower center of gravity was achieved that is 5mm lower than current vehicles. The suspension has also advanced significantly by revising the suspension geometry and improving the rigidity of mounting points.

As a result of all of these advances, next generation vehicles that adopted the Subaru Global Platform have realized astounding straight line stability as if gliding solidly anchored to rails. As the steering responsive is extremely high, this astounding straight line stability was made possible by the driver being able to rectify turbulence of the trajectory path due to factors such as slight bumpiness to the road surface, side winds, etc.

At the same time in terms of countermeasures for noise and vibration, conventionally there were certain areas of the body and suspension that resonated to amplify vibrations but on the "Subaru Global Platform", the natural frequency of the body is raised by improving body rigidity, preventing resonance with the suspension. In addition, as concentration of localized strain was averted on the subframe mounting points, known to be the portion that is the weak point for stiffness, and the body's overall torsional characteristics were evened out for uniformity, then by optimizing the body frame structure and utilizing structural adhesive, we have rationally improved the body rigidity without adding weight. Furthermore, the amount of mass offset on the strut suspension, which is a source of vibration input, was also reduced 15% versus conventional levels which also contributed to reduction in noise and vibration.

In terms of providing a smooth and comfortable drive, increasing the rigidity of the body frame brought out the intrinsic shock damping performance capabilities of the suspension that enabled quick convergence of vibrations generated by factors such as bumps in the road, etc. By mounting the rear stabilizer directly onto the body, the new platform reduces the body roll of the vehicle by 50% compared to present models.

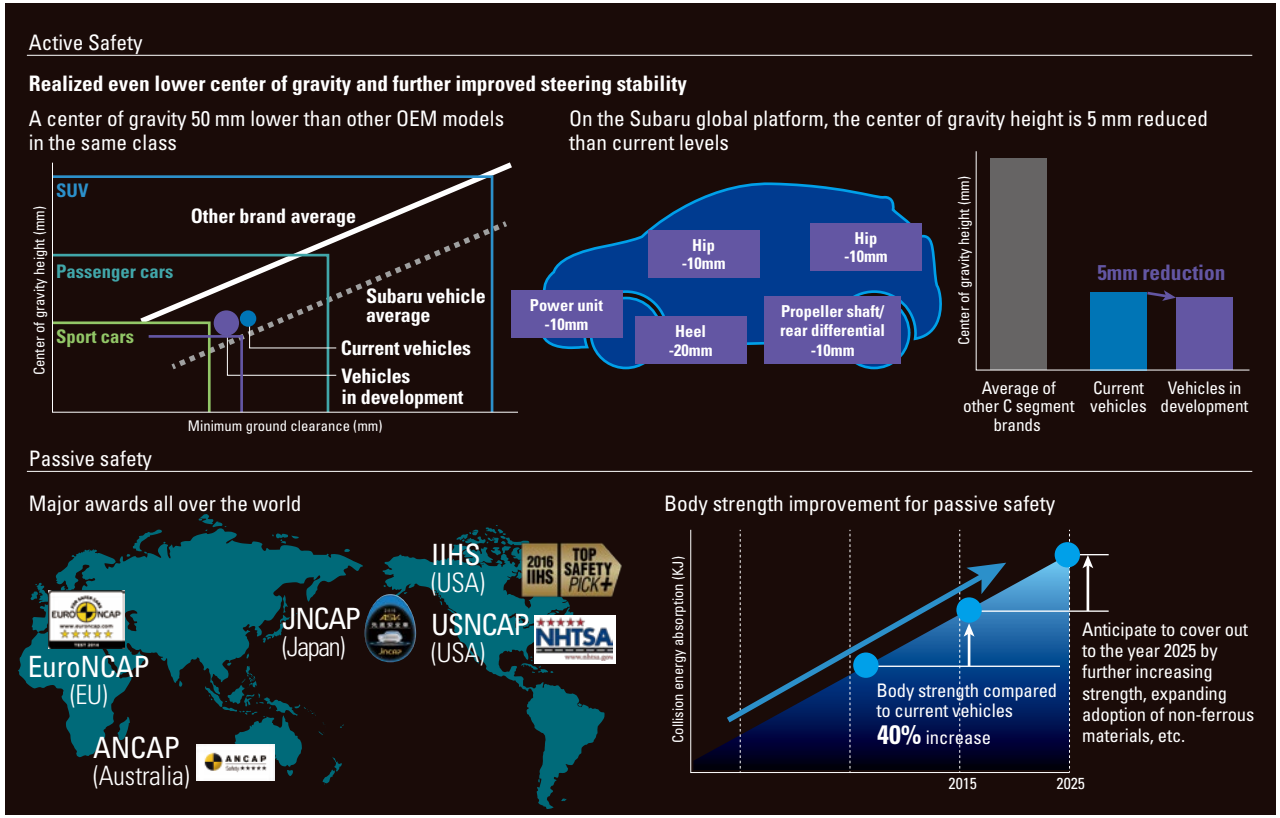
Through these activities, next generation Subaru vehicles equipped with the Subaru Global Platform will provide enhanced dynamic feel that will surely dominate not only Japanese vehicles but also top grade European vehicles as well.

## Pursuing Far-sighted Safety Technology that Anticipates Ten Years in the Future Based On Subaru's Unique Safety Concept.

Another major objective of introducing the Subaru Global Platform is the further evolution and enhancement of the world's highest level of safety performance. Among the four focus areas based on the Subaru safety concept, the new platform brings major benefits especially in "Active Safety" and "Passive Safety."

In terms of "Active Safety," significant improvements to body and chassis rigidity and even lower center of gravity has improved steering stability on Subaru cars that had already been rated highly and had taken it up to the next level. In internal tests, the next generation Impreza danger avoidance speed has exceeded the 84.5 km/h on the existing vehicle considerably at 92.5 km/h which achieves levels comparable to European sports cars.

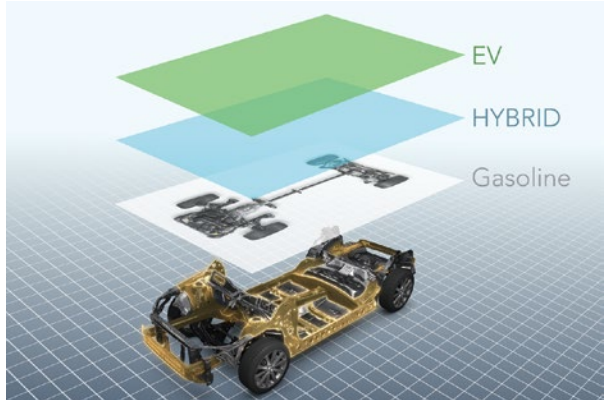
At the same time, in terms of "Passive Safety," body strength was raised by optimization of the frame structure, multiplexing of



the load transmission paths, adoption of high strength material, as well as improving collision energy absorption by 40% versus existing vehicles. These improvements further evolved crash safety performance that had already achieved the highest level of ratings in the world. In the future, compliance to various and diverse forms of crashes will be required, and we believe that collision energy absorption will have to be improved further by more than 30% at around 2025. The Subaru Global Platform is designed to have the potential to be able to comply with these improvements by further increasing strength to higher levels, expanding adoption of non-ferrous materials, etc.

If the rigidity and strength of the vehicle is improved significantly in this way, it would normally increase weight but the Subaru Global Platform effectively utilizes the amount of weight saved due to the rational design, on performance improvements and safety improvements, as a lightweight body that is on par with conventional Subaru vehicles has been made a reality. Moreover, in anticipation of the evolution of vehicles up till 2025, starting with gasoline engine vehicles, hybrid vehicles (HEV/PHEV) to electric vehicles (EV), it is designed as a platform that can accommodate various types of power units. The Subaru Global Platform that makes overall vehicle performance evolution possible such as outstanding straight line stability, high level danger avoidance performance, and the world's highest level of crash safety performance, will be an important core technology even in terms of realizing automated driving in the future.

**Platform that anticipates out to 2025**




## Pursuing Human Centered Automated Driving Functions Toward Making "Zero Traffic Accidents" a Reality.

For Subaru that has "Human Centered Automobile Manufacturing" at its essence, the ultimate goal for automated driving is not "to have the car drive itself in place of the human" but it is "to aim for zero traffic accidents" that threaten human life and assets. Based on technical concepts such as these, Subaru will evolve driver assist and automated driving toward the realization of "Zero Traffic Accidents" by the introduction of the Subaru Global Platform and further advances to high performance and high functionality for the driver assist system "EyeSight."

Surveys in Japan have revealed a 61% fewer accidents resulting in injury or death for vehicles equipped with the "EyeSight Ver. 2" compared to those without it. If the conditions of the accidents are broken down further, car-to-car accidents dropped 80%, broadside collisions dropped 50% to demonstrate the benefits the system provides. The latest "EyeSight Ver. 3" that is currently launched in the market has improved performance in areas such as capabilities to detect obstacles, speed range that the brakes actuate, etc. thus we should be able to expect even further reductions in accident occurrences.

In terms of activities toward driver assist and automated driving, automated follow-up system in congested express ways will be added in 2017. This is a function that drives the car at 0 km/h to 65 km/h on the same lane while recognizing the movements of the vehicle driving ahead and the conditions of curves in the roadway with the "EyeSight" in traffic jam on expressways. Furthermore, in 2020, we plan to add a radar and digital map to the "EyeSight" that uses only stereo camera technology to realize automated driving on expressway roads including lane changes.

In this way, by practical implementation placing a priority on driver assist functions targeting situations with a high risk of becoming an accident, such as during heavy traffic when drivers are susceptible to losing their concentration, lane changes that demand careful checks in the rearward direction, etc. through this the capability of Subaru vehicles to avoid accidents will be improved exponentially. As a result of this pursuit of safety performance, we hope to make automated driving with distinctive Subaru value and provide "enjoyment and peace of mind" that is one step above to users.

Evolution of the EyeSight

**2017**
Automated follow-up on congested expressways

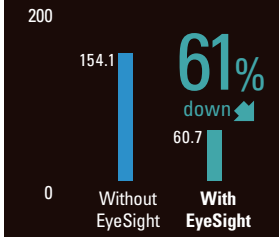
**2020**
Automated driving including lane changes on expressways

EyeSight Accident Reduction Data*1

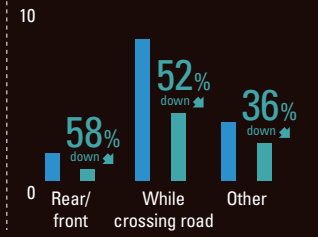
61% reduction in accident rate

Comparison of rate of accidents resulting in injury or death with and without EyeSight (Ver.2)

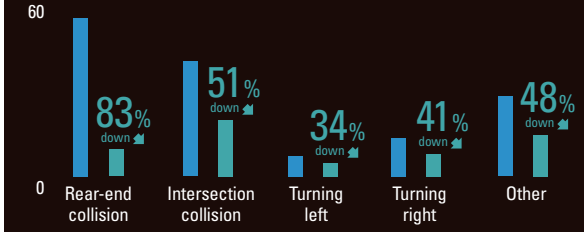
No. per 10,000 vehicles (over 4 years)




Between people and vehicles




Between vehicles*2




*1 Independent calculations from data on accidents that took place over the four years from 2011 – 2014 among vehicles sold between 2010 and 2013 in which installation of EyeSight (Ver. 2) is possible based on Institute for Traffic Accident Research and Data Analysis (ITARDA) data. There were 2,234 accidents.
Calculates the number of accidents resulting in injury or death per 10,000 vehicles with and without EyeSight (over four years). Of the target vehicles, there were 246,139 with EyeSight (Ver. 2) and 48,085 without it.

*2 Placed top in frequency

# New Subaru Design that Puts "Enjoyment and Peace of Mind" Into the Physical Form of a Vehicle

Mamoru Ishii
General Manager, Subaru Design Department

## Pursuing "Lifestyle Design" to make life richer, and "Long Life Design" that people will want to use for a long time.

At Subaru, for the mid-term management vision "Prominence 2020," six activities have been established to polish up the brand. One of the major items of these activities is positioned in the realm of design. In order for Subaru to be a prominent presence for customers, we have reconfirmed goals that design should be aiming for and developed a renewed Subaru design strategy. The new Subaru design will aim for "lifestyle design" to make the lives of customers richer and "long life design" that customers will want to use for a long time.

At Subaru, cars will obviously be designed to comfortably fit the customer's lifestyle but on top of that, to take that next step, and actively promote the design a new lifestyle that will make the life of customers richer. This is "Lifestyle design."

Of course, the car will become a partner in the rich life of the customer, thus it must be equipped with functional performance that can be used daily without stress but at the same time be designed in a way that customers will feel an affinity to want to use the car for a long time. For example, at Subaru, in order to achieve superior visibility performance, sure, effective field of view angle was secured but an interior design was executed that went as far as taking into account controlling light glare and reflections in the glass. On top of this, instead of following the latest trends haphazardly, the priority was placed on design that pursued genuine beauty of the vehicle that came about naturally. Reflecting the mentality of this kind of Subaru car making is what we believe will lead to "Long life design."

## Design Philosophy of DYNAMIC×SOLID that Expresses "Enjoyment and Peace of Mind" from the Perspective of Design.

In pursuing our new design direction, we have also worked to interpret from a design perspective the value of "Enjoyment and Peace of Mind" that Subaru offers to customers and put it into the form of vehicles. As a result of analyzing "Enjoyment and Peace of Mind" based on this concept, we reacknowledged three meanings that should be expressed as a common theme throughout the new Subaru design and decided to evolve each area accordingly.

The first meaning is "functional value" in terms of "fine visibility," "comfortable interior space," "load capacity" and "run through capability," that had been a priority since the founding of Subaru. In addition to these factors, in recent years "Aerodynamic performance," have also become important factors. The second meaning is "manufacturing spirit" in terms of "rational design concepts" and a "Challenging spirit" that have been passed down over generations since the founding of Subaru as our DNA to want to create new value. Then the third meaning is "emotional value" in terms of communicating the sophisticated "shape" borne out of necessity represented by the distinct front face that is identified as

a Subaru car in a single glance.

The latest design philosophy that embodies this new Subaru design is DYNAMIC×SOLID. The "solidness full of sense of security" and "sturdiness to protect passengers," that had been carefully developed into designs conventionally by Subaru is expressed by SOLID and throbbing Dynamic for next generation and active lifestyle, etc. is expressed by the keyword DYNAMIC.

At Subaru, this design philosophy of DYNAMIC×SOLID is incorporated into specific three-dimensional forms from the following three factors. The first and most important is the "stance." This could also be called the proportions of the vehicle and is the structure of framework that determines the profile of the vehicle. The second factor is "solid mass." This could also be referred to as volume or volume feel, and develops the way the muscles are built to give an impression of trust and toughness that the vehicle possesses. The third factor is "surface structure." Starting with Subaru's unique hexagon grille through this three-dimensional expression, this is what gives the impression of car's individual facial expression and character.

The next generation Impreza will be the first mass production vehicle to fully adopt this DYNAMIC×SOLID design. Please look forward with high expectations for future Subaru designs.