

Development of Honda Techmatic System for 2020 Model Year FIT

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ABSTRACT

The Honda Techmatic System, a hand-operated driving assistance device that supports the independence of users with physical disabilities, has been developed as an official Honda product for the 2020 model year FIT.

Starting with the 2020 model, a Qi wireless charger for smartphones has been installed in the area where the existing Techmatic control lever is installed. By providing Qi functionality in a Techmatic system vehicle, Honda aimed to reduce the amount of effort required by drivers. Honda was able to continue use of the 2016 model year FIT control lever mechanism by moving it further forward in the vehicle. This compensated for the loss of horizontal space due to the Qi charger and for the installation point loss directly below the control position. In this way, Honda made the control lever mechanism more compact without impacting usability.

1. Introduction

Barrier-free thinking has evolved over time into the idea of diversity. In the field of mobility, work is progressing on building environments in which everyone can get around more easily⁽¹⁾. However, in order for people with physical disabilities to access public transportation, they still often need the help of others, such as for setting up ramps when entering/exiting vehicles, or helping to push a wheelchair up a slope. Therefore, a vehicle that allows people with disabilities to get around freely without the help of others is a growing necessity.

Typically, the drive controls of a vehicle are arranged on the assumption of full use of all limbs, i.e., arms and legs. The accelerator and brake pedals are operated with the right foot and the steering wheel requires both hands. In addition, there are various switches such as the light switches and the gear-shifting controls. Many people who have a limb disability can thus find it challenging to drive a vehicle⁽²⁾. Driving assistance devices developed to address this issue are mechanisms that are added to a vehicle. These vary depending on the specific limb disability of the driver so as to enable that person to drive the vehicle⁽³⁾.

This paper will provide an overview of the Honda Techmatic hand-operated driving assistance device, and present a development case in which the assist device was installed together with a wireless recharger (a Qi charger) for smartphones in the 2020 model year FIT.

2. Driving Assistance Devices

In Japan, a 1960 revision to the Road Traffic Law made it possible for people with physical disabilities to obtain a license. In the 1980s, devices such as those shown in Fig. 1⁽⁴⁾ were studied. In 2019, approximately 190,000 people had a conditional driver's license that limited them to "vehicles for people with physical disabilities"⁽⁵⁾.

In terms of sales, the Japanese market consists of 4,000 units/year. Two specialized retrofit manufacturers account for 80% of these sales. A number of automobile manufacturers have participated in the market in the past, but as far as the authors can determine, this number has fallen.

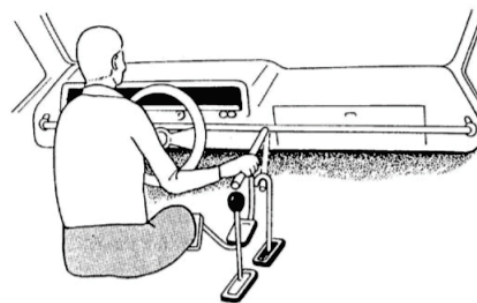


Fig. 1 Driving assistance device developed in 1980s

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By offering an official Honda product, Honda provides customers with the convenience of a vehicle and accessories that can be delivered together, rather than having to modify a vehicle post-purchase, and thus helps provide people with physical disabilities more access and opportunities to engage in activities without constraints.

2.1. History of Driving Assistance Devices

The history of Honda driving assistance devices began in 1968 when Tech Production began developing and installing hand-operated driving assistance devices under the “Honda Techmatic System” trademark⁽⁶⁾. In 1982, Honda released the Honda Franz System⁽⁸⁾, Japan’s first foot-operated driving assistance device. This was in conjunction with a revision of the Road Traffic Law for people with upper limb disabilities, who until that time could not receive a driving license⁽⁷⁾.

2.2. Types of Driving Assistance Devices

As shown in Fig. 2, various driving assistance devices are available, depending on the disability of the driver. These are explained in detail below.

2.2.1. Hand-operated driving assistance devices

These are devices that enable people with disabilities in their lower limbs to drive using only their hands. They are designed so that the accelerator and brake can be mechanically operated by hand. For example, Fig. 3 shows an example of a lever type, in which the accelerator is

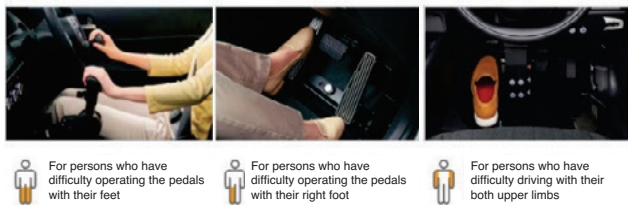


Fig. 2 Types of driving assistance devices

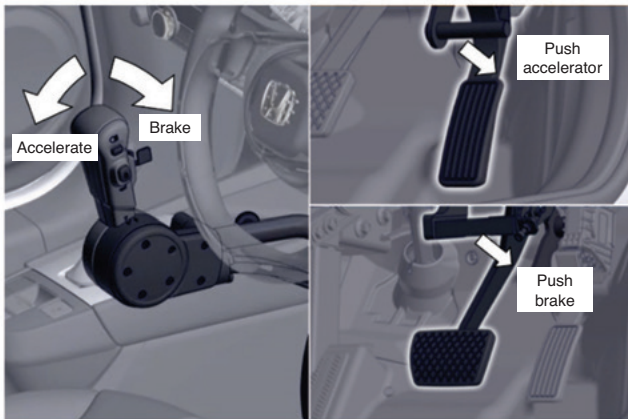


Fig. 3 System of driving assistance device for hand use only

applied when the lever is pulled, and the brakes are applied when the lever is pushed.

Honda offers a D-type lineup as shown in Fig. 4, which is a combination of devices in which the left hand operates the accelerator and brake pedals as shown in Fig. 3, and the right hand turns the steering wheel. The hand-operated driving assistance devices have a roughly 50% share of the driving assistance device market in Japan, and various lever-type and steering-wheel-type devices are offered.

2.2.2. Left-footed accelerator

This is a device that enables people with a disabled right leg to operate the accelerator and brake with their left foot. As shown in Fig. 5, an accelerator pedal is installed on the left-foot side. When this is depressed, the connecting mechanism causes the vehicle accelerator to also be depressed. To help prevent the right foot from stepping on the vehicle accelerator, the right-foot pedal is replaced with a footrest.

This is Honda’s B-type lineup, as shown in Fig. 6. Sales of this product have been increasing in recent years, and it is believed that market demand is growing.



Fig. 4 Honda Techmatic D-type

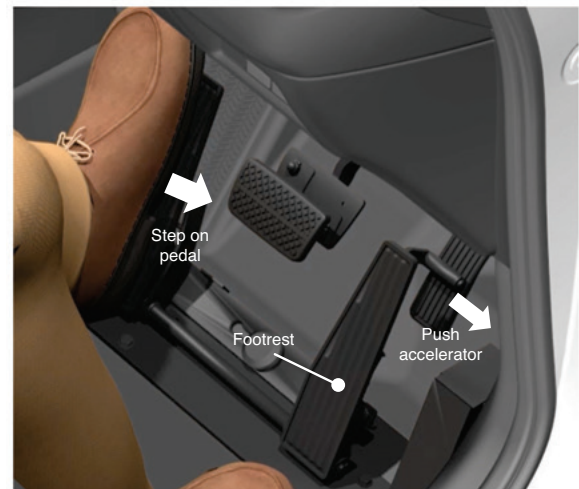


Fig. 5 System of driving assistance device for left foot

2.2.3. Foot-operated driving assistance devices

These are devices for enabling people with disabilities in both upper limbs to embark, drive, and disembark from the vehicle using only their legs. Honda offers the Honda Franz System lineup, as shown in Fig. 7.

The Franz System was developed by Germany's Eberhard Franz. Figure 8 shows the system. The left foot operates the device like a bicycle pedal, with the rotation transmitted to the steering wheel to provide steering input.



Fig. 6 Honda Techmatic B-type



Fig. 7 Honda Franz System for 2017 model year FIT

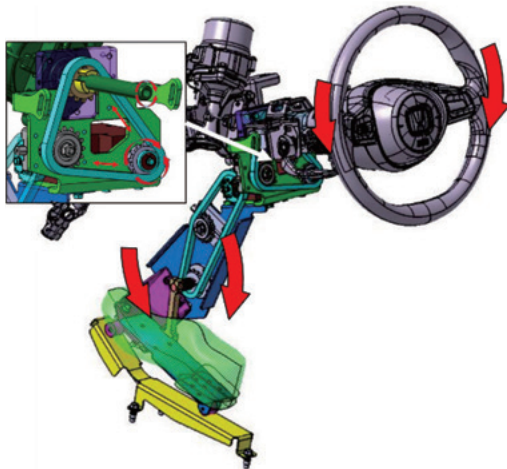


Fig. 8 Franz System driving assistance device

3. Development of the Hand-operated Driving Assistance Device for the 2020 Model Year FIT

3.1. Development Goals

In the lever-type hand-operated driving assistance device described in Clause 2.2.1., the left hand controls the accelerator and brakes. Therefore, for the purpose of usability, the lever is positioned to the right of the center console. To help ensure sufficient strength and durability, the lever is fixed directly to the body of the vehicle below the center console⁽⁶⁾.

In the 2020 model year FIT, the Qi charger, which in recent years has become a common automobile accessory, is installed in the forward part of the center console. With smartphones, people with physical disabilities can check for information about services at their destination, such as accessible toilets or parking with sufficient space for entering/exiting a vehicle. Smartphones are also useful at the destination, to search for new information when plans suddenly change. Smartphones are thus an important tool, and this makes the Qi charger, which can recharge devices that are simply placed on top of it, an important device for people with disabilities, as it does away with the hassle of connecting cables.

Therefore, in this development, Honda aimed to configure the Techmatic lever layout while still enabling use of the Qi charger.

3.2. Moving the Installation Position and Reassessing the Structure

In developing Techmatic for the 2020 model year FIT, Honda looked to continue using the Techmatic D-type while deploying the latest functionality and equipment. As shown in Fig. 9, the drink holder in the 2016 model year that was used as a fixing point directly under the body of the control lever was replaced by the Qi charger in the 2020 model year. At the same time, the gear-select lever was positioned right behind the Qi charger, and the space that was previously available to secure the Techmatic control lever to the body, as shown in Fig. 10, was no longer available. From the point of view of left-hand operability, the control lever had to be in the same position as previously, near the right rear of the gear-select lever, and a structure had to be



(a) 2016 model year



(b) 2020 model year

Fig. 9 Comparing drink holder of 2016 model year FIT and Qi of 2020 model year FIT

present that could provide sufficient support for the driver's body during braking. Therefore, in this development, the position of the control lever attachment relative to the vehicle body was moved 54.5 mm forward and 72.5 mm laterally toward the outside of the vehicle, compared to the 2016 model year. It was set on the side surface of the center console so as not to interfere with the seat when the latter was moved backward and forward. Furthermore, a structure was studied that could withstand loads from that side surface while fitting within the limited interior width of 25 mm.

3.3. 2020 Model Year Load Support Structure

For the purpose of this development, Honda decided to produce a load-bearing structure and the minimum necessary layout based on the new control lever mounting position. The control lever needed a support structure that could withstand longitudinal loads under braking, as well as loads imparted in all possible directions that could occur during embarking or disembarking or in unintended circumstances. With these considerations, for this structure Honda utilized two gear-select lever fixing points on the driver side and the two forward fixing points that were used in the 2016 model. With the change in control lever position, the two passenger-side fixing positions would no longer be available to bear loads, so additional structures were required to support the remaining four available fixing positions from the front, back, left, and right. Here, Honda considered a structure in which load paths were controlled only on the right side of the center console for longitudinal loads, while a T-shaped structure on the right side provided support for lateral loads.

Inside the center console, space between the Qi charger

and the gear-select lever and between the gear-select lever and center console side surface was utilized. Figure 11 shows how the structure that receives the longitudinal loads inside the center console and the structure that receives the lateral loads were installed between the Qi charger and the gear-select lever. Longitudinal loads are received by the two fixing points indicated by the triangles in the figure on the right side of the gear-select lever. The two fixing points indicated by the triangles in the figure near the center of the center console provide both horizontal balance when longitudinal loads are applied, and support for lateral loads.

3.4. Examining the Structure

In consideration of driver usability, the control lever was installed in the same location as the 2016 model year. The load-bearing requirement was based on an assumed maximum load in the longitudinal and lateral directions representing the full weight of the user being applied to the control lever. Figure 12 shows the actual structural layout resulting from this conception. The structure at the side of the console is better able to bear longitudinal loads with

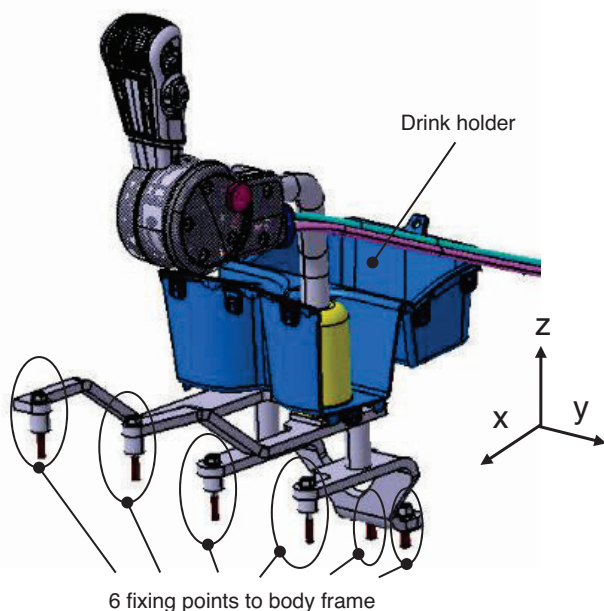


Fig. 10 Fixing image of 2016 model year FIT

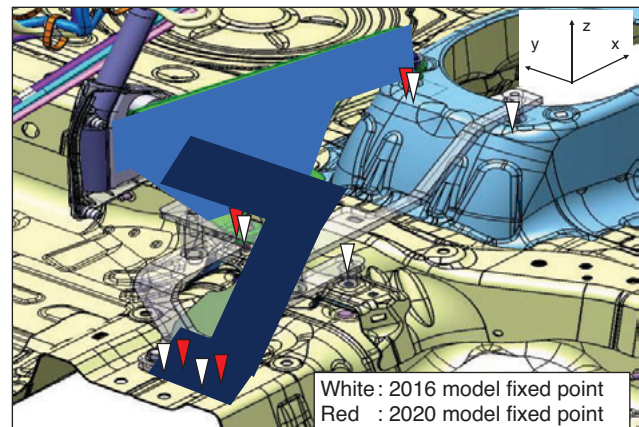


Fig. 11 Concept of structure for Techmatic

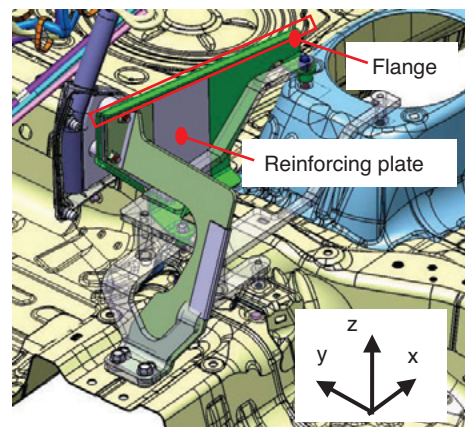


Fig. 12 Layout of load resistance structure

the two fixing points and, additionally, a flange that was added to the upper surface of the bracket. For lateral loads, a reinforcing plate was added to the aforementioned bracket to mitigate deformation, while an L-shaped load-bearing structure was fixed to the floor, being routed around other vehicle parts.

In constructing this layout, the longitudinal and lateral load paths were studied at the same time. These load paths are shown in Figs. 13 and 14. The red arrows in the figures indicate loads applied from the control lever, while the loads distributed within the bracket and applied to the floor fixing sections are shown by the blue arrows.

The basic thinking with regard to these load paths is as follows. The longitudinal loads applied to the control lever are evenly distributed from the pipe to the flat surface where deformation is suppressed by the attached flange. The two fixing points at the side of the console resist forward loads with pulling resistance of the fixing bolts and rearward loads with compression resistance. For lateral loads, of the four fixing points in the floor, the front three bear loads to the left with pulling resistance of the fixing bolts. The bolts bear loads toward the right with compression resistance. Although the structure provides less momentary support compared to the 2016 model year, it was made so that it could withstand the anticipated loads with the minimum available four fixing points, instead of the six fixing points of the previous model. It was then verified that the structure had the strength to resist the generated stresses.

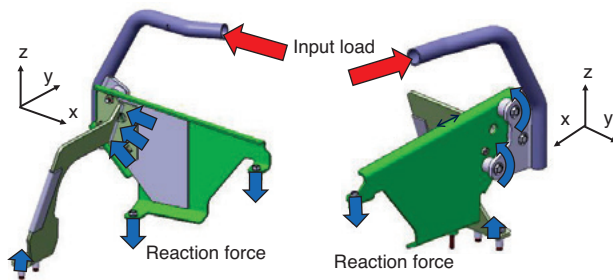


Fig. 13 Load path of back to front direction pressure

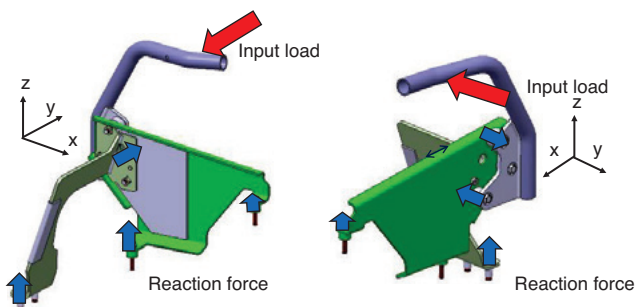


Fig. 14 Load path of outside to inside direction pressure

3.5. Verification Results

A strength analysis of this layout was performed for longitudinal and lateral loads. The strength analysis results are shown in Figs. 15 and 16.

According to the results of the analysis, although the longitudinal and lateral loads are concentrated on the pipe, the longitudinal loads are distributed to the two fixing points at the side of the console and the lateral loads are distributed to the three forward fixing points. This was as expected.

With the picture provided by these results, a test using actual equipment was conducted, which showed residual displacement within tolerances when the specified loads were applied. The physical test results are shown in Fig. 17. The vertical axis of the graph shows the change in load, where the required load is 100%, and the horizontal axis shows the ratio of displacement of the control lever, where maximum displacement is 100%.

As shown above, by utilizing a three-dimensional structure, it was possible to maintain the same structural strength in a more limited space and with only four fixing points, compared to the six fixing points previously available. Also, the new structure could be installed more quickly than the previous model. Further, the structure made it possible to maintain the same control lever position as before, which was a consideration in terms of ease of use. Figure 18 shows a comparison between structures of the 2016 model year and the final 2020 model year.

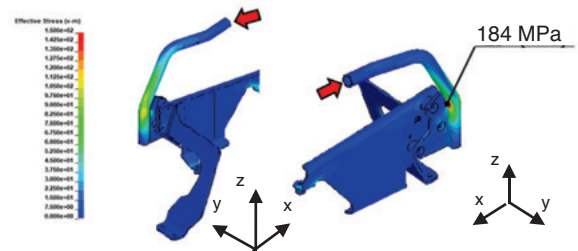


Fig. 15 Analysis of longitudinal direction

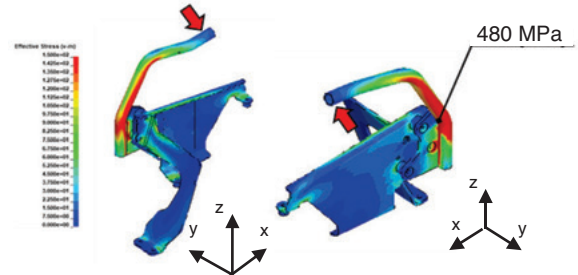


Fig. 16 Analysis of lateral direction

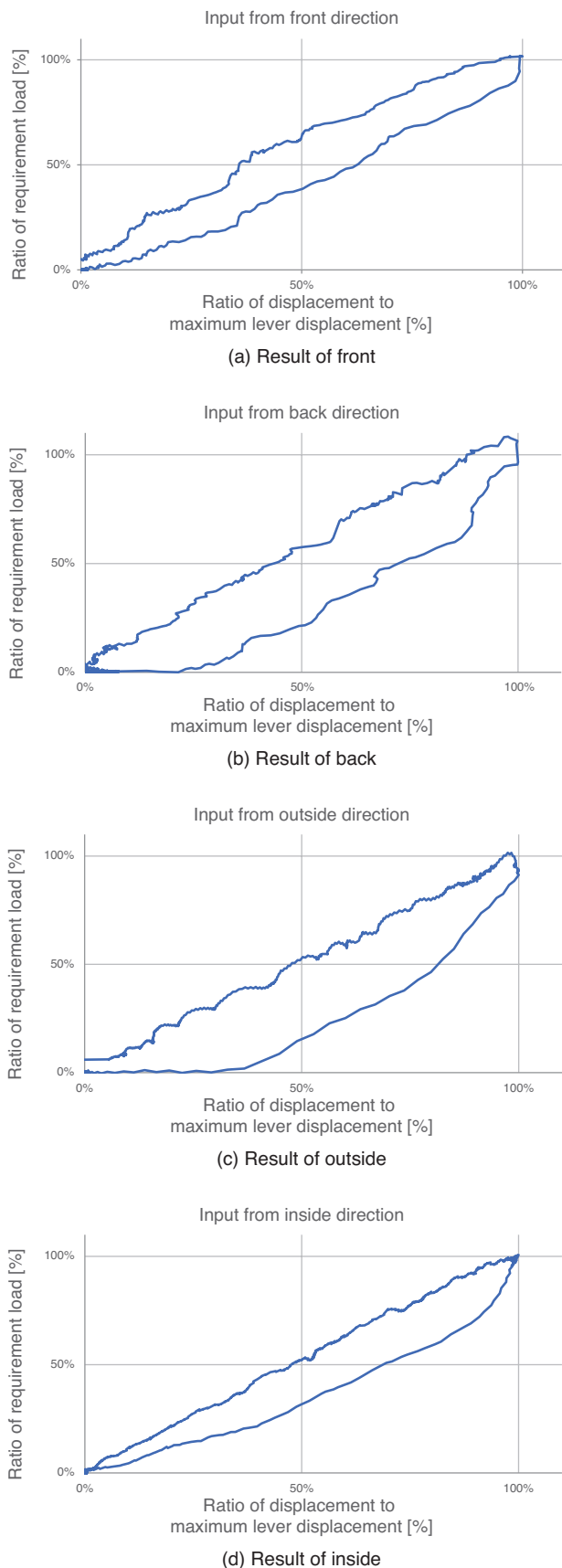


Fig. 17 Result of strength test

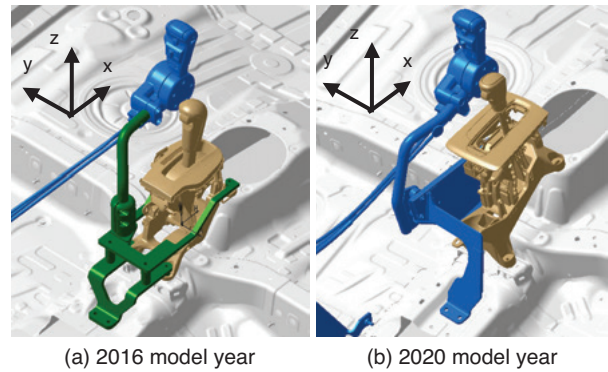


Fig. 18 Comparison of Techmatic for each model year

4. Conclusion

As a result of this development, Honda was able to achieve a different mounting structure on the side of the console, while still making the best use of the existing core Techmatic system.

A Techmatic system compatible with the 2020 model year FIT has now been released to market. From this initiative, Honda will accelerate and expand the company's "Fun for Everyone. Honda"⁽⁹⁾ concept throughout the industry, and work to further develop products to bring the joy of mobility to even more customers.

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