

Development of 2005 Model Year US Odyssey Incorporating “King of Minivans” Concept

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ABSTRACT

The 2005 model year US Odyssey was developed as the “King of Minivans,” providing superior styling and excellent utility combined with drivability and quality that rival any luxury sedan. It is built on the foundation of Honda safety and environmental leadership, and will become the benchmark for the next generation of minivans.

The Odyssey powertrain employs North America’s first Variable Cylinder Management (VCM) engine, achieving best-in-class fuel economy. The chassis ensures a quiet cabin through a subframe supported with rubber mountings, and at the same time, achieves handling stability.

The interior incorporates many new ideas for the small item storage spaces required of a minivan, adopting features such as the world’s first rotary in-floor storage unit. The seats work to provide maximum utility, with the adoption of one-motion stowing for the 3rd row seats, and in the eight-passenger specification, a stowable 2nd Row PlusOne Seat that can be easily fitted in the center of the second row.

The vehicle structure is designed to perform well in frontal impacts, offset impacts, and car-to-car collisions with the adoption of Honda’s Advanced Compatibility Engineering Body structure. In addition, the Odyssey combines existing safety features with side curtain airbags and Vehicle Stability Assist (VSA) as standard for all grades. The Odyssey is a vehicle that demonstrates Honda’s commitment to “Safety for Everyone.”

1. Introduction

In 1994, Honda entered the US minivan market with the US Odyssey. Accompanying the full model change in 1998, the Odyssey became the true North American benchmark minivan, continuing to receive high praise through today.

Japanese manufacturers have actively entered the North American minivan market, facing the competition of minivans produced by US manufacturers. The market competition is now

getting more intense. In the development of this third generation Odyssey, Honda has carried out thorough market research and product comparisons with competitor vehicles, and restudied the features and uses required of a minivan to develop the new Odyssey with the aim of creating a next generation minivan that will set the benchmark.

At the development stage, never forgetting the essence of Honda, the new Odyssey was developed so that the customer is impressed with its appearance, with its drivability, and with its utility. To

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achieve this, technology was developed that actualizes the drivability expected of a Honda, and new features have been developed that incorporate new ideas in all aspects of the exterior and interior. As a result, this next generation minivan provides safety, drivability and a feeling of quality equal to that of a luxury sedan.

2. Concept and Development Goals

The concept of “King of Minivans” was selected for the 3rd generation Odyssey. To actualize this, the new Odyssey was developed as a fun and adventurous product for young families in their 30’s, the main users of minivans, as one target group. It also provides quality on a par with a luxury sedan, appealing to empty nesters as a second target group, based on the results of market research.

Development proceeded towards the following targets, in order to actualize the concept.

- (1) Safety and Environmental Performance
 - Development of best-in-class collision safety performance and safety features
 - Best-in-class fuel economy and emissions performance
- (2) Styling
 - An innovative luxury and high-quality feel that exceeds expectations of the minivan class
 - An exterior that feels powerful and solid
 - An interior that makes one think of high quality and makes a first class impression
- (3) Drive Performance and Handling Stability
 - Best-in-class engine power and drivability
 - Handling, ride comfort, and quietness performances on a par with European luxury sedans, breaking out of the minivan segment
- (4) Utility
 - A seat arrangement that can accommodate eight passengers, and that anyone can easily operate
 - Ensuring convenient, easy-to-use storage space, never before seen in a minivan
 - Creation of an environment that is comfortable for children and adults, with enhanced comfort features

3. Product Performance and Main Technologies

3.1. Design

3.1.1. Packaging

The goal of the package was to provide best-in-class practicality in the minivan category, by increasing interior space and improving the convenience of storage and seats.

While adding many new features such as a sunroof, curtain airbags, and a power tailgate, etc., the interior space was increased. Knee clearance in the 3rd row was increased over that of the previous model, by reducing front overhang by 50 mm, ensuring the largest 3rd row space in the class and achieving increased collision safety performance, so that even adults can easily sit in the 3rd row. This was accomplished without increasing total length. Moreover, the layout is such that the 3rd row seats can be stowed without removing their headrests. By moving the spare tire from under the floor to the side of the 3rd row seats, in-floor storage has been given a new design (Fig. 1).

3.1.2. Exterior design

While the exterior design maintains the minivan package, it has broken free of the strong, existing minivan image of the family, and moved towards the key words of “Powerful and Solid.” This expresses the character of emphatic and majestic solidity.

The styling is based on the watchword “Cyber Lion,” with a handsome sense of presence and strong legs.

In addition, plated mold, lights, and the grill, etc., have all been created using luxury sedan methods, exhibiting a premium feel that has not been seen in a minivan previously (Fig. 2).

3.1.3. Interior styling

The concept for the interior styling is “Premium Class Interior.” By combining a comfortable first class lounge space with an innovative cockpit, the functionality of a family car is emphasized, while the family image is wiped away. These contradictory elements are both achieved.

The instrument panel extends laterally, with the driver as the reference point making it driver-oriented. The lateral expansion is strengthened by gauges that are shaped as if they have wings extended. The styling is horizontal in tone, like that of a luxury sedan, and unlike the vertical orientation of other companies’ minivans (Fig. 3).

The gauges are large in diameter, making them easy to read, with a freshness added through the use of a light gradation that gives the image of a lunar eclipse. The shift knob is given an optimum location, optimum shape, and optimum operation feel vis-à-vis the driving position. At the same time, due consideration has been given to the shift knob as well as instrument panel for achieving easy walk-through, which is an essential part of a

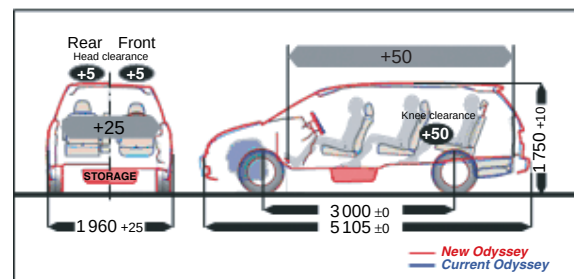


Fig. 1 Comparison of packaging design of new and previous models

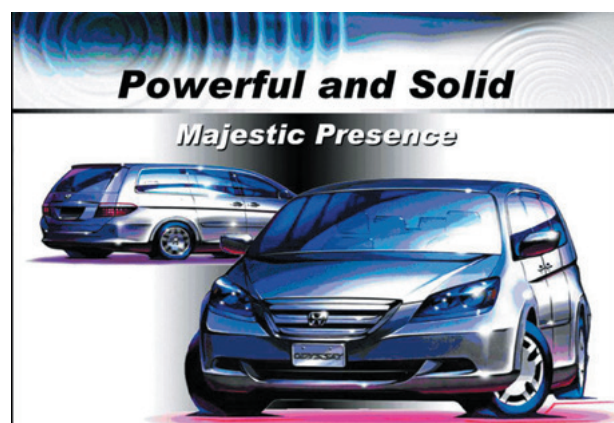


Fig. 2 Exterior design concept for new Odyssey

minivan. The linings such as on the sliding doors are of deeply sculpted shapes, with a finish like that of a luxury sedan. They increase the quality feel for the interior as a whole.

The luxury specification has a sporty, formal interior trim of black leather not available in minivans to date. In addition, the seats achieve both an excellent feeling of hold and a relaxed quality ride comfort. The fabric is modern with a quality taste.

Moreover, many clever utilities, seat arrangements, and features have been incorporated so that families can use it while having fun.

3.2. Interior

The interior, particularly in the front seats, was aimed to express a strong feeling of quality with metallic tone panels and illuminated gauges. At the same time, based on the results of many surveys of use by the targets users and thorough investigations and research, it was aimed to incorporate the convenience and practicality required of a minivan in the actual vehicle.

3.2.1. Seats

In terms of product appeal for a US minivan, the market requires not only a seat giving ride comfort but also the easy-to-use seat arrangement. Therefore, the goal was to satisfy both of these requirements.

The second row side seats are captain's chairs of a generous size. It is possible to accommodate eight passengers with the adoption of 2nd Row PlusOne Seat, which is a compact and lightweight seat in the center of the vehicle (Fig. 4). This PlusOne Seat can be used as a table if the cushion is removed and the seat back is folded down. It can be removed with a simple operation, creating a seven-passenger vehicle with a center walk-through. The use of high tensile steel reduces its weight, so it can easily be carried or moved. In addition, removing the Lazy Susan (described later), stowed under the floor in front of the 2nd row, creates a space where the PlusOne Seat can be stored, if its legs are folded in.



Fig. 3 Interior design concept for new Odyssey

The 3rd row seats have evolved beyond the old rotary stowing type. They have been given a 60/40 split, and are even easier to operate thanks to one motion stowing which makes it possible to stow them simply by folding the seat back over, once the lock has been released (Fig.5). When returning the seats to their upright position, the operation load is less than half of what it was, thanks to the use of a spring at the pivot points on each side. One person can carry out these operations.

3.2.2. Interior trim

Part of the interior concept is revolutionary storage. This focuses on in-floor storage, together with additional trays and large pockets creating advanced storage capabilities. In-floor storage, in particular, has been enhanced with a new rotary stowing box (Lazy Susan) in the floor at the foot of the 2nd row. This contributes to greater product appeal, with its convenience and new design (Fig. 6). The structure of the storage box is such that the lock mechanism releases when the lid is opened, and it can easily be rotated manually. There is a small window in the lid, meaning it can also be reached from the front seats.

The sliding doors have integrated sunshades, increasing the functionality of the vehicle as a minivan, in which children often ride in the 2nd row.



Fig. 4 Second row seats arrangement (2nd row +1 seat)



Fig. 5 Third row seats (6:4 split)

A curved mirror has been added to the roof console. Use of the back of the sunglasses holder as a conversation mirror makes it possible for a driver to glance at the faces of the children in the back seat. This plays an important role in improving communication within the cabin (Fig. 7).

3.2.3. Air-conditioning

Adoption of Tri-Zone Automatic Climate Control system that includes dual zone automatic climate control for the front and a separate control for the 2nd row and rearward enables the product appeal for all seats to be increased. In addition, with the adoption of floor ducts and outlets, 2nd row and 3rd row heater performance is improved.

In the heater control panel, locations of the switches and function displays were designed based on the feedback and requests of actual customers and local staff in the US, improving ease of use (Fig. 8).

3.3. Electrical Equipment

The electrical features have been enhanced with the aims of improving the convenience of a minivan for the family, and the Touring grade is provided with features similar to those of a luxury sedan.

3.3.1. Rear Entertainment System (RES)

The RES is made up of a display screen for the rear seats that is mounted in the ceiling and a DVD player, and functions to prevent boredom for the passengers in the 2nd and 3rd rows even on long drives. The visual image is even better than before, with North

America's first 9-inch wide display. Moreover, the system has been made thinner by having the tall parts inside the display offset from the screen itself, and when the display is stowed, there is minimal protrusion from the ceiling. While it is a large screen, the walk-through performance maintained by open space is beyond comparison with other vehicles. An infrared wireless remote control that can be stored on the ceiling is used for operation for the first time in RES, reducing the possibility of forgetting where the remote control is. Consideration has been given to improving operation at night, and illumination has been added to the operation buttons. In addition, there are fewer buttons, making it easier for children to operate (Fig.9). The remote control for the RES is a two-handed type familiar to children through video and computer games. The special headphones have an ASIMO motif, creating friendliness.

Personal surround technology has been developed that provides sensation of a 5.1 channel surround audio output through the headphones. With conventional headphones, the stereo image is in the middle of the person's head, creating a feeling of pressure. In comparison, with this personal surround system, transmission within the cabin, characteristics of sound dispersion into the external ear canal, and characteristics of head-related transmission are corrected by a special IC before sound is output to the headphone. This means that the stereo image moves outside the head, and sound with releasing and surrounding feelings is given as if listening to a 5.1 channel speaker. This contributes to a reduction in fatigue, when listening to the headphones for a long period.

3.3.2. Audio, NAVI

The Touring model provides the high quality, high power sound appropriate for a luxury minivan with its premium audio system having a 360-watt amplifier as standard equipment. For superb sound quality, the system has 17 cm aramid reinforced polypropylene cone speakers, aluminum dome tweeters, and a specially designed subwoofer box. The subwoofer box is positioned under the front passenger seat. The shape of the box utilizes resonance, and low sounds with punch are actualized in compact and lightweight speakers.

The NAVI (navigation system) features an 8-inch display for better visibility, which opens and closes electronically. It holds a 6-disc CD changer, and achieves a compact instrument panel layout. Operating switches on the steering wheel makes it possible to search



Fig. 6 Lazy Susan



Fig. 7 Conversation mirror



Fig. 8 Heating control switches



Fig. 9 Rear entertainment system display

for street names and location names through voice recognition. To give one example of enhanced content, it includes data from the 2004 Zagat restaurant guide data, the highest volume restaurant guide in the USA. Provision of information to the customers is better than ever (Fig. 10).

Furthermore, the NAVI specification includes an XM radio, with more than 100 channels of programming provided by satellite, so that it is not necessary to change stations even when traveling across the entire continent. The liquid crystal display, which can display up to 16 characters of written information, is placed within the head unit.

3.3.3. Gauges

The gauges of the Odyssey Touring model employ a multi-information display that can display tire pressure (using TPMS), a compass (8 directions), trip functions (immediate and average fuel economy, distance traveled, driving period, average speed), a welcome display, external temperature, oil deterioration index, corner sensor nearing indication, and various warnings (Fig. 11).

Using this display, it is also possible to create a customized menu that matches customer preferences, such as door lock settings, lighting, etc. These customized items can be activated on either of the two key fobs, and the memory seat operation can be carried out. In addition, the adoption of steering switches makes operation easier.



Fig. 10 Navigation system display



Fig. 11 Multi-information meter display

3.4. Engine Performance

In order to realize the new Odyssey's power plant concept of "Best Minivan Drivability and Fuel Economy," the power plant employs a V6 i-VTEC VCM engine, based on the North American MDX V6 SOHC-VTEC engine fitted with a Variable Cylinder Management (VCM) system that was installed in the Japanese INSPIRE⁽¹⁾. The following fundamental targets were set to make this minivan the best in class.

- (1) Best-in-class acceleration performance
- (2) Best-in-class fuel economy
- (3) Low emissions performance

3.4.1. Engine overview and main specifications

Figure 12 shows the external appearance of an engine for the new Odyssey, output characteristics are given in Fig. 13, and Table 1 gives the main specifications.

3.4.2. Drivability and fuel economy

In order to achieve both drivability and fuel economy, VCM technology was added to the 3.5L V6 engine, achieving acceleration performance and reduced fuel consumption as shown in Fig. 14.

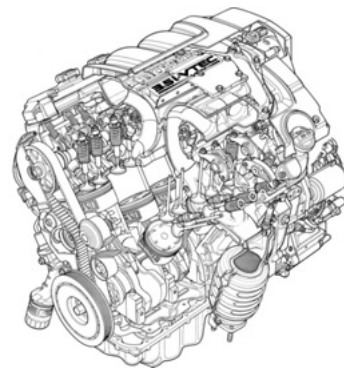


Fig. 12 View of V6 i-VTEC VCM Engine

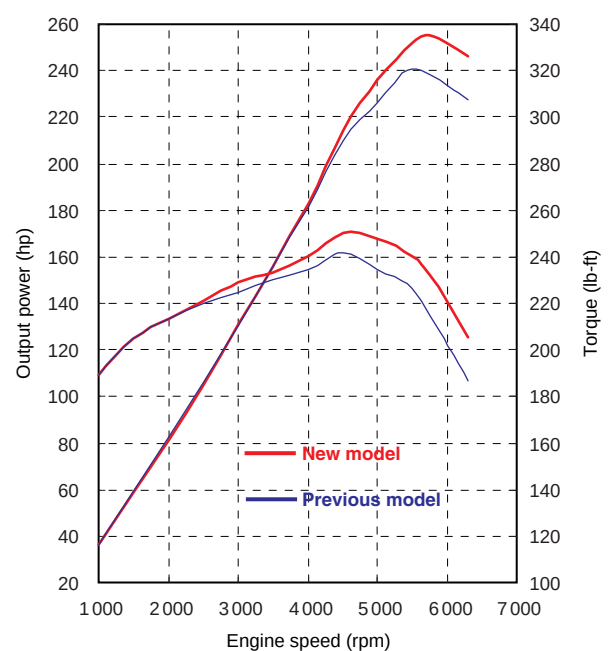


Fig. 13 Output performance

Table 1 Main specifications of engine

	New model		Previous Odyssey
Engine type	60°V-6 SOHC VTEC	60°V-6 i-VTEC VCM	60°V-6 SOHC VTEC
Displacement (cm ³)	3471	3471	3471
Compression ratio	10.0	10.0	10.0
Fuel	Regular unleaded	Regular unleaded	Regular unleaded
Max.power (hp/rpm)	255/5750	255/5750	240/5500
Max.torque (lb-ft/rpm)	250/5000	250/4500	242/4500
Transmission	5AT	5AT	5AT
Fuel economy	19/25	20/28	18/25
Emissions	LEV II-ULEV	LEV II-ULEV	NLEV (LDT2)

3.4.3. Environmental performance

Figure 15 outlines the systems used to achieve low emissions in this engine. The V6 SOHC-VTEC/i-VTEC VCM engines use high-atomization, multi-hole fuel injectors, and each bank has its own independent emission control systems.

In addition to the above emission control systems, adoption of a high-precision A/F ratio control system has helped achieve excellent environmental performance of a 75% reduction in NO_x, in comparison with the current model's NLEV (LDT2). This performance meets the “LEV II – ULEV” standards (Fig. 16).

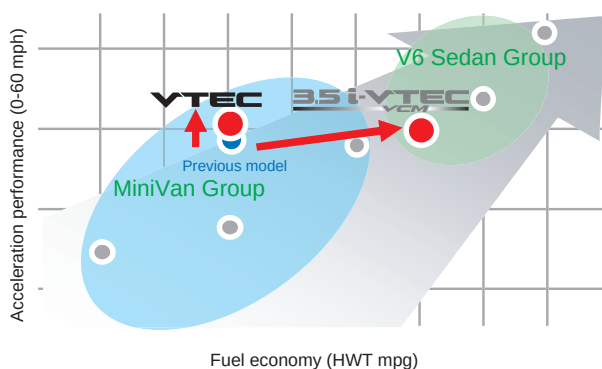


Fig. 14 Driving performance and fuel consumption

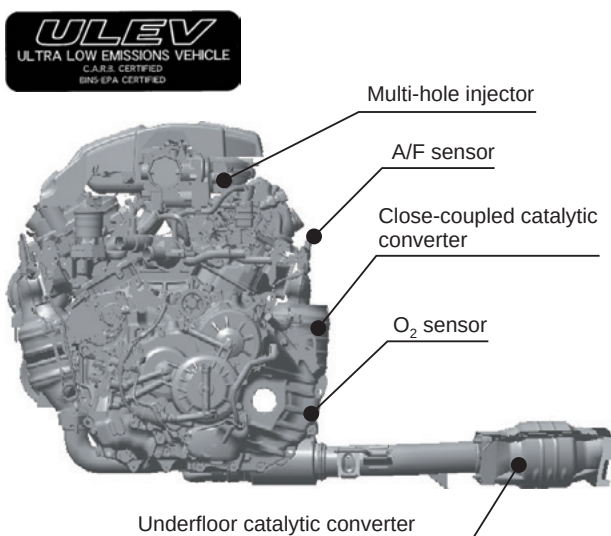


Fig. 15 Emission control system

3.5. Chassis Performance and Technology

A carpool lane is a special lane on US highways, where it is permitted to drive only if there are two or more people in the vehicle. Taking as its key word “Carpool Express,” this vehicle can drive with superior steering stability and excellent riding quality in the carpool lane. The chassis has been developed in order to actualize this concept.”

3.5.1. Suspension

In order to achieve both steering stability and ride comfort, based on the previous model acclaimed in the market, the front suspension utilizes struts, while the steering stability has been enhanced through optimization of geometry. In addition, adoption of force axis control springs wound symmetrically left and right, optimization of steering friction, and high-precision alignment are combined to give enhanced straight-line performance (Fig. 17).

The rear suspension is based on an existing in-wheel, double-wishbone suspension. Responsiveness has been enhanced through a damper layout close to the axle fluctuation locus, and a 30% increase in side force rigidity was promoted through the adoption of a 3rd generation bearing.

In addition, the diameter of the tires was increased (225/60R16 → 235/65R16), and other measures taken in order to improve ride comfort.

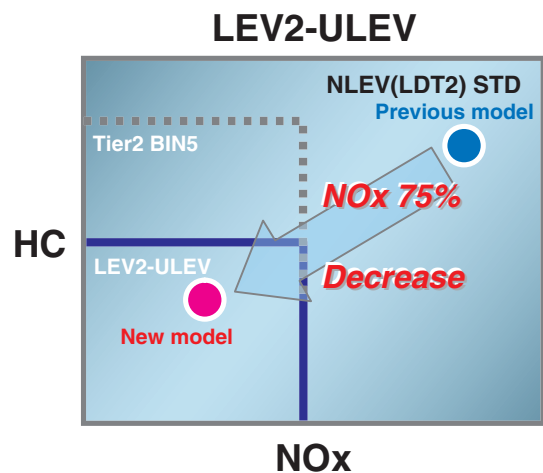


Fig. 16 Emissions performance

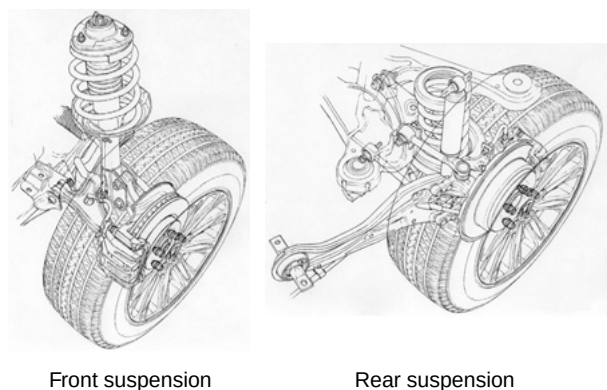


Fig. 17 View of suspension for new Odyssey

3.5.2. Subframe structure

In order to reduce road noise, the subframes were given a vibration-resistant structure, which is effective in attenuating road surface input, but conventionally this has been an issue when seeking to balance it with steering stability performance (side force rigidity, etc.).

This subframe was developed with the goals of continuing to increase steering stability, which has been evaluated highly thus far, while making improvements in ride comfort and road noise performances. Based on the following points of view, the ideal body support points were set at the design stage considering the suspension mounting points, and a vibration resistant structure with the enlarged rear subframe was adopted. At the same time, the previously mentioned suspension characteristics were tuned uniquely for minivans.

- (1) Enlarging the front and rear, left and right spans of the vibration resistant support rubber mountings, optimizing those spring constants
- (2) The front and rear supporting points to the body are set so that subframe steering, in which the suspension geometry moves in the toe-in direction, is achieved when turning (that is, side force is input) (Fig. 18, $A < B$)

As a result, there is no disruption of alignment when there is side force input, and it is possible to ensure a greater vibration insulating performance than what has been offered conventionally.

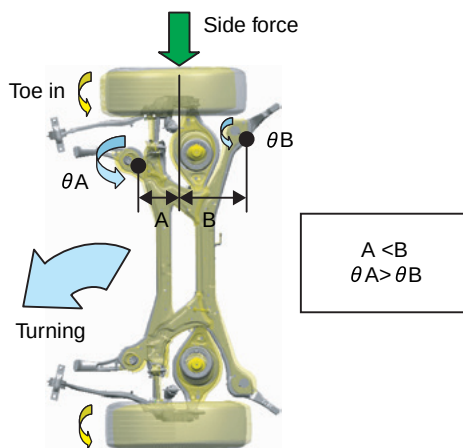


Fig. 18 Configuration of rear suspension subframe

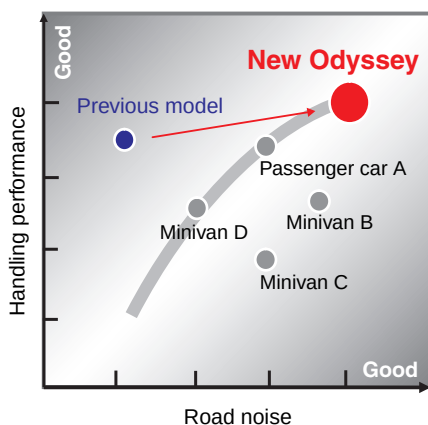


Fig. 19 Handling and road noise performance

This enables increased steering stability that is best in the minivan class, and at the same time road noise and ride comfort were achieved (Fig. 19).

3.5.3. New pedal system

Honda has adopted its first adjustable pedal system, designed to enhance the comfort of drivers of various sizes. Forward and back adjustment of the pedal position makes it possible for the driver to have a comfortable driving position. The switch has been placed on the instrument panel for ease of operation.

A special feature of this system is that a link mechanism is used, making it possible to move the acceleration and brake pedals 76 mm to the back, with the forward-most position being taken as the standard position, using a single motor. The structure is such that there are no changes to the tread level difference between the acceleration and brake pedals, nor to pedal ratio, within the adjustment range (Fig. 20).

As for the acceleration pedal, at the same time as integrating the mechanism generating tread force and the position sensor, a compact, lightweight acceleration pedal module was adopted.

3.5.4. Run-flat tire system

A US market survey shows that there is a demand has grown for run-flat tires, for safety, convenience, and security reasons.

The new model Odyssey has adopted the PAX system, an inner support ring type of flat-running tire that is beneficial in helping reduce rollovers, and which gives better steering stability and ride comfort than side support flat-run tires (Fig. 21, 22). The structure of the system includes the tire, the wheel, a support ring that carries the load of the vehicle if pressure is lost, and a Tire Pressure Monitoring System (TPMS) that monitors tire pressure.

A completely new bead structure has been created, that helps prevent the tire coming off the bead, particularly when driving with low tire pressure, and at the same time helps to reduce hysteresis loss when the tires are rolling.

In this application development, body reinforcement to offset an increase in road surface input was optimized. At the same time, steering stability when driving with low tire pressure was increased and unique suspension settings were established so that even when the vehicle has a flat tire, the vehicle can be driven at 50 mph for 125 miles without needing to fit the spare tire.

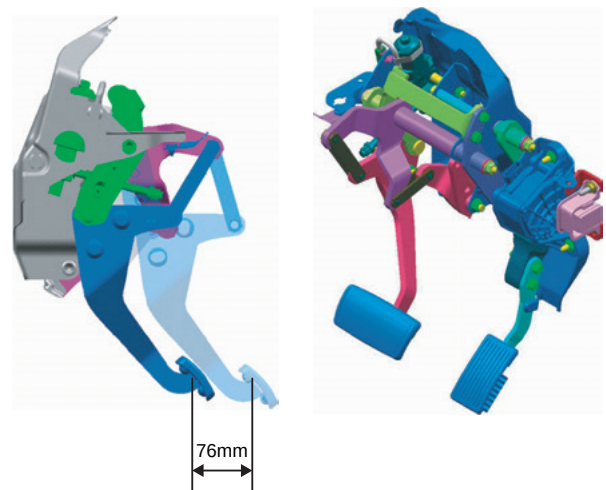


Fig. 20 Adjustable pedal system

3.6. Body Performance

3.6.1. Collision safety performance

Based on the "Safety for Everyone" concept, North America's first body with compatibility measures (Advance Compatibility Engineering: ACE)⁽²⁾ was applied to the minivan segment. In addition, Honda has addressed the new regulations in FMVSS208 and FMVSS301, as well as the Insurance Institute for Highway Safety's new Side Impact Crashworthiness Evaluation (IIHS SICE) standard.

From the point of view of minimizing collision stroke in front impact collisions due to the expansion of the cabin area, an ACE body structure was adopted in which the front bulkhead section was given a closed structure, and formed to a board (Fig. 23). The force load is distributed to the frame and the pillar, to help achieve high collision safety performance. In addition, light truck vehicles like minivans can cause more damage to small cars in car-to-car collisions. However, the ACE body structure disperses and absorbs collision energy, to help reduce such damage. For side impact collisions, the center pillar has been given a divided structure, actualizing a lightweight, high-rigidity pillar. In addition, concerning passenger protection performance, all grades have an interior with head impact protection on cabin pillars and roof sides, as well as side curtain airbags with rollover sensors for side impacts. As pedestrian protection measures, the front of the body uses an impact absorbing structure that helps reduce injury to a pedestrian.

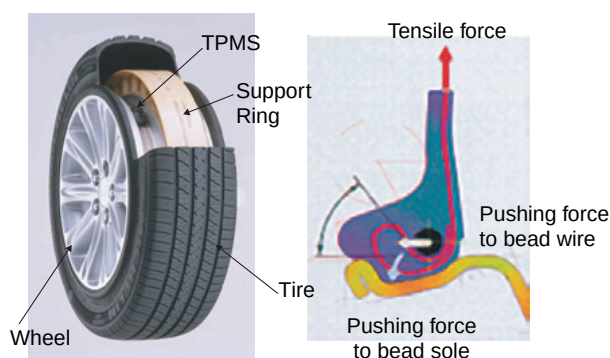


Fig. 21 Run flat tire system (Pax Tire system)

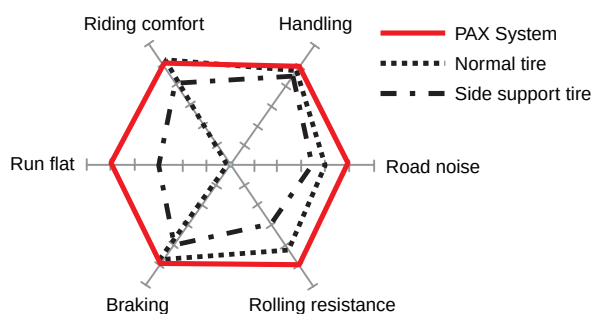


Fig. 22 Comparison of tire system performance

3.6.2. Body rigidity

Computer simulations were used in designing the body, making it possible to achieve sedan-level body rigidity by optimizing members for a frame having the same body length but an increased cabin length of 50 mm, an increased overall length of 25 mm, and large cabin openings.

The basic framework combines the aforementioned North American first ACE body structure for the engine bay, with a member around the front damper base and a cross member underneath the upper dashboard to ensure rigidity for steering stability. In the rear, the structure includes highly efficient connecting cross members between the floor and frame (Fig. 24). In addition, weight-reducing techniques were adopted for fuel economy improvements, including the adoption of 440/590 grade high tensile steel sheets with a steel sheet weight ratio of 45.3%. The body-in-white weight is the same as the previous model, and the body torsion rigidity is improved by 20% while the cabin is larger.

3.7. Noise and Vibration

In order to provide passengers in every seat with a quiet and comfortable space, full consideration was given to improving noise and vibration (NV) product appeal performance. At the same time, one goal was NV product appeal that does not cause the passengers to be aware of the switch to the VCM system adopted in the high output 3.5L engine.

3.7.1. Active Noise Control technology^{(3),(4)}

With the engine adopted, one issue was an increase of noise and vibration level due to an increase in torque changes when the VCM

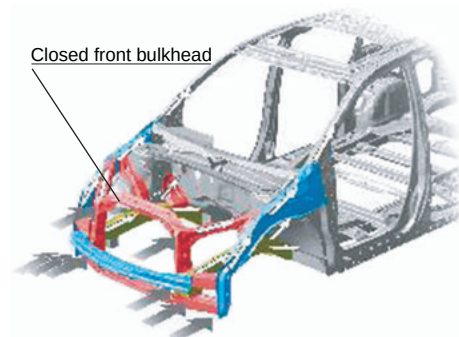


Fig. 23 Advanced compatibility engineering construction

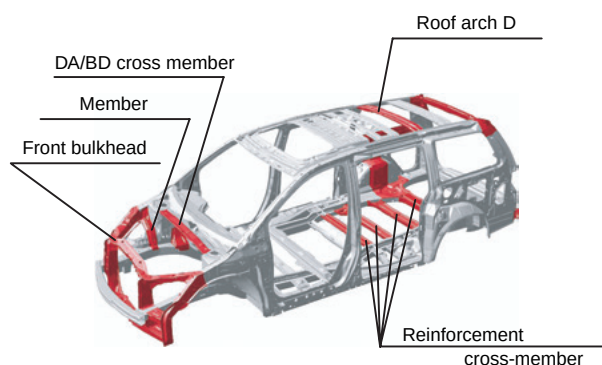


Fig. 24 Configuration of whole body construction

Table 2 Technologies for noise and vibration control

	Boom	Vibration	Shock
Active control engine mount	○	○	
Active noise control system	○		
Electric throttle control			○
Lock up control Lock up long torsion spring		○	○

system operated. However, the Active Control Engine Mount (ACM) system and Active Noise Control (ANC) technologies, used in the INSPIRE and the ELYSION, have been adopted in the new Odyssey, with special settings. In addition, switch shock was reduced through cooperative controls between the electronic throttle control and lock up control (Table 2).

As a result, booming noise, vibration, and shock were reduced, achieving a high NV performance with which the passengers are not aware of switching in the VCM system.

3.7.2. Engine noise reduction

The 3.5L V6 engine installed in the new model Odyssey uses a thin, lightweight intake manifold that achieves both weight reduction and quietness.

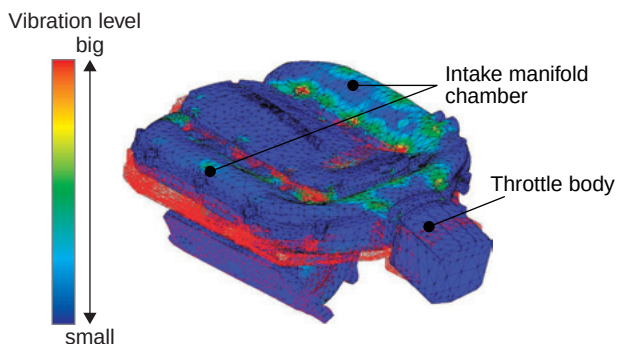


Fig. 25 Radiation noise from inlet manifold

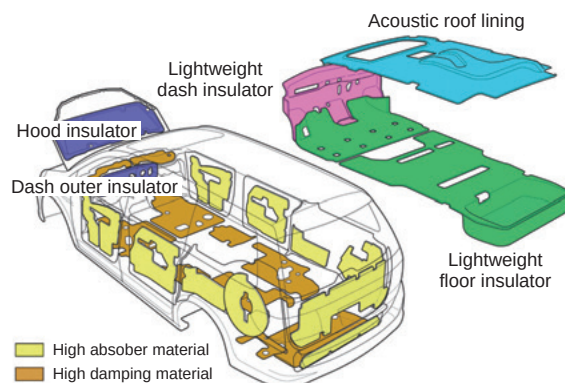


Fig. 26 Lightweight soundproofing materials

Starting with the intake manifold chamber, which contributes greatly to radiation noise, the rigidity tuning of each part was efficiently carried out, minimizing the worsening of noise due to weight reduction (Fig. 25). As a result, best-in-class noise reduction for a minivan (engine quietness) was maintained, and at the same time, weight reduction was achieved (-26%).

3.7.3. Lightweight soundproofing package

Traditionally, soundproofing materials to reduce transmission noise with sound insulation materials are applied to reduce cabin noise. However, the new model Odyssey applies a damping material to reduce noise radiated from the floor surface, and adopts a lightweight, sound-absorbing type of soundproofing system. Parts using sound absorbing material include the dashboard insulator, floor mat, and roof lining, as well as a wide variety of other components. This means that the surface area for sound absorption is extended, noise in the high frequency range is greatly reduced, and a level of quietness that is best in the minivan class is ensured.

As a result, at the same time as quietness in the cabin is improved, a weight reduction of -15 kg has been achieved, in comparison with the previous model.

4. Conclusion

The new model Odyssey has inherited the acclaim of the old model, and development started with the expectation of creating new value.

In addition to the technology that aimed at actualizing high safety and environmental performances, which should ensure the new Odyssey's position as the next generation minivan benchmark, it was aimed to actualize high levels of sophisticated styling, performance, and utility. For that purpose, the Odyssey should provide joy to its users and should be the best in class vehicle.

Efforts were made to improve performance of the interior and exterior design, powertrain, body, and chassis, etc. and to enhance comfort features that included safety features. As a result, the 2005 model year US Odyssey was developed as the "King of Minivans" providing drivability and a quality feel that match those of a luxury sedan.

The development engineers have always put themselves in the customer's position, have persistently pursued new and creative ideas for product development, and have strived to actualize their dreams. They believe that they have created a minivan that is full of appealing features.

This development project was completed thanks to the generous cooperation of many people, both in the company and outside it. The authors would like to take this opportunity to express their sincere gratitude and appreciation.

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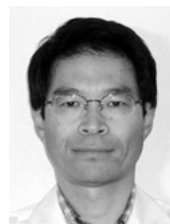
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