

Development of New 50 cc Scooter Dunk

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ABSTRACT

Honda developed the new 50 cc scooter Dunk to revitalize the Japanese market for small (50 cc or below) motorcycles.

The Dunk, whose target users are male high school students, took “Premium Sneakers” as its development concept. The development theme was “A scooter that expands the fun of commuting of younger people and their daily lives as well.” To realize that concept, the development team incorporated a design and a body packaging created under our new-concept. The 50 cm³ engine eSP (enhanced Smart Power), which was dedicatedly developed for this application, was adopted as well to realize a superior economy and environmental performances. By implementing those factors, it was pursued to create a new scooter in superior quality that would be appreciated not just by high school students but also by a broader range of customers.

1. Introduction

The sales of small motorcycles (displacement of 50 cc or below) in Japanese market had peaked in 1982. Though it had experienced small scale sales increases several times, the market shrinkage has been continuing as an unchanged underlying trend. This tendency of shrinking market can be interpreted as the decline of the scooter market, which makes up more than 80% of small motorcycle market.

Two-stroke engines are commonly applied for scooters in small motorcycle class. However, with environmental awareness started to gain attention in the 1990s, Honda began developing scooters with four-stroke engines to enhance environmental performances, power and ease of handling. Then in 1999, the *Giorno Crea Deluxe* was developed as a scooter with a water-cooled four-stroke engine. It was also the world's first motorcycle with an idling stop system⁽¹⁾ for mass production. That model offered excellent environmental performances and a fashionable styling gaining considerable level of preferences from the customers.

To boost the market further, Honda released the *Today*, which was equipped with an air-cooled four-stroke engine, in 2002. It featured an affordable price with a simple vehicle configuration. Utilizing global resources within Honda, it was developed in Japan and manufactured in China. Through those efforts, the small motorcycle market was made stable at the level of annual sales about 500,000 units until 2007. However, the stricter emission regulation was issued in 2007 and the specification changes were made to comply with that change resulting in its price increase.

Moreover, the Lehman Shock in 2008 imposed a significant impact on the market. With those influences on the market, the market stayed flat at about 240,000 units from 2009 through 2013⁽²⁾ (Fig. 1).

Another serious issue is the aging of users⁽³⁾. Figure 2 shows the trends in motorcycle sales by customer age groups. As seen in this figure, younger people have been rapidly losing their interests in motorcycles. However, a small motorcycle is still a vital tool for the people who need short distance commuting and for the people who want to expand the range of everyday activities for fun. Honda made a firm decision for a commitment to ensure a

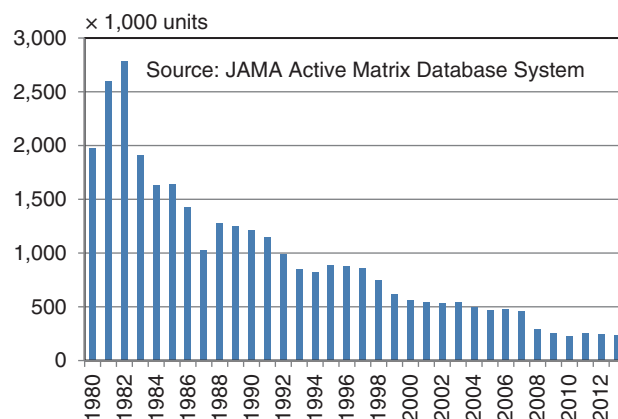


Fig. 1 Shipping volumes of 50 cm³ class motorcycles in Japan

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vigorous motorcycle market in the future. Especially, it was considered to be the most important thing to get younger people to share the understanding on usefulness and attractiveness of motorcycles in this class.

In the scooter category of small motorcycle class, the DIO series used to be popular among a wide range of customers, especially among young male users. Since its market release in 1988, many customers showed their appreciation to it because of its practicality (e.g. a helmet can be stowed under the seat) and sporty styling (with a swift appearance). However, this continued customer appreciation created an unchanged stereotyped idea that younger people just like sporty design. With that established understanding, any in-depth study on changes in the tastes and values that younger people, particularly DIO users, have.

In this paper, the new scooter Dunk will be introduced (Fig. 3). Based on the aforementioned background, before starting its development, Honda conducted a research on the current situation of commuting for the students and what they expect to scooters. We also researched the values they recognize and the tastes in their life style. This research was conducted focusing on the targeted user group. Based on the research results, Honda proposed a new styling concept

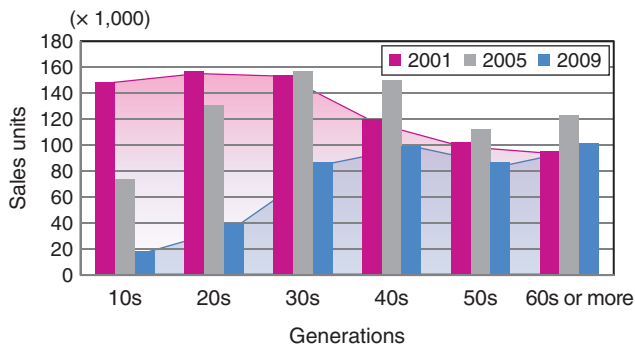


Fig. 2 Generation transitions of motorcycle buyers in Japan



Fig. 3 Exterior view of the Dunk

unlike that of any previous scooter. In addition, a new engine eSP (enhanced Smart Power) for a small scooter was dedicatedly developed and applied. The engine offers the sufficient acceleration performance required for a mixed traffic condition together with excellent environmental performances. Implementing those ideas and technologies, it was pursued to create a product in which younger people would naturally show their favor.

2. Concept

2.1. Defining the Target User

Under the objective of boosting small motorcycle market, the product concept was constructed focusing on users in younger age group. The core target customers were defined as male high school students using small motorcycles for their commuting.

To better know the surrounding situations of their motorcycle usage, various kinds of statistical data were analyzed as well.

First, the number of high school students who use small motorcycles for their commuting was investigated. It is conducted based on the data from the national census⁽⁴⁾ and the driver's license statistics⁽⁵⁾. Figure 4 shows the population in age group of 16 to 18 years old, which corresponds to high school student ages, and the number of license holders of small motorcycles among the students in this age group. The data is shown for a sequence of years. Between 2001 and 2010, the population in this age group fell about 20%. Meanwhile, the number of license holders in this age group shows a steep decrease by about 60%. The study results show that the percentage of high school students having licenses decreased, roughly, from 10% to 5%.

However, breakdown of the data, into a specific age and gender, shows that there are about 50,000 potential users in 17 years old male group (i.e. in a sub-group of 16 to 18 years old, which is the age segment showing the largest

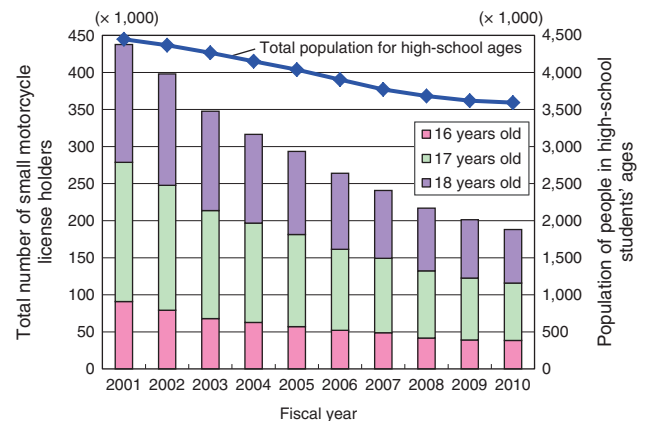


Fig. 4 Number of small motorcycle (under 50 cm³) license holders in high-school students' ages

Table 1 Percentage of small motorcycle license holders of male in age of 17 years old in top 10 prefectures

Ranking	Prefecture	Number of holders	Prevalence of holders
1	Yamanashi	1,524	32.15%
2	Kagoshima	2,801	29.45%
3	Kumamoto	2,081	20.95%
4	Kochi	822	20.60%
5	Nara	1,387	18.80%
6	Ibaraki	2,836	18.58%
7	Osaka	7,289	18.51%
8	Tochigi	1,583	15.95%
9	Niigata	1,855	15.30%
10	Oita	802	13.26%

increase of license holders) (Fig. 5).

Research on various population statistics of each prefecture⁽⁴⁾ and the statistics of driver's license⁽⁵⁾ were also conducted. Through the research, it was tried to identify the regions where a large number of high school students are using small motorcycles for commuting. It was considered based on the number of 17 years old males with motorcycle licenses and its percentage to the whole population in that age group (Table 1).

The data indicates that cities in rural area have potential needs for high school students to use small motorcycles for commuting. Based on those research results and our considerations, the target user for the development was specifically defined as male freshmen of a high school living in a rural city.

2.2. Concept and Target of Development

In this development, the theme was set as “A scooter that expands the fun of commuting of younger people and their daily lives as well.” Moreover, the conceptual vehicle identity for this development was defined as “Premium sneakers”. Then it followed by the following development objectives.

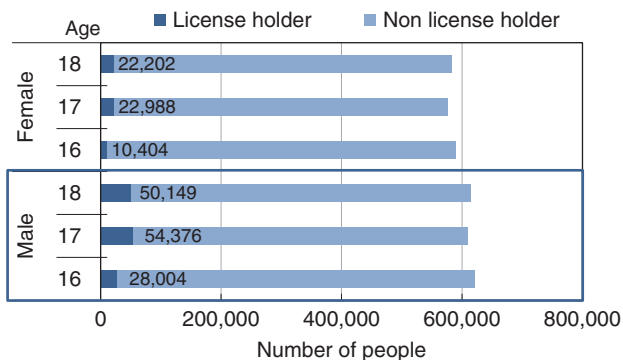


Fig. 5 Number of license holders of small motorcycles in high-school student age group

- (1) Design: A simplified styling expressing a superior quality yet with casual feeling as well
 - Showing an atmosphere of a natural behavior refraining an exaggerated appealing or showy ostentations
 - Well-tended makeup that extends the intentions and devotions of the designers
 - A rider and the scooter should be perceived not as separate substances but as a single whole mass united into one object
- (2) Convenience: Equipment for enhancing the satisfactions of younger people in their “daily lives”
 - A utility box with a large capacity that has enough room to hold a full-face helmet plus some additional space
 - An accessory of an electrical socket, for charging smartphones, etc., a clock, and other conveniences that are easy to use in everyday life
 - Good fuel economy contributing to less frequency of refueling
- (3) Comfort: 30 minutes commuting without feeling tired
 - A relaxing and comfortable ride in an upright seated posture
 - Secured stability in riding posture even when the rider stretches the legs forward
 - Performance with an ample of power for a comfortable cruising in a mixed traffic

3. Styling Design

3.1. “Daily Lives,” the Sense of Value

For a creation of attractive exterior design fitting to the concept of a product, it is generally required to sort out in advance the conceptual approaches of the design with good understanding of feelings and perceptions of targeting users.

Accordingly, “the design that makes younger people to be stimulated for their ownership” was investigated to establish a design concept in line with the previously described product concept. The results pointed out the following trends in younger people’s thinking and actions.

The image of the younger person who wears uniforms in a disheveled way and has a style that features their bangs is truer of the previous generation than of this one. The majority of younger people “daily lives” tend to prefer good-fitting clothes that they wear neatly, with hair that looks casual and natural. However, this does not mean that they do not care how their hair looks. They do not want to stand out, but younger people really think about how they can look natural.

They have decided that having a conspicuous hairstyle or wearing novel fashions is a way for performers or others to whom it might be appropriate to assert their individuality. Younger people want to know their place. Taking their peers as their standard, they figure out how to look natural and nonchalant among them. To this age group, this is what it means to look smart.

Following are some examples of products appealing inconspicuous smartness in the eyes of these younger people.

For example, fashionable road bikes and mountain bikes are not the bicycles they use to commute to school. Rather, they choose so-called “keikaisha” (light and comfortable bicycles) such as one can see anywhere. The most common color is inconspicuous silver. These bikes are meant to be practical, with a basket in front. However, this does not mean that just any inconspicuous, practical bicycle will do. Younger people choose manufacturers they trust, which is to say, it is the clever side of bicycles –practicality and durability– that younger people find smart. Something similar is happening with mobile phones, which are now indispensable to younger people. Smartphones are becoming more prevalent, and unlike in the past, they no longer choose according to color, form, and the like. Smartphones are all the same rectangular shape, and none of their external characteristics make them stand out. What satisfies younger people are the feel of well-built quality and functionality as a communication tool.

3.2. Styling Theme

When establishing the styling theme, the usual process was not chosen, which is to start from the styling of the scooter itself. Rather, we sounded out younger people’s sense and took that as the starting point of our study. These users want to assimilate into their surroundings and choose possessions that assimilate into the owner. In other words, what we sought for was that neither of the vehicle or the rider solely stands out. The point is that those two objects are to be naturally balanced in total in its styling. That is to say, we pursued “the styling that incorporates the person who maneuvers the vehicle.” This was chosen as the styling theme. Then, to ensure that the quality and function have a certain level of individual finishing, “high quality,” “sturdiness,” and “functionality” were chosen as important keywords embedded in this “styling.”

To that end, the observations of younger people’s postures were conducted when they are riding scooters. In 1990’s, the popularity of high powered two stroke engine models was in its peak and the younger people were riding them in an untidy manner with a crab crotched posture. However, through the results of the research conducted this time, it was found out that they are no longer doing that way of riding in these days.

Younger people today sit towards the rear of the seat and stretch their legs so their feet are on the front end of the floor. Their backs are upright. Overall, their posture looks relaxed and quite natural. They adjust the length of the shoulder strap from which their rectangular sports bags hang, so that the bag rests lightly on the carrier and is less of a burden on the body. And in many cases they wear full-face helmets.

Based on the above, the “human form,” was the first thing to be created, complete with full-face helmet and sports bag hanging from the shoulder while the rider is in

the above riding posture. Once that was done, the “rider-incorporating styling” was designed.

To begin with, three points were determined indicating the height of the rider’s head and the position of the front and rear tires, which are important for ensuring comfort. The line that encloses these three points was sketched out. Based on this form, a trapezoidal outline was defined so that the outline of the vehicle body and the rider fits to it without protrusions or indentations (Fig. 6).

Next, the form with an awareness of the angle of the rider’s arms and legs were adjusted, creating “rider-incorporating styling.”

Utilizing this base “form,” it was made possible to create a compact and not unnecessarily oversized impression. On the other hand, it was also made possible to establish a balanced looking of stability in which the front and rear tires are showing the posture of firm standing on the ground.

3.3. Styling Expression

The essence of the design does not include an intention to create a strong characteristic, such as “sporty” or “pretty.” Instead, the design focus remained squarely on integration with the owner’s taste. With this direction of designing, the design features of “high quality finishing,” “sturdiness,” and “functionality” were expressed as seen in the things, such as smartphones or bags that younger people use in their lives (Fig. 7).



Fig. 6 Concept sketch showing styling theme



Fig. 7 Design sketches of front quarter view and rear quarter view

Specifically, the body achieves an elaborately designed finish quality that constructed of plain surfaces and multi-faceted elements with the integrated lamps (Fig. 8). In addition, the metallic mole line that wraps around the entire body from the upper side of the body below the handles puts the focus on the body's sense of unity. This helps eliminate the overly delicate impression that is peculiar to the scooter silhouette, which tends to look as if the portions in front of and behind the step floor are separate entities (Fig. 9).

The meter has a tough-looking exterior and a simple structure. The easy-to-read dial face and all the necessary information are positioned to be functional (Fig. 10).

3.4. Coloring

Keeping in mind the tastes of the target user, the body colors that would agree with the sensitivities of younger people today were chosen.

Six color coordination patterns were created considering the feature of tough outer appearance, with a simple shaped body design and a wide-strip mole line, and high quality atmosphere. This set of color patterns made it possible to satisfy large range of customers' preference (Fig. 11).

(1) Matte dark green with silver mole line: a condensed unified appearance



Fig. 8 Rear combination lamp assembly



Fig. 9 Metallic mole line



Fig. 10 Gauge unit



Matt armored green metallic

Poseidon black metallic



Pearl jasmine white

Urbane denim blue metallic



Candy noble red

Matt galaxy black metallic



Fig. 11 Variations of color combinations

- (2) Metallic black with silver mole line: the simplest, superior quality image
- (3) Pearl white with smoke silver mole line: a natural, neutral image
- (4) Metallic blue with turquoise mole line: a refreshing combination of blue denim color with a more vibrant shade of blue
- (5) Candy red with smoke silver mole line: the combination of two low-chroma colors projects an aura of superior quality
- (6) Matte black with pink mole line: a sophisticated combination with a striking plain and solid style

As the section on the styling theme mentioned, the coloring used on this model is more than simple decoration.

By emphasizing the sense of unity of the entire body, the coloring inspires confidence and expresses an understated look of superior quality. The metallic mole line that runs throughout the body is a particularly important part of this model. The mole line expresses not only the toughness and sense of unity of the whole body, but is also intended to protect the body exterior from minor scratches. Therefore the image expected of a mole line was explicitly stated.

In the early stage of the process of consideration, we fixed the ways to express the toughness with accompanying a high quality atmosphere. One of them is to have the stripe in metal tone and another is to make its width broad enough to some extent. Midway through the development process, after a three-dimensional mole line made of molded resin had been considered, it was decided to use film instead. Because young people were the target, keeping the price affordable was important. The above design elements were intended to help offer both a functional exterior and a reasonable price.

However, in order to express the concept illustrated in the drawing using this film material, there exist various kinds of obstacles to be faced. It was necessary to use metal tone film capable of expressing superior quality, not the thin film that is ordinarily used and is so good at adhering closely to curving surfaces. Metal tone film draws the attention to the texture of the underlying paint and surface unevenness that results when foreign matter digs into the surface while applying the film. Therefore it was necessary to enhance the painting quality and consider the environment in which film is applied. It is also required to implement a technology to apply long film strips within a limited range of allowance. Furthermore, the relative positions of the films, which are separately affixed onto the individual parts, should create no discrepancies from mislocations when the assembly is completed into a whole vehicle.

It was required to solve all of those difficult issues at the same time while none of them had been experienced in the actual production site so far. When a metal film is applied, there is a tendency that dents and lumps on the surface significantly stand out if there is an irregularity on the paint surface of a part or there are some intrusions of dust particles. Therefore, it is strongly required to have

a special effort for improving the paint finish quality and for maintaining the clean environment for film affixing process. Next, a technique capable of stable positioning of the film was established and verified. Furthermore, the other issues were addressed one by one, including enhancing assembly precision of each component. By applying the aforementioned elements for the structural shape in styling together with the optimized combination of body colors and metal tone mole colors, the message of the realization of both “sturdiness” and “high quality” was effectively expressed for easy understanding of the users.

4. Body Packaging

The “man maximum, mechanism minimum” (MM) concept was incorporated as a prerequisite to consideration of the body packaging. The MM idea of creating more space for people and requiring less space for the machinery underlies all of Honda’s craftsmanship.

Following this perspective, the comfort and convenience in everyday use was pursued, taking the following two key targets for the body of the Dunk.

- (1) Lasting comfort for even long rides
- (2) The most under-seat storage capacity in the small motorcycle class

One way to achieve these would be to simply make the motorcycle larger. However, for the sake of pull-up handling on a daily basis, a wheelbase was chosen equivalent to that of the Today, a previous scooter in the small motorcycle class. Therefore, for this development, the key targets above were achieved by selecting an appropriate placement and form for each component, starting with the orientation of the engine installation. Table 2 presents a comparison of the major specifications.

4.1. Comfort

The heights from the floor surface to the seat and to the handle bar were designed large enough while ensuring the minimum required body sizes considering a good pull-up handling of the vehicle. Figure 12 shows the riding position triangle, which connects the hip point, grip point, and foot point. The solid line shows the riding triangle of the Dunk, while the dotted line shows that of the Today, the formerly designed model. The riding triangle of the Dunk affords a more relaxed position.

The Dunk also has a longer seat and floor, which gives greater sitting and leg position freedom. The seat has a thick layer of urethane so users can make long rides in comfort. The under-floor fuel tank is directly mounted to the frame, using no stays or other devices in between. This keeps the floor from having to be raised too high and adds to comfort.

4.2. Under-seat Storage

In the new packaging design, a large capacity storage space was created under the seat. A several measures were adopted as described below.

Table 2 Comparison of major specifications

Model name	Dunk	Crea SCOOPY	Today
Curb mass (kg)	81	79	79
Dimensions (mm) (Length × Width × Height)	1,675 × 700 × 1,040	1,695 × 625 × 1,000	1,695 × 630 × 1,030
Wheelbase (mm)	1,180	1,190	1,180
Seat height (mm)	730	710	695
Ground clearance (mm)	110	115	110
Fuel tank capacity (L)	4.5	4.8	4.6
Brake system Front/Rear	Disk (CBS) /Drum	Drum (CBS) /Drum	Drum (CBS) /Drum
Tire size (Front/Rear)	90/90-10 50J	90/90-10 50J	80/100-10 46J

First, the fuel tank was placed under the floor, whereas many models put it behind the seat. A double under-bone type frame was chosen to do this, but this is basically heavier than the ordinarily used mono under-bone type frame. For this development, the diameter and thickness of the pipes were optimized, resulting in a frame of about the same weight as mono under-bone type.

Next, The space for the compartment has been increased by shifting the lateral cross member tubing, which is supposed to be located behind the utility compartment, to the back end of the body. Figure 13 shows the configuration of frame, fuel tank, and utility box in the Dunk, while Fig. 14 shows the same for the Today.

The engine, which is located below the utility box and has a major impact on storage capacity, has an Alternative Current Generator (ACG) starter. As a result, the starter motor in the upper part of the crank case could be taken out. This helped to optimize the engine mounting angle and create space in the lower part of the utility box.

These innovations of the surrounding layout enlarged the utility-box storage capacity to 23 liters, big enough to hold both a full-face helmet and a raincoat. Because the opening

of the utility box is so large, the box can hold an A4-size file folder, such as schools are increasingly distributing in recent years, without folding (Fig. 15).

In addition, the seat, which functions as the lid of the utility box as well, was designed to have enough length to

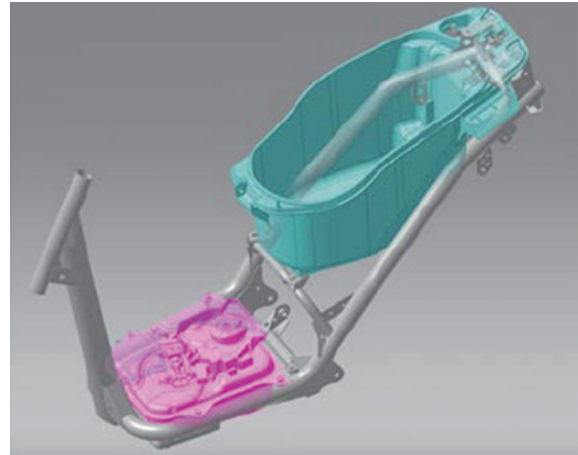


Fig. 13 Developed double under-bone type body frame

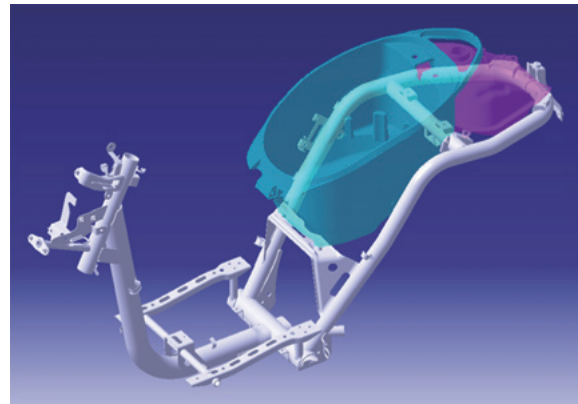


Fig. 14 Mono under-bone type body frame applied to Today

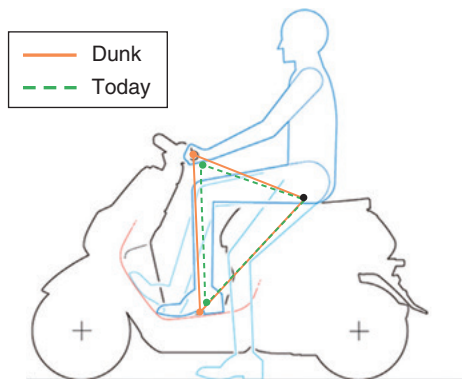


Fig. 12 Riding position



Fig. 15 Utility space

support a sports bag toted on the shoulder. This enhances both an undistorted styling and its practicality (Fig. 16).

4.3. Specifications and Equipment

For the convenience of senior high school students commuting to and from school, the Dunk comes with equipment not previously available on a small motorcycle class scooter. Smartphones have become a necessity for younger people, so an accessory socket that can recharge a smartphone is located in the glove box (Fig. 17). A digital liquid crystal clock was also added to the speedometer. The front inner bin is large enough to hold a 500 ml drink in a paper carton (Fig. 18).



Fig. 16 Seat length sufficient to support sports bag



Fig. 17 Charging socket for smartphones equipped in glove box



Fig. 18 A 500 ml drink packed in a regular paper carton can be stored in front inner bin

Other equipment provided for practicality and functions are a front disc brake with Combined Brake System (CBS), along with aluminum die-cast wheels (Fig. 19).



Fig. 19 Front disc brake with CBS and aluminum die-cast wheel

5. Development of 50 cc Scooter Engine eSP

Based on our development concept, the engine development target was defined as a lightweight and compact engine with a sufficient power compatible to a mixed traffic in urban areas with an excellent economy.

Honda developed the “eSP”⁽⁶⁾ series of next-generation small scooter engines, which have previously been produced for 125 cc and 150 cc scooters like the PCX. For the Dunk, new 50 cm³ engine was developed as a youngest brother of “eSP” series (Fig. 20). It was the first new development of a 50 cm³ water-cooled engine for scooters since the 2001 Crea SCOOPY.

Because the currently mass-produced model Today has an air-cooled engine, this section will mainly discuss the developed engine in comparison to the engine for the Crea SCOOPY (2007 model), which has a water-cooled system like the Dunk. Table 3 shows the major specifications of these three engines.

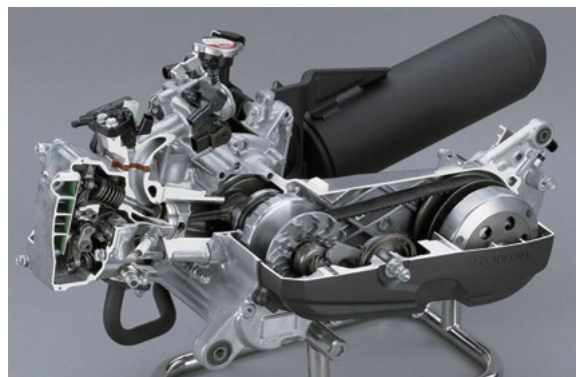


Fig. 20 Developed engine eSP

Table 3 Comparison of engine specifications

Model name	Dunk	Crea SCOOPY	Today
Displacement (cm ³)	49	49	49
Cooling system	Partial water cooled	Water cooled	Air cooled
Bore × stroke (mm)	39.5 × 40.2	37.8 × 44.0	37.8 × 44.0
Compression ratio	12.0	12.0	10.1
Cylinder offset (mm)	5.5	0	0
In. Valve diameter (mm)	21	20	20
Ex. Valve diameter (mm)	15.5	16.0	16.0
Rocker arm type	Roller	Slipper	Slipper
Decompression system	Equipped	Not equipped	Not equipped
PCV system	Not equipped	Equipped	Not equipped
Maximum power (kW/rpm)	3.3/8,000	3.2/8,000	2.8/8,250
Standing start acceleration performance : 0-200 m (sec)	16.0	16.7	17.3
Fuel consumption (class) : WMTc mode (km/L)	56.6 (class 1)	-	51.2 (class 1)
Engine mass (kg)	19.3	20.4	21.6

5.1. Enhancing Power Performance

In this engine, when Continuously Variable Transmission (CVT) ratio changes in the acceleration state with a full open throttle, the engine speed ranges from 7,000 to 7,500 rpm. The output on the crankshaft in this range was improved by 6 to 9% compared to the conventional water-cooled engines (Fig. 21).

The output on the axle of rear wheel was also enhanced over that of the former models by raising the engine speed of 500 rpm when changing speed ratio. The standing start acceleration performance from 0 to 200 meters has been enhanced by 0.7 seconds compared to the Crea SCOOPY and 1.3 seconds compared to the Today. The passing acceleration performance from 20 km/h has been enhanced by 0.5 seconds compared to the Crea SCOOPY and 1.3 seconds compared to the Today (Fig. 22). The techniques applied to enhance output are discussed as follows.

5.1.1. Enhancing charging efficiency

The bore and stroke of 37.8 mm × 44 mm of the existing engine was changed to 39.5 mm × 40.2 mm. The larger bore diameter enabled the enlargement of the intake valve diameter from 20 mm to 21 mm.

In addition, the angle between the inlet valve axis and the cylinder axis was made reduced by enlarging the inlet port curvature by about 15% (Fig. 23). These modifications expanded the effective intake valve opening area by 18% (Fig. 24) to enhance charging efficiency by as much as 20% (Fig. 25). Combining these modifications with a cylinder

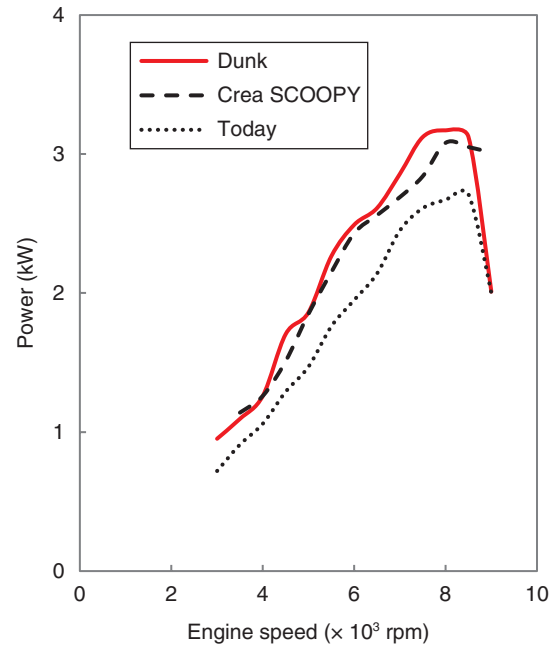


Fig. 21 Engine performance

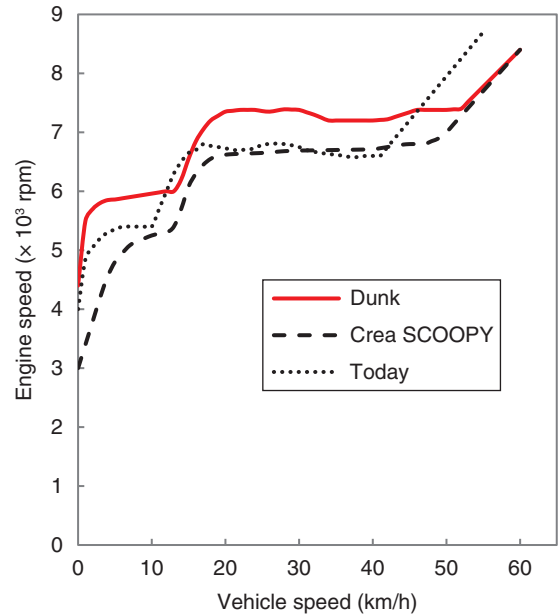


Fig. 22 Speed diagram

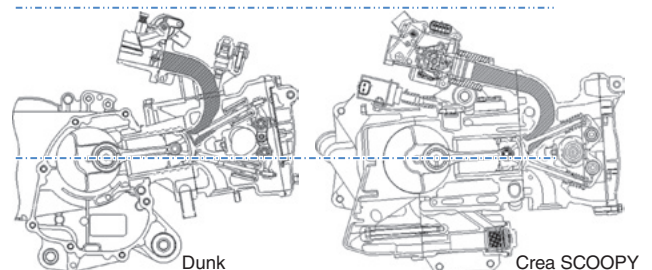


Fig. 23 Inlet port form

that is offset downwards by 5.5 mm (described later) enabled keeping the throttle body at about the same height as the former water-cooled engine.

5.1.2. Reducing friction loss

Typical examples to reduce friction loss were shown as follows. The percentages of friction loss reduction indicated hereafter are the values at 8000 rpm, which is the engine speed at the maximum output.

- (1) The increase of intake valve diameter (from 20 mm to 21 mm) described above reduced pumping loss by 23%.
- (2) The larger bore diameter made it easier to provide clearance between the connecting rod and cylinder skirt, so a cylinder offset of 5.5 mm was chosen (Fig. 26), reducing reciprocating motion loss by 10%.
- (3) The rocker arm uses the small roller (exterior diameter $\phi 13$) used in the 2014 PCX, reducing cam drive loss by 54%.

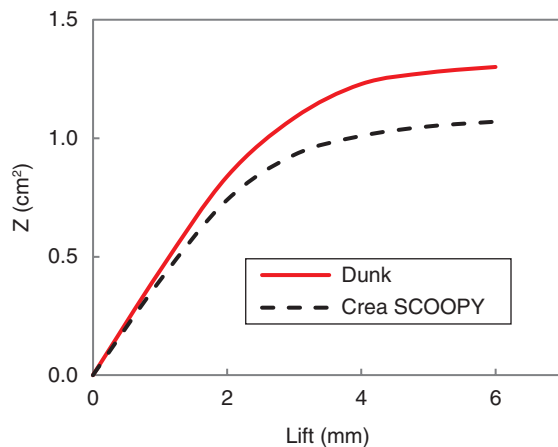


Fig. 24 Effective intake valve opening area

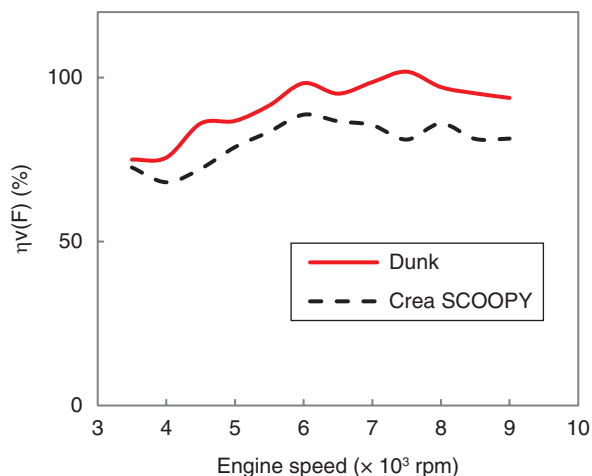


Fig. 25 Charging efficiency

- (4) The engine uses a “partial-water-cooled configuration”: only the cylinder head is water-cooled, while the cylinder itself is air-cooled. Compared to an ordinary water-cooled engine, this lowers the temperature of the cooling water at the radiator inlet and allows a smaller radiator cooling fan. With the fan now 4 mm lower, friction on the fan itself was reduced by 53% (Fig. 27).

5.2. Reducing Cost

Controlling manufacturing costs is also important to achieve outstanding economy. The adoption of partial-water-cooling helped control cost increases.

5.2.1. Eliminating the PCV system

Temperature goes up slower at the cylinder wall in a water-cooled engine after a cold start than that in an air-cooled engine. Therefore, if the motorcycle travels short distances repeatedly, water and some part of a constituent of gasoline may remain in liquid status and stay within

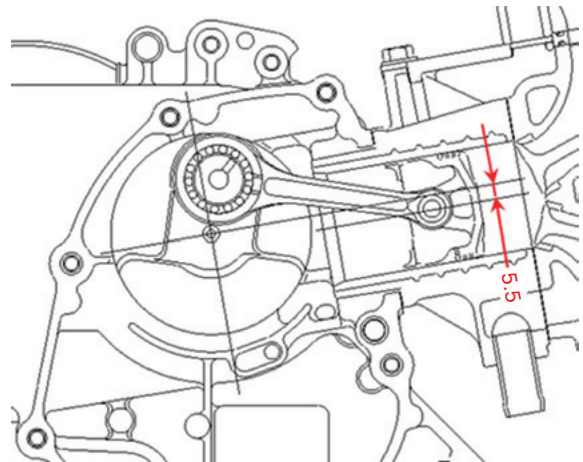


Fig. 26 Cylinder offset

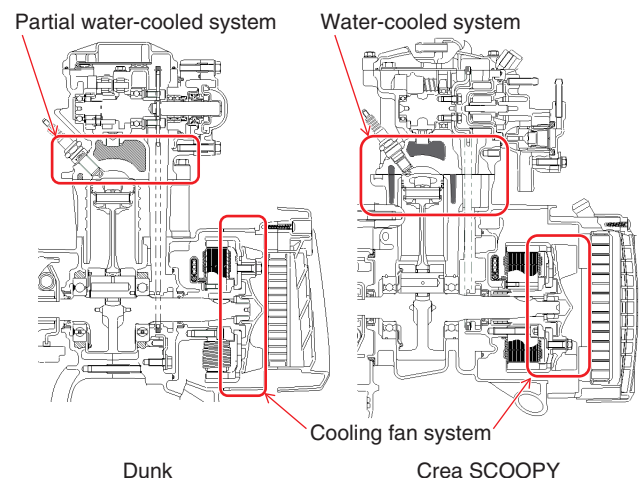


Fig. 27 Comparison of cooling system

the engine oil. Thus, former water-cooled engines for small scooter used a positive crankcase ventilation (PCV) system⁽⁷⁾. This helped decrease deterioration of the engine oil and thus the need to change it more frequently. In the case of the Dunk, a partial-water-cooled engine was chosen with the intent to ensure that the cylinder walls heated up as quickly as those in an air-cooled engine (Fig. 27). Figure 28 shows changes in cylinder wall surface temperature after the engine start. The developed partial-water-cooled engine achieved the warming-up characteristics compatible to air-cooled engines and made it possible to eliminate the PCV system.

5.2.2. A common cylinder clamping bolt pitch

In the partial-water-cooled engine, since the cylinder does not have a water jacket, the cylinder clamping bolt pitch was able to be reduced by about 6 mm as compared to a conventional water-cooled engine. This facilitated using the same dimensions as a 50 cm³ and 110 cm³ air-cooled engine, as Fig. 29 shows. This has enabled the usage of the same machining equipment that it already has in place for air-cooled engines at its production facilities outside Japan.

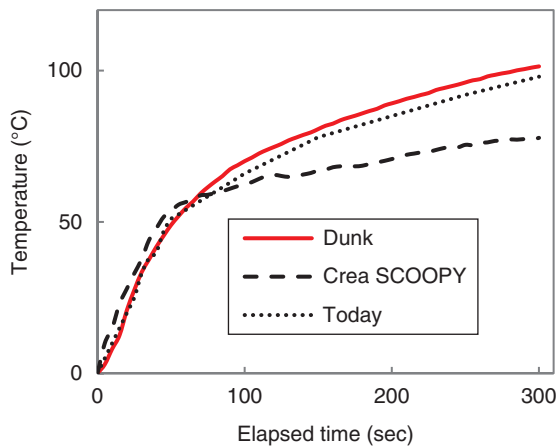


Fig. 28 Cylinder wall surface temperature

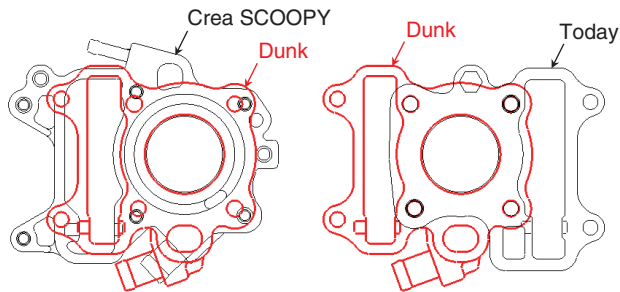


Fig. 29 Comparison of cylinder clamping bolt pitch

5.2.3. Vertical split of crankcases

Until now, 50 cm³ scooter water-cooled engines manufactured in Japan have had a separate swing arm construction to facilitate modular assembly, and their crankcases have had a horizontal split. However, the crankcases of scooter engines currently manufactured outside Japan have a vertical split with a swing arm that is integrated into the left side. The developed engine also uses a crankcase with a vertical split so that it can be machined and assembled with equipment available at production bases outside Japan.

5.3. Lighter and More Compact

With the adoption of an ACG starter, a centrifugal clockwise decompression device was equipped for the first time in 50 cm³ engine. This helped reduce cranking torque when starting the engine, lowering the ACG starter torque by 15% (Fig. 30). In addition, the increased external diameter of the ACG starter made it possible to reduce its width by 24% (Fig. 31) and thus 15% lighter. The width from the cylinder center to the exterior of the radiator

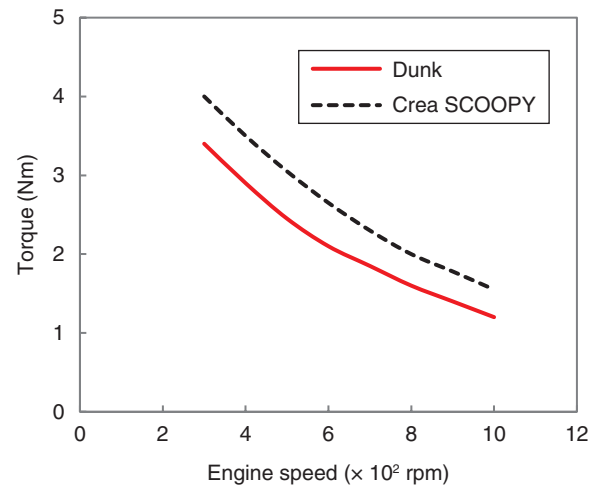


Fig. 30 ACG starter torque characteristics

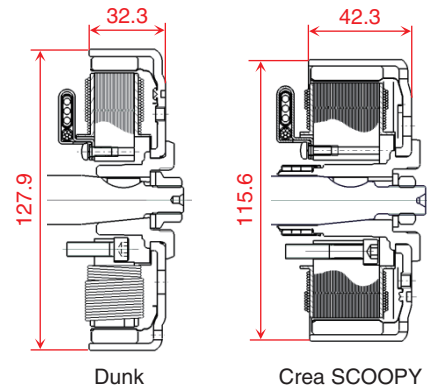


Fig. 31 ACG starter comparison of size

was shortened 14 mm with the lowering the height of the cooling fan as described previously.

Also, the adoption of vertical sprit of crankcases and the integration of swing arm to the left side of the crankcase enabled a weight savings of about 0.75 kg.

Consequently, these changes make it possible 1.1 kg in weight savings compared to the former water-cooled engine.

6. Conclusion

Honda developed the new 50 cc scooter Dunk targeting younger people in order to revitalize the market for small motorcycles.

It was built with styling integrated with the rider, the new engine eSP, and packaging based on the “MM concept.” The result is a simple style with both a sense of easiness and superior quality, plenty of equipment for enriching the “daily lives” of younger people, and comfort that decreases fatigue even after 30 minutes of school commuting.

We hope that many younger people will use the model and that it will help revitalize the small motorcycle market when more people appreciate its styling and convenience.

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