
PASSENGER VEHICLES

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1 Introduction

In 2020, COVID-19 spread throughout the world. In the absence of effective treatment, various countries established lockdowns or restrictions on activities, especially in cities, to limit contact between people as a measure against the spread of the disease. As a result, many corporations saw their economic activities become severely curtailed, and there was a tremendous drop in the movement of people across national borders. In Japan as well, the declaration of a state of emergency and shortened hours for restaurants were followed up with measures to restrict the movement of people inside and outside the country. Nevertheless, parallel measures aimed at simultaneously sustaining economic activity resulted in an increase in the number of cases of infection at the end of the year. There was no end to the pandemic in sight in Japan or the rest of the world as of the end of 2020.

The global automotive market was also affected as the strong restrictions imposed on the movement of people led to scaling down or canceling automobile-related events. Sales ground to a halt as production was affected for both automobile manufacturers and suppliers, causing both unit sales and production volume to drop significantly compared to 2019.

Various countries have announced restrictions or bans on vehicles with internal combustion engines as part of environmental measures. In that respect, the UK announced it would move its ban on such vehicles, including hybrid vehicles, up to 2035, while China announced that new vehicle sales would consist only of environmentally friendly vehicles (including hybrid vehicles) starting in 2035. Similarly, in Japan, the government announcement of achieving net zero greenhouse gas emissions by 2050 was followed by the announcement of a policy to promote vehicle electrification. However, the tight supply of electricity during the winter indicates the need to reinvent our overly electricity-dependent lifestyle and to

institute a fundamental reform of energy policy that encompasses the supply of electricity.

Safety was addressed with the continued introduction of vehicles equipped with active safety and driver support systems on the market in 2020. In Japan, a limited time Safety Support Car incentive program aimed at encouraging the purchase of vehicles equipped with specific active safety systems was introduced as part of measures to prevent traffic accidents involving elderly drivers.

2 State of Vehicle Production, Sales, and Exports

2.1. State of Production in Leading Manufacturing Countries

The number of passenger cars produced worldwide in 2020 was 64.37 million vehicles, a decrease of 13.56 million vehicles (82.6%) compared to 2019 (Table 1). Restrictions on economic activity due to measures to stem the spread of the COVID-19 pandemic in combination with social confusion, and the difficulty of securing production plant staff for both automobile manufacturers and suppliers were among the factors leading to that major decline.

In European countries, large-scale lockdowns had a severe impact on both sales and production, with the latter exhibiting a significant plunge of 74.2% compared to 2019. A similar slowdown was observed in both India, where the virus continues to spread and there are ongoing social disturbances in reaction to imposed restrictions, and Brazil, where, measures prioritizing economic activity resulted in a rapid increase in cases of infection. Production in those countries fell to 78.7% and 65.7% of 2019 levels, respectively. China succeeded in containing the infection early, achieving a balance between preventing the spread of the disease and promoting economic activity that resulted in a relatively minor impact, with a production of 93.5% compared to 2019. In the U.S., some regions saw large increases in the number of infections,

Table 1 Passenger Car Production in Leading Manufacturing Countries

	2019	2020	Compared to previous year (%)
Japan	8,328,756	6,960,411	83.6
U.S.	10,522,753	8,562,004	81.4
Canada	1,898,546	1,361,904	71.7
Europe	15,351,566	11,389,374	74.2
Germany	4,728,116	3,509,500	74.2
UK	1,303,135	920,649	70.6
France	1,473,339	866,398	58.8
Italy	587,366	475,623	81.0
Spain	2,467,527	1,838,474	74.5
Russia	1,523,594	1,260,517	82.7
South Korea	3,612,587	3,174,728	87.9
China	20,958,175	19,598,869	93.5
India	3,623,167	2,849,841	78.7
Brazil	2,449,347	1,609,294	65.7
World total	77,932,993	64,369,198	82.6

Note 1: The production unit numbers from Japan were obtained from Japan Automobile Manufacturers Association data.

Note 2: Numbers for other countries were obtained from the applicable collated MarkLines data.

Note 3: The values for Europe are the total for the EU automobile producing nations (15 countries) and the U.K.

EU automobile producing nations (15 countries) and the U.K.: Germany, the U.K., France, Spain, Italy, Portugal, Belgium, the Netherlands, Austria, Sweden, Finland, the Czech Republic, Slovakia, Hungary, Romania, and Slovenia.

Note 4: The totals include the SUVs, MPVs and other light-duty trucks treated as passenger vehicles in the U.S. and Canada.

Note 5: Including the SUVs and MPVs treated as passenger vehicles in South Korea, China, and India.

Note 6: The global total consists of the sum of available collated data for all countries, including the major countries above.

Table 2 Passenger Car Production in Japan

	2019	2020	Compared to previous year (%)
Passenger vehicles	5,317,165	4,192,767	78.9
Light-duty trucks	1,538,380	1,409,994	91.7
4-wheeled mini-vehicles	1,473,211	1,357,650	92.2
Total	8,328,756	6,960,411	83.6

Source: Japan Automobile Manufacturers Association (JAMA)

Note: The classification criteria of the sales statistics are based on the license plate number.

and even regions relatively successful at containing the spread, suffered a non-trivial economic fallout as the chaotic state of affairs stemming from measures to prevent the spread of the pandemic continued, and production fell to 81.4% of 2019 levels. These statistics take regional particularities into account and count SUVs and other light-duty trucks as passenger vehicles.

2.2. State of Japanese Vehicle Production, Exports, and Sales

(1) Production

Passenger car production in Japan was 6.96 million ve-

Table 3 Number of Passenger Cars Exported from Japan According to Destination

	2019	2020	Compared to previous year (%)
North America	1,881,825	1,517,169	80.6
Europe	965,115	663,785	68.8
Oceania	339,948	320,707	94.3
Asia	514,962	469,419	91.2
Middle-East	390,155	263,710	67.6
Central America	138,552	102,048	73.7
South America	87,535	38,194	43.6
Africa	52,140	30,582	58.7
Others	2,413	2,385	98.8
Total	4,372,645	3,407,999	77.9

Source: Japan Automobile Manufacturers Association (JAMA)

Table 4 Passenger Car Sales in Japan

	2019	2020	Compared to previous year (%)
Ordinary trucks	1,586,342	1,356,163	85.5
Light-duty trucks	1,235,544	1,122,669	90.9
4-wheeled mini-vehicles	1,479,205	1,331,149	90.0
Total	4,301,091	3,809,981	88.6

Sources: Japan Automobile Dealers Association (JADA) for ordinary and light-duty vehicles, and Japan Light Motor Vehicle and Motorcycle Association for four-wheeled mini-vehicles.

Note: The classification criteria of the sales statistics are based on the license plate number and exclude imported vehicles.

hicles, or 83.6% of the 2019 production (Table 2). As part of measures to prevent the spread of COVID-19, the state of emergency declared in the Tokyo metropolitan area, Osaka area, and Fukuoka on April 7 was extended to the entire country, restricting the movement of people. At the same time, production was reduced due to stoppages in production and measures to prevent worker infection at automobile manufacturing plants. Although production resumed with infection prevention measures in place after the state of emergency was lifted, supply delays and other issues caused by the impact of the pandemic both in and outside Japan kept the number of units produced, domestic sales, and the number of exports down.

(2) Exports

The number of exported passenger vehicles in 2020 was 3.41 million vehicles, representing 77.9% of the 2019 figure (Table 3). The slowdown in economic activity caused by the global spread of COVID-19 caused sales to stagnate and reduced the number of vehicle exports. In particular, exports fell to 68.8% compared to 2019 in Europe and to 43.6% in South America as COVID-19 continues to spread. In the Middle-East, stagnant oil prices and a drastic drop in tourism brought exports down to 67.6%, while in the U.S. where economic activity was main-

tained amid the spread of COVID-19, they leveled off at 80.6% compared to 2019. In contrast, the drop in exports in Asia and Oceania, where the pandemic has been contained, was limited to 91.2% and 94.3% of 2019 levels, respectively.

(3) Sales

Sales of passenger vehicles in Japan were 3.81 million units, or 88.6% compared to 2019 (Table 4). That figure reflects the impact of the slowdown in sales resulting from the state of emergency declared as a measure against the spread of the pandemic. However, demand picked up slightly after the state of emergency was lifted thanks to automakers offering revamped and new models with extensive active safety systems eligible for the Safety Support Car incentive, as well as the ability of au-

Table 5 Used Vehicle Sales in Japan

	Ordinary trucks	Light-duty trucks	4-wheeled mini-vehicles	Total	Compared to previous year (%)
2011	1,542,614	1,733,519	1,906,523	5,182,656	98.1
2012	1,688,606	1,826,335	2,133,725	5,648,666	109.0
2013	1,666,732	1,740,725	2,255,560	5,663,017	100.3
2014	1,630,421	1,653,214	2,367,235	5,650,870	99.8
2015	1,668,429	1,602,719	2,354,077	5,625,225	99.5
2016	1,729,194	1,564,982	2,322,533	5,616,709	99.8
2017	1,802,956	1,588,747	2,414,874	5,806,577	103.4
2018	1,834,306	1,523,537	2,449,940	5,807,783	100.0
2019	1,885,765	1,485,339	2,504,576	5,875,680	101.2
2020	1,898,616	1,443,889	2,394,963	5,737,468	97.6

Sources: Japan Automobile Dealers Association (JADA) for ordinary and light-duty vehicles, and Japan Light Motor Vehicle and Motorcycle Association for four-wheeled mini-vehicles.

tomobiles to offer an individual space compared to public transportation systems that involve contact with many other people.

(4) Used Vehicle Sales

Sales of used vehicles in Japan were 5.74 million units, representing 97.6% of the 2019 figure (Table 5). The de-

Table 6 Imported Vehicle Sales in Japan

2020 Ranking	2021 Ranking	Brand	2020 (Units)	2020 (Units)	Compared to previous year (%)
1	1	Mercedes-Benz	56,999	66,523	85.7
2	3	VW	36,574	46,791	78.2
3	2	BMW	35,712	46,814	76.3
4	9	Nissan (vehicles produced outside Japan)	24,147	9,374	257.6
5	4	Audi	22,304	24,222	92.1
6	—	Toyota (vehicles produced outside Japan)	21,257	21,931	283.9
7	5	BMW Mini	20,196	23,813	84.8
8	6	Volvo	15,547	18,583	83.7
9	7	Jeep	13,562	13,354	101.6
10	8	Peugeot	10,752	10,626	101.2
11	10	Honda (vehicles produced outside Japan)	10,026	9,181	109.2
12	11	Porsche	7,284	7,192	101.3
13	12	Renault	5,963	6,803	87.7
14	13	Fiat	5,889	5,987	98.4
15	16	Citroën	5,028	4,113	122.2
16	15	Land Rover	3,945	4,549	86.7
17	14	Suzuki (vehicles produced outside Japan)	3,235	4,744	68.2
18	19	Abarth	2,571	2,628	97.8
19	18	Mitsubishi (vehicles produced outside Japan)	2,216	3,182	69.6
20	20	Alfa Romeo	1,674	2,370	70.6
21	17	Jaguar	1,423	3,259	43.7
		Total for non-Japanese manufacturers	254,404	298,378	85.3
		Total of vehicles produced outside Japan	61,767	48,878	153.9
		Total	316,171	347,256	91.1

Source: Statistics of the Japan Automobile Importers Association (JAIA). The total includes ranks 21 and below.

Table 7 Passenger Car Sales in Leading Manufacturing Countries and share of Japanese Vehicles

	2020			2019			Compared to previous year	
	No. of units sold	Japanese vehicles	Share of Japanese vehicles	No. of units sold	Japanese vehicles	Share of Japanese vehicles	No. of units sold	Japanese vehicles
Japan	3,809,981	3,553,730	93.3%	4,301,091	4,001,573	93.0%	88.6%	88.8%
U.S.	14,658,625	5,337,351	36.4%	17,049,080	6,436,915	37.8%	86.0%	82.9%
Canada	1,541,476	546,113	35.4%	1,920,548	710,157	37.0%	80.3%	76.9%
Brazil	1,597,229	249,484	15.6%	2,240,068	406,025	18.1%	71.3%	61.4%
China	20,071,308	4,985,755	24.8%	22,156,453	5,114,273	23.1%	90.6%	97.5%
India	2,434,350	1,370,517	56.3%	2,969,155	1,772,499	59.7%	82.0%	77.3%
Total for Europe	11,884,882	1,494,107	12.6%	15,733,155	1,991,027	12.7%	75.5%	75.0%
UK	1,631,064	263,810	16.2%	2,311,140	360,190	15.6%	70.6%	73.2%
Germany	2,917,678	244,290	8.4%	3,607,258	313,610	8.7%	80.9%	77.9%
France	1,657,324	168,073	10.1%	2,221,380	210,698	9.5%	74.6%	79.8%
Italy	1,381,496	161,158	11.7%	1,917,619	211,769	11.0%	72.0%	76.1%

Note 1: The Japanese sales figures are collated from figures obtained from the Japan Automobile Dealers Association (JADA) for ordinary and light-duty vehicles, from the Japan Light Motor Vehicle and Motorcycle Association for four-wheeled mini-vehicles, and from the Japan Automobile Importers Association for imported vehicles. Imported Japanese brand vehicles are counted as Japanese vehicles.

Note 2: Numbers for other countries were obtained from the applicable collated MarkLines data. The proportion of Japanese vehicles was collated by picking up Japanese brand vehicles in each country.

Note 3: The totals include the SUVs, MPVs and other light-duty trucks treated as passenger vehicles in the U.S. and Canada.

Note 4: Europe includes the 27 EU nations, the three EFTA nations (Iceland, Norway, and Switzerland), and the U.K. Of those, figures for Cyprus, Latvia, Lithuania, Iceland, and Malta have not been included as no data is available. Incidentally, the ACEA provides the following figures. Cyprus: 10,061 units in 2020/12,220 units in 2019. Latvia: 13,864 units in 2020/18,692 units in 2019. Lithuania: 40,232 units in 2020/46,200 units in 2019. Iceland: 9,369 units in 2020, 11,723 units in 2019. Malta: no data. The ACEA data also does not include figures for the number of Japanese vehicles sold.

cline was minor compared to that in production and new passenger vehicle sales figures, making it clear that there is a strong need for used vehicles, which have a lower purchase price point. Ordinary passenger cars have been making up a larger proportion of new vehicle sales, the used vehicle market exhibited a similar higher proportion of ordinary passenger car sales.

(5) Imported Vehicle Sales

The number of vehicles imported in Japan was 317,000, or 91.1% of 2019 levels (Table 6). The restrictions on movement imposed as part of measures to prevent the spread of COVID-19 resulted in a major drop in sales of vehicles by non-Japanese manufacturers, to 85.3% compared to 2019. In contrast, sales of vehicles manufactured outside Japan by Japanese manufacturers rose impressively to 153.9% of the 2019 figure. Broken down by manufacturer, sales of the top five brands of the previous year declined, while Nissan (vehicles produced outside Japan) rose to fourth place as its sales increased to 257.6% of 2019 levels. Among mid-rank brands, some manufacturers succeeded in maintaining robust sales exceeding 100% of their 2019 figures.

2. 3. Vehicle Sales in Markets outside Japan

Table 7 shows passenger car sales in leading manufacturing countries along with the share of Japanese vehicles. Sales slowed down on a worldwide scale due to the global spread of the COVID-19 pandemic. In China, which relaunched economic activity, reached 91% of the 2019 figure, while Japan, the U.S. and India, where economic activity was maintained despite government intentions, figures reached 80-some percent of the previous year's total. In Europe, where strict restrictions were imposed, and in Brazil where the pandemic led to social disturbance, sales dropped to the 70% range, except in Germany, which managed to contain the number of infections to some extent and obtained figures of over 80% compared to 2019. Sales of Japanese vehicles also declined overall, with variations in the level of impact. Market share fell in North America, India, and Brazil, but remained at the same level in other regions, and even rose in some countries. The difference in the market share of Japanese vehicles between regions is attributed to the effects of restrictions on economic activity.

3 Product Technology Trends

Table 8 presents, in chronological order, the revamped, partially redesigned, fully redesigned, and new models of

ordinary, light-duty and mini-vehicles that feature major technological refinements and were introduced by Japanese manufacturers in the domestic market in 2020.

In 2020, restrictions imposed to contain the spread of COVID-19, along with the attendant limitations on the sales activities of each automaker, sharply decreased the number of revamped, partially redesigned, fully redesigned, and new vehicles introduced on the market before and after the state of emergency.

The start of the limited time Safety Support Car incentive program aimed at encouraging the purchase of vehicles equipped with specific active safety systems introduced as part of measures to prevent traffic accidents involving elderly drivers spurred the introduction of new and revamped models, including mini-vehicles, equipped with compliant active safety systems.

3. 1. Environmental Performance

As European countries moved their global CO₂ emissions reduction targets forward, the Japanese government announced it would achieve net zero greenhouse gas emissions by 2050. The electrification of vehicles is expected to accelerate as a result.

The slowdown in economic activity caused by the pandemic caused the price of crude oil to plunge from around 65 dollars per barrel at the beginning of the year to the 30 dollar range as demand fell. The subsequent resumption of economic activity and regulation of production gradually brought that price back up to near 50 dollars by the end of the year. Similarly, the lower crude oil price, along with the decrease in demand due to people staying home, caused gasoline prices to drop from 140 yen per liter at the beginning of the year to the 110 yen per liter range. The rise in the price crude oil and the recovery of economic activity later brought gasoline prices back up to the 140 yen range.

With respect to environmental and fuel efficiency technologies, the transition from internal combustion engines to electricity espoused in the policies of various governments in Europe has led European manufacturers to step up the introduction of electric vehicles in the market. At the same time, the Japanese market has seen an infusion of models with improved environmental performance functionality, including dedicated (Honda e, C+ pod) vehicles capitalizing on the distinct characteristics of electric vehicles and a fully redesigned fuel cell vehicle (the Mirai) offering not only superior performance, but also enhanced passenger car convenience, in addition to models

Table 8 Main Ordinary and Light-Duty Automobiles Technology Trends and Market Launches in Japan in 2020

Date of launch	Vehicle model	Brand	Purpose	Technological aspect	Main technologies
January 7	Sienta	Toyota	Special specifications vehicle	Safety	Special features include intelligent clearance sonar (parking support brake (stationary object)) to reduce collision damage caused by accelerator or brake pedal misapplication or by applying too much force to the accelerator, as well as the Navi Ready package with panoramic view to help check whether difficult-to-see surroundings are safe.
January 9	NV200 Vanette	Nissan	Refinement	Safety	The Intelligent Emergency Braking (collision mitigation braking system), which reduces damage from collisions and helps avoid rear-end collisions, improves nighttime functionality by complementing the front camera with a front radar featuring high detection capability at night. Advanced safety technologies such as High Beam Assist and a lane departure warning (LDW) system have been adopted. The Traffic Sign Recognition (no entry, speed limit, and stop signs) system, which alerts the driver with visual and audio warnings when it detects no entry signs ahead and with visual warnings on the display with when it detects a speed limit or stop sign, has been installed.
January 16	CX-30	Mazda	Additional model	Environment	This model is equipped with the next-generation SKYACTIV-X gasoline engine featuring the world's first commercial application of compression ignition in a gasoline engine through spark controlled compression ignition (SPCCI) combustion control technology. The use of the M Hybrid mild hybrid system realizes smooth and pleasant driving and efficient fuel consumption.
January 16	X-Trail	Nissan	Refinement	Safety	The Intelligent Emergency Braking system, which monitors conditions ahead of the vehicle and helps avoid collisions with vehicles and pedestrians, or mitigates damage in the event of a collision, has been equipped with a millimeter wave radar. In addition, the nighttime performance of the ProPilot driver support technology has been improved. The Intelligent Forward Collision Warning (FCW) system, which detects vehicles two cars ahead and warns the driver if taking evasive action is necessary due to sudden deceleration or other factors, has been made standard equipment on all models.
January 23	Flair	Mazda	Refinement	Safety	Safety when driving, and backing up in particular, has been enhanced by the addition of brake support in reverse, a false start prevention function (reverse), and a rear parking sensor.
January 29	Flair Cross-over	Mazda	Complete redesign		In terms of design, the exterior maintains its unique character and evolves into a tough and powerful style that expresses strength and robustness. Inside the cabin, the extended wheelbase compared to the previous generation and the minimized engine compartment provide more space between occupants in the left and right front seats, and more legroom for those in the rear seat, creating a more comfortable interior and improving user-friendliness with varied storage options. The adaptive cruise control with all-speed tracking and a lane departure control active safety features were made available. Driving performance enhancements are achieved by the newly developed naturally aspirated gasoline engine and CVT, which provide both excellent fuel economy and nimble driving, while the newly designed body structure improves ride comfort and handling stability and controllability. The 4 WD model adds a snow mode that optimizes engine torque and controls the brakes to support safe and secure driving on slippery road surfaces.
February 13	Fit	Honda	Complete redesign		The cross-sectional structure of the vehicle body was modified to ensure ample collision safety performance while halving the thickness of the front pillars. At the same time, the straight line theme horizontal instrument panel combines with the visorless, easy-to-read meter to offer a comfortable field of view that provides a sense of security. The front seats are equipped with body-stabilizing seats that use a resin mat to support the pelvis and lumbar spine, and the rear seats are equipped with thick, soft pads to provide comfortable seating that diminishes fatigue. The powertrain is equipped with the e:HEV two-motor hybrid system, which delivers powerful acceleration and smooth driving. The vehicle balances fuel efficiency and driving pleasure through a lightweight, high-rigidity, high-strength body and a suspension with improved road-following performance that offer greater ride comfort. The spacious interior and diverse seat arrangements have been carried over from the previous model, while the intelligent power unit (IPU) has been downsized to secure more cargo space. The easier to use storage layout enhances convenience and user-friendliness. The Honda Sensing, driving safety support system has been made standard equipment. Along with eight sonar sensors installed at the front and rear of the vehicle, the vehicle has been equipped with a front wide-view camera with a broad angle of detection to the front of the vehicle. Those eight functions are complemented with a rear false start prevention function, automatic high beams, and short-range collision mitigation brakes.
February 13	Mazda3	Mazda	Additional model	Driving performance	A model with the i-ACTIV AWD four-wheel drive system has been added to the lineup of models equipped with the SKYACTIV-G 2.0 gasoline engine. The i-ACTIV AWD system interprets tire motion and sensor or other information to detect the driving conditions of the vehicle and uses coordinated control with G-Vectoring Control (GVC) technology to optimize torque distribution to the front and rear wheels, realize smooth and stable driving, and achieve both ease of turning and stability.

Table 8 Main Ordinary and Light-Duty Automobiles Technology Trends and Market Launches in Japan in 2020 (cont.)

Date of launch	Vehicle model	Brand	Purpose	Technological aspect	Main technologies
February 20	Accord	Honda	Complete redesign		<p>A next-generation platform lightweight, high-rigidity next-generation platform with a low center of gravity and low moment of inertia has been developed, enabling nimble driving with little change in behavior and improved stability. An adaptive damper system that controls damping force independently in each wheel, offers high levels of both handling performance and ride comfort.</p> <p>A roomier occupant interior space was provided by modifying the body frame and lengthening the wheelbase, and the luggage compartment was made larger by relocating the intelligent power unit (IPU) under the rear seats.</p> <p>In addition to the next-generation platform with a superior all-direction energy-absorbing and dispersing structure, and the Honda Sensing driving safety support system, a rear false start prevention function and automatic high beams were also made standard equipment to achieve high levels of passive and active safety performance.</p>
February 24	Landy	Suzuki	Refinement	Safety	The adoption of Blind Spot Intervention (BSI), Blind Spot Warning (BSW), Lane Intervention (LI), and Rear Cross Traffic Alert (RCTA) provides a full suite of safety systems.
February 25	Roox	Nissan	New model		<p>This super high mini-vehicle van was planned and developed by Nissan based on project management by NMKV, the joint venture between Nissan and Mitsubishi.</p> <p>Built on the Dayz platform, its wide interior allows four adults to sit comfortably. It also offers hands-free automatic sliding doors, which open or close automatically when the driver places one foot under the vehicle body, on both sides. The rear seats have a higher hip point than the front seats to provide a wider field of view.</p> <p>The BR06 engine settings were optimized, and engine noise was made quieter through higher rigidity. A quiet interior space was achieved through the effective placement of sound-absorbing material.</p> <p>The addition of a millimeter wave radar to the ProPilot driver assistance technology improves detection at night and for distant vehicles ahead, and the nighttime performance of the Intelligent Emergency Brake system was enhanced. Other installed systems include the Intelligent Forward Collision Warning (FCW) system that detects vehicles two cars ahead and warns the driver upon determining that the vehicle must take evasive action, an adaptive LED headlight system that capable of maintaining the high beams even if there is an oncoming vehicle, the Traffic Sign Recognition system that detects no entry, speed limit, and stop signs in front of the vehicle, Intelligent Driving Alert (DA, consisting of swerving information), and the preceding vehicle starting alert. The SRS knee airbag system (driver's seat) and high-strength safety body designed to mitigate impacts to the front, rear, or side in the event of an accident, and the SOS Call system, providing automatic notification of an accident and reports to be sent manually in an emergency, have been made standard equipment on the Highway Star series.</p>
March 19	eK space eK Cross Space	Mitsubishi	Complete redesign		<p>The planning and development of these mini-vehicles was carried out by NMKV, a joint venture between Mitsubishi and Nissan.</p> <p>The eK Cross Space presenting a powerful SUV aura, and the stylish and friendly eK Space, which both feature the distinctive Mitsubishi design, were released. The lengthened wheelbase creates a spacious occupant area, and the top level sliding range of the rear seat in this class maximizes rear seat comfort. The rear hands-free automatic sliding door have a wider opening and can be opened or closed with a kick sensor...</p> <p>The hybrid system offers a naturally-aspirated or a turbocharged engine that combines with the CVT to achieve both acceleration performance and fuel efficiency. In models equipped with the turbocharged engine, paddle shifters make it possible to shift gears without letting go of the steering wheel. Handling performance nimble at low speeds and stable at high speeds was achieved by optimizing the steering force and the damping force of the shock absorbers. The Hill Descent Control system (standard equipment on the eK Cross Space) holds vehicle speed within a low range when going down a steep or slippery slope.</p> <p>The single lane driver support MI-Pilot system, which involves the vehicles assisting with accelerating, braking and steering on expressways, has been made available, and supplemented with a millimeter wave radar that assists with acceleration within a set speed range after the driver activates the turn signal when overtaking.</p> <p>The Mitsubishi e-Assist active safety technology is standard equipment. Safety has been enhanced with the addition of four functions, namely Predictive Forward Collision Warning (PFCW), Driver Attention Alert (DAA), Traffic Sign Recognition (TSR), which detects no entry, speed limit, and stop signs and warns the driver and, lastly, Leading Car Departure Notification (LCDN). Adaptive LED headlights (ALH) (with automatic optical axis adjustment) have been made available. These headlights automatically limit the illumination range of high beams to avoid dazzling oncoming or preceding vehicles and preserve their visibility. The light switch no longer has an OFF position, and the automatic light control function that automatically turns the headlights on and off is constantly active to prevent the driver from forgetting to turn on the headlights. With the addition of the driver SRS knee airbag, seven airbags are installed in the vehicle, enhancing full-body protection in the event of a collision.</p>

Table 8 Main Ordinary and Light-Duty Automobiles Technology Trends and Market Launches in Japan in 2020 (cont.)

Date of launch	Vehicle model	Brand	Purpose	Technological aspect	Main technologies
April 7	Passo	Toyota	Special specifications vehicle	Safety	This model is equipped with a special panoramic view Navi Ready and Super UV Cut packages that help check whether the area around the vehicle is safe when parking.
April 16	Mirage	Mitsubishi	Refinement	Safety	The front and rear have been redesigned based on the Dynamic Shield front design concept to create a sharp and powerful design, and LED daytime running lamps (DRLs) have been adopted to improve conspicuity during the day. The rear LED combination lamps and vertical reflectors provide a sense of breadth and stability. The active safety systems have been enhanced with the addition of a pedestrian detection function and extension of the activation speed range for the Forward Collision Mitigation (FCM) system. A lane departure warning system (LDW) and automatic high beams (AHB), which automatically switch between high and low beams to improve nighttime visibility, have been made standard equipment. The headlight switch OFF position has been removed to prevent forgetting to turn on the headlights, and rain-sensing wipers that automatically adjust the wiper interval based on the amount of rain has been installed.
April 17	HiAce	Toyota	Refinement	Safety	Safety systems has been enhanced with the Digital Rear-View Mirror system that shows the image from the camera at the rear of the vehicle and the Panoramic View Monitor system that displays a bird's-eye view of the vehicle on the navigation system screen. The Optitron meter features a 4.2-inch TFT color multi-information display offering improved readability and convenience. The adoption of Intelligent Clearance Sonar (with Parking Support Brakes (Stationary Objects)) to mitigate damage from collisions due to accelerator pedal misapplication by the driver, in conjunction with the Toyota Safety Sense collision avoidance support package option, provides a full suite of safety systems.
April 28	Supra	Toyota	Special specifications vehicle	Performance	The output of the RZ 3.0-liter engine was increased to 285 kW (PS)/5,800 rpm (+14% compared to the previous model), body rigidity was strengthened by adding a brace to the front section, and the suspension was recalibrated to improve stability while cornering.
May 13	Corolla Corolla Touring	Toyota	Special specifications vehicle	Safety	The GX is equipped with safety features such as Intelligent Clearance Sonar (with Parking Support Brakes (Stationary Objects)) and the Back Guide Monitor. It also provides privacy glass with UV protection.
May 15	Swift Swift Sport	Suzuki	Refinement	Safety	The rear brake support, rear false start prevention, rear parking sensors, adaptive cruise control (with all-speed tracking), lane departure control, traffic sign recognition, blind spot monitor (with lane change support) to detect vehicles approaching from behind in the adjacent lane, and rear cross traffic alert to detect vehicles approaching from the left or right behind the vehicle features have been made standard on all models.
May 18	CX-3	Mazda	Additional model	Safety, environment	A 1.5-liter gasoline engine model has been added. The i-ACTIVSENSE advanced safety technology has been made standard equipment.
May 21	Mazda3	Mazda	Additional model	Product appeal	A model equipped with the SKYACTIV-G 1.5 gasoline engine has been added.
May 28	Mazda2 CX-5 CX-8	Mazda	Additional model	Safety	In addition to the pedal layout with an organ accelerator pedal enables an ideal driving posture, along with the Advanced Smart City Brake Support system that helps avoid collisions while driving and the Blind Spot Monitoring system that supports checking the rear when changing lanes, and other technologies common to all Mazda vehicles, a 360-degree view monitor that helps detect hazards outside the line of sight when parking or driving at low speeds and adaptive LED headlights that support visibility on dark roads have been made available.
June 3	Aqua	Toyota	Special specifications vehicle	Safety	The Panoramic View Monitor system that helps check that difficult-to-see areas are safe while parking, was added...
June 8	RAV4 PHV	Toyota	Additional model	Environment	The pinnacle of its brand, the RAV4 PHV features a sporty and elegant design. The newly developed THS II Plug-in hybrid system achieves a maximum output of 225 kW (306 PS), and the E-Four (electric 4 WD) system distributes drive force to all four wheels to achieve driving stability and offer greater confidence when driving in snow or rain. The use of the TNGA platform (GA-K) means the large-capacity lithium-ion battery is mounted in the center of the vehicle underfloor, lowering the center of gravity and optimizing weight balance. The EV range on a full charge is 95 km, and hybrid fuel economy is 22.2 km/L. The gasoline tank has a capacity of 55 liters, providing a cruising range exceeding 1,300 km. An external power supply with a maximum of 1,500 W (AC 100 V) has been made standard equipment. Two external power supply modes, an EV mode and an HV mode, are available. Compliance with normal charging at home or elsewhere simply by connecting the included charging cable (for both AC 200 V and AC 100 V) to an outlet has been made standard.

Table 8 Main Ordinary and Light-Duty Automobiles Technology Trends and Market Launches in Japan in 2020 (cont.)

Date of launch	Vehicle model	Brand	Purpose	Technological aspect	Main technologies
June 10	Taft	Daihatsu	New model		<p>The “Tough & Almighty Fun Tool” was developed under the “reliable partner active in day-to-day and leisure scenarios to makes everyday life fun” concept. It is the third product using the next-generation DNGA car building platform, following the Tanto and Rocky. Representing SUV toughness and strength in the expanding mini-vehicle crossover market, the model plays an active role in day-to-day life and leisure.</p> <p>Vehicle rigidity was improved by adopting the new DNGA platform and the lightweight, high-rigidity “D monocoque” body.</p> <p>The Smart Assist active safety function was enhanced with a newly developed stereo camera, and the five functions of higher supported speed for collision avoidance braking, nighttime pedestrian detection, road departure warning, swerving warning, and recognition of more traffic signs (speed limit and stop signs in addition to the current no-entry sign) have been made standard equipment on all models. An electric parking brake has also been adopted to improve safety and security performance.</p>
June 17	Harrier	Toyota	Complete redesign		<p>Emphasizing aesthetics that stir emotions when seen, entered, and driven, the simple, elegantly stylish coupé form, refined interior and quiet cabin, and pleasure of driving as intended provided by this model gives it value as a life-enriching partner that makes users feel fulfilled. The TNGA platform (GA-K) was adopted to provide high rigidity and a low center of gravity. A front MacPherson suspension and rear double wishbone suspension achieve both ride comfort and driving performance.</p> <p>The hybrid variant is equipped with a 2.5-liter Dynamic Force engine (A25 A-FXS) and the THS II hybrid system, while the 4 WD model combines the engine with the E-Four (electric 4 WD) system. Fuel efficiency in the WLTC test cycle is 21.6 km/L for the 4 WD model and 22.3 km/L for the 2 WD model. The gasoline variant combines a 2.0-liter Dynamic Force engine (M20 A-FKS) with the Direct Shift CVT to achieve a test cycle fuel efficiency of 15.4 km/L for the 2 WD model and 14.7 km/L for the 4 WD model.</p> <p>The model is equipped with the Toyota Safety Sense active safety package featuring a pre-collision safety system extended to detect pedestrians (day and night) and cyclists (daytime), Intelligent Clearance Sonar (with Parking Support Brakes (Stationary Objects)) to mitigate collisions and damage at low speeds, and Digital Rear-View Mirror with a function to record images from the front and rear cameras.</p> <p>The hybrid variant has a power outlet (AC 100 V/1500 W) that can serve as a power generator or a power source for electrical appliances.</p>
June 18	Lexus LC 500 convertible	Toyota	Additional model	Performance	<p>A convertible variant of the LC, which sets the tone for the ride quality of the entire Lexus lineup has been offered. Built on the vision of “developing a driving performance that draw out the unique intrinsic capabilities of the LC in addition to its elegance” espoused by Chief Branding Officer/ Master Driver Akio Toyoda, this new model has both presence and a driving performance/engine sound that stirs people. It also reduces weight and improves comfort to impart the joy of driving.</p> <p>Lightweight and highly rigid die-cast aluminum is used for the rear suspension tower brace and underfloor brace joints. Weight balance was optimized by ideally arranging lightweight materials such as magnesium and aluminum to achieve high rigidity while reducing weight, and performance dampers were set in the rear to achieve excellent dynamic performance.</p> <p>The 5.0-liter V8 naturally aspirated engine and Direct Shift 10-speed AT were combined to provide linear acceleration with a sense of power, as well as produce a pleasant sound.</p>
June 22	Gran Max	Daihatsu	New model		<p>This light-duty 1-ton class commercial vehicle remains compact and easy to handle while also being comfortable and having high loading capacity. Produced by in Indonesia by the local Astra Daihatsu Motor, it is the first vehicle produced in another country imported and sold in Japan by Daihatsu. A newly developed 1.5-liter engine and the Smart Assist active safety system has been added to the Indonesia-produced model to address demand in the Japanese market.</p>
June 22	TownAce	Toyota	Refinement	Safety	<p>This model is equipped with the Smart Assist collision avoidance support package which features not only collision avoidance brakes capable of detecting pedestrians at night and cyclists during the day, but also false start prevention to avoid sudden acceleration if the driver presses the wrong pedal.</p> <p>It is equipped with a 1.5-liter 2 NR-VE gasoline engine newly developed for light-duty commercial vehicles, and improves fuel economy by approximately 20% over the previous model, achieving a 50% reduction relative to the 2018 emissions standards.</p>
June 24	Kicks	Nissan	New model		<p>The e-Power electric powertrain, a one-pedal electric powertrain that enables the driver to accelerate powerfully and decelerate using only the accelerator pedal, has been installed in SUV segment models. Maximum output has been raised by about 20%, and power in the middle to high speed range has been increased. Timing control for engine for power generation has been optimized to reduce the frequency of engine operation, resulting in improved quietness.</p> <p>The front window opening angle and low waistline provide a sense of openness, the rear seats offer 600 mm of knee room and 85 mm of headroom, and the luggage compartment provides 423 liters of luggage space.</p> <p>(continued on next page)</p>

Table 8 Main Ordinary and Light-Duty Automobiles Technology Trends and Market Launches in Japan in 2020 (cont.)

Date of launch	Vehicle model	Brand	Purpose	Technological aspect	Main technologies
					(continued from previous page) The Intelligent Emergency Braking and Emergency Assist for Pedal Misapplication systems, which provide smoother control by detecting the conditions of the preceding vehicle using a millimeter-wave radar and assist in avoiding collisions with vehicles or pedestrians, or in mitigating damage in such collisions, have been added to the ProPilot system. In addition, the SOS Call system that provides automatic notification of an accident and allow manual reporting in an emergency has been made standard equipment on all models. A platform with enhanced body rigidity realizes stability and maneuverability, and the minimum turning radius enables tight turns. The ergonomically designed Zero Gravity Seat provides comfortable seating and reduces fatigue.
June 25	Bongo Brawny	Mazda	Refinement	Safety	This model has been equipped with Intelligent Clearance Sonar (with Parking Support Brakes (Stationary Objects)), which contributes to mitigating collision damage when the accelerator pedal pressed by mistake, a color multi-information display in the meter, and an automatic lighting system that automatically turns on the headlamps based on ambient brightness.
July 1	Prius Prius PHV	Toyota	Refinement	Safety	The Toyota Safety Sense active safety package was enhanced by extending the scope of detection in the pre-collision system to cover nighttime pedestrians and daytime cyclists, adding the Lane Tracing Assist (LTA) to assist steering when using radar cruise control Road Sign Assist (RSA) to show road signs on the display, and a function to notify drivers when the vehicle ahead starts moving. Intelligent Clearance Sonar (with Parking Support Brakes (Stationary Objects)), which mitigates collisions caused by accelerator or brake pedal misapplication has been made standard equipment. Also, the Plus Support (sudden acceleration suppression system), which is automatically activated when the corresponding Plus Support Smart Key is used, prevents acceleration when it detects a pedal misapplication. The limited specifications model is equipped with a blind spot monitor that help check the rear when changing lanes, the Rear Cross Traffic Alert to detect approaching vehicles and alert the driver when backing up, a rearview camera to project images of the rear, the Navi Ready system for voice control and hands-free communication, and LED accessory lamps (dusk lights) to supplement the headlamps.
July 2	Porte Spade	Toyota	Special specifications vehicle	Safety	The Intelligent Clearance Sonar (with Parking Support Brakes (Stationary Objects)) system that mitigates collisions in the event of an accelerator or brake pedal misapplication, the Navi Ready package that includes a rearview camera showing an image of the view at the rear on the navigation system screen when backing up, and discharge headlamps that assist with driving at night have been made standard equipment.
July 17	Bongo	Mazda	Complete redesign		All models are equipped with the Smart Assist collision avoidance support package, which includes collision avoidance support brakes and a false start prevention function to control sudden starts, as standard equipment. All models feature a newly developed gasoline engine that achieves a 50% reduction relative to the 2018 emissions standards and exceeds the 2015 fuel economy standards by 25% or more.
July 22	Lexus RX	Toyota	Refinement	Safety	The Parking Support Brakes (PKSB) (stationary objects, vehicles approaching from the rear) and Blind Spot Monitor (BSM) systems have been made standard equipment on all grades. Outlets (AC 100 V, 1500 W) has been added to the front center console and in the luggage compartment.
August 3	Land Cruiser Prado	Toyota	Refinement	Performance, safety	The diesel engine turbocharger was made larger, and maximum output was raised from 177 PS to 204 PS. The Toyota Safety Sense package has been upgraded. The detection function of the pre-collision safety collision mitigation system has been improved to recognize pedestrians at night and cyclists during the day, and the Lane Departure Alert with yaw assist, Road Sign Assist (RSA), and advanced warning functions have been made standard equipment on all grades. Rear cross-traffic alert, which detects an approaching vehicle when backing up and alerts the driver, is available as an option.
August 4	C-HR	Toyota	Refinement	Safety	The Toyota Safety Sense package includes a pre-collision safety system that recognizes pedestrians (nighttime), cyclists (daytime), oncoming vehicles traveling straight ahead when turning right at an intersection, and pedestrians crossing from the opposite direction when making a left or right turn. The Emergency Steering Assist system offering low-speed acceleration control to help prevent accidents at low speeds and a function that assists the driver steering to avoid collisions with pedestrians in the vehicle's own lane has also been added. Lane Tracing Assist when using radar cruise control, Road Sign Assist that uses a camera to recognize road signs and display them on the navigation system screen, and Back Guide Monitor have been made standard equipment on all models. A limited specifications model featuring Panoramic View Monitor, which displays images of the vehicle's entire surroundings on the navigation system screen, Intelligent Clearance Sonar (with Parking Support Brakes (Stationary Objects)), which reduces damage from collisions caused by pedal misapplication, rear cross-traffic automatic brakes (parking support brake (vehicles approaching from the rear)), which detects approaching vehicles when backing up and controls the brakes, is also available.

Table 8 Main Ordinary and Light-Duty Automobiles Technology Trends and Market Launches in Japan in 2020 (cont.)

Date of launch	Vehicle model	Brand	Purpose	Technological aspect	Main technologies
August 6	Lexus ES	Toyota	Refinement	Safety	Digital outer mirrors with an approximate distance display feature are available. The Parking Support Brakes (PKSB) (stationary objects, vehicles approaching from the rear) and Blind Spot Monitor (BSM) systems have been made standard equipment on all grades. The nickel-metal hydride battery was replaced with a lithium-ion battery.
August 7	Rav4	Toyota	Refinement	Safety	Intelligent Clearance Sonar (with Parking Support Brakes (Stationary Objects)), which mitigates collision damage due to pedal misapplication, has been made standard equipment on all models, and Panoramic View Monitor, which displays images of the vehicle's entire surroundings on the navigation system screen, has been made available as an option.
August 20	Spacia	Suzuki	Refinement	Safety	Dual-camera brake support with nighttime pedestrian detection, and SRS curtain airbags, have been made standard equipment. Adaptive cruise control with all-speed tracking was installed, and the Suzuki safety support system was enhanced with an upgraded stop sign recognition function.
August 20	Lexus CT	Toyota	Refinement	Safety	Parking Support Brakes (PKSB) (stationary objects) has been made standard equipment on all models.
August 20	eK Cross eK Wagon	Mitsubishi	Refinement	Safety	Four functions, Traffic Sign Recognition (TSR), which detects no-entry, speed limit, and stop signs, and alerts the driver, Predictive Forward Collision Warning (PFCW) which uses millimeter-wave radar to detect changes in conditions ahead of the vehicle to avoid rear-end collisions, Leading Car Departure Notification (LCDN), which notifies the driver of the start of the vehicle ahead, and Driver Attention Alert (DAA), which emits a warning when the driver becomes inattentive, have been added to the e-Assist active safety package. In addition, the nighttime detection performance of the Forward Collision Mitigation (FCM) system was enhanced by adding a millimeter wave radar, an acceleration when overtaking function was added to the MI-Pilot single-lane expressway driver support system, and the performance of the Lane Keep Assist (LKA) function at low speeds, and of the Adaptive Cruise Control (ACC) function at high speeds, when the wipers are activated has been improved. Other features include a driver SRS knee airbag, pretensioner mechanism for the rear seat belts, seat belt reminder sensor, Hill Descent Control (HDC) to maintain a low speed when going down a steep hill, and the elimination of the headlight switch OFF position.
August 20	Dayz	Nissan	Refinement	Safety	Intelligent Forward Collision Warning (FCW), Intelligent Driver Alertness (DA), Leading Car Departure Notification, Traffic Sign Recognition, double pretensioner seat belt with load limiter (front passenger seat) and other features were made standard equipment. In addition, the performance of the ProPilot driver support system was enhanced improved by the addition of a millimeter wave radar. An SRS knee airbag system (driver), pretensioner seat belts with load limiters (rear seats), LED fog lamps, and SOS call have been made standard equipment.
August 27	Hijet Atrai Wagon	Daihatsu	Refinement	Safety	Automatic lighting was made standard equipment on all model. In Hijet Truck models with Smart Assist III, the rear sonar and rear erroneous start prevention function were also made standard equipment.
August 27	Honda e	Honda	New model		Honda has proposed a future-oriented urban commuter that focuses on the essence of EVs. It features a five-screen full-width horizontally-arranged digital instrument panel, with wide-screen display Honda CONNECT consisting of two 12.3-inch screens in the center. The Honda Personal Assistant, which uses cloud AI to perform speech recognition and provide information is included. The installation of Honda CONNECT, an on-board communication module exclusive to Honda vehicles provides compatibility with the Honda Total Care Premium connected service. A dedicated application can be downloaded to turn the user's smartphone into a digital key. The flush handle pops out automatically when the user approaches the vehicle, and the door is unlocked when the user touches the handle. After the user gets into the vehicle and closes the door, the system detects the occupant and turns on the power. The driver can press the D range button to start driving after fastening his or her seat belt. The power turns off automatically when occupants get out of the car and close the door, resulting in a total seamless experience from getting in to getting out. The vehicle is equipped with a side/center camera mirror system that displays its images on the monitors at either side of the instrument panel. Powerful acceleration from the high-torque motor in the rear, high body rigidity, and a four-wheel independent suspension provide a high level of ride comfort and a sense of stability. The installed Honda Parking Pilot parking assist system supports six patterns of parking space entry and exit modes. At the push of a button, the system uses four multi-view cameras and twelve sonars to recognize the parking space boundaries, and carries out accelerator, brake, steering wheel and shifting operations. Body frame technology that achieves passive safety performance in all directions in a compact EV package was developed, and the Honda Sensing driving safety support system (Collision Mitigating Braking System (CMBS), False Start Prevention, False Backward Start Prevention, short-range collision mitigation brakes, Pedestrian Collision Mitigation Steering, Road Departure Mitigation, Adaptive Cruise Control (ACC) with Low-Speed Follow, Lane Keeping Assist System (LKAS), Lead Car Departure Notification, Traffic Sign Recognition, Auto High-Beam Headlights) have been made standard equipment.

Table 8 Main Ordinary and Light-Duty Automobiles Technology Trends and Market Launches in Japan in 2020 (cont.)

Date of launch	Vehicle model	Brand	Purpose	Technological aspect	Main technologies
August 31	Yaris Cross	Toyota	Additional model	Performance	The TNGA platform for compact cars (GA-B) was adopted. Gasoline models feature a 4 WD system with three multi-terrain select modes, while hybrid models use the E-Four (electric 4 WD) system. The Toyota Safety Sense active safety package has been made standard equipment, and radar cruise control with all-speed tracking, Adaptive High Beam System (AHS), and Toyota Teammate (Advanced Park) advanced driving support were included.
September 1	Pixis Truck	Toyota	Refinement	Safety	A new rear sonar enabling the activation of false start prevention even when the vehicle is backing up has been made available.
September 3	Flair Wagon	Mazda	Refinement	Safety	Dual-camera brake support with nighttime pedestrian detection and an SRS airbag system (curtain) have been made standard equipment on all grades, and adaptive cruise control with all-speed tracking is available as an option.
September 4	GR Yaris	Toyota	Additional model	Performance	Learning from how the Toyota GAZOO Racing World Rally Team (WRT) built a vehicle capable of competing in the WRC and involving professional drivers from outside Toyota in evaluations in the early stage of development led to the creation of a vehicle that anyone can confidently drive as intended and maneuver as they please on any road in the world. RZ: A powerful model that offers driving stability and formidable acceleration. It is equipped with the compact, lightweight, and powerful 1.6-liter inline 3-cylinder intercooler turbocharged G16 E-GTS engine, the newly developed GR-Four sports 4 WD system with uses a front and rear variable driving force system enabled by a multi-plate clutch, and the iMT4 6-speed manual transmission. RS: A model offering the joy of driving the GR Yaris. It is equipped with the inline 3-cylinder 1.5-liter M15 A-FKS Dynamic Force engine, the Direct Shift-CVT with an additional launch gear giving a direct driving feel, and the 10-speed Sequential Shiftmatic paddle shifting that provides a manual-like experience.
September 15	Thor	Daihatsu	Partial redesign		A new stereo camera, collision warning, collision avoidance support brakes with nighttime pedestrian detection and motorcycle following, improved detection distance and response, false start prevention with brake control (forward and reverse), roadside departure (swerving) warning, traffic sign recognition (no entry, stop, and speed limit signs), Adaptive Driving Beam (ADB), side view lamps, and adaptive cruise control (ACC) with all-speed tracking were added to the Smart Assist 3 active safety system. The electric parking brake and auto-hold brake increase convenience. The inclusion of the Touch & Go locking, Welcome Door unlocking, and Welcome Open functions facilitate getting in and out of the vehicle.
September 15	Roomy	Toyota	Partial redesign		The Smart Assist active safety system (collision avoidance support brakes, collision warning with motorcycle, bicycle and other two-wheeled vehicle, as well as nighttime pedestrian detection, adaptive cruise control with all-speed tracking, and more) has been standard equipment on all models.
September 17	Lexus RC and RC F	Toyota	Refinement	Safety, performance	Improved body rigidity and the use high-strength steel for the stabilizer bar and high-strength aluminum for the rear upper arm has enhanced the unique "Lexus Driving Signature" ride quality that combines maneuverability, stability, and ride comfort. The electric parking brake/brake hold, radar cruise control (with all-speed tracking), clearance sonar and rearview sonar, Blind Spot Monitor (BSM), and Rear Cross Traffic Alert (RCTA) features have been made standard equipment on all models.
September 24	Justy	Subaru	Refinement	Safety	The Smart Assist system has been extended with a new stereo camera, and functions such as improved collision warning and collision avoidance support brakes performance, adaptive cruise control with all-speed tracking, road departure warning, swerving warning, has been made standard equipment. Power sliding doors with Welcome Open, an electric parking brake, and auto-hold brake function have been installed.
October 8	Impreza	Subaru	Additional model	Environment	Models equipped with e-Boxer, which uses motor assist to realize nimble acceleration, and e-Active Shift Control, an adaptive gear shift control system that coordinates with SI-DRIVE, have been added.
October 8	MX-30	Mazda	New model		This compact SUV achieves high collision safety performance through a high-strength, efficient energy-absorbing structure while also adopting center-pillarless freestyle doors... It is equipped with e-SKYACTIV G, a combination of the SKYACTIV-G 2.0 direct injection gasoline engine and Mazda's proprietary M-Hybrid mild hybrid system. The console tray is made of Heritage Cork, a sustainable material made by harvesting tree bark, and the door trim uses a sound-absorbing material made from recycled plastic bottles. The i-Activsense advanced safety technology has been enhanced, and the Smart Brake Support (SBS) collision mitigation braking technology has been extended with a function to avoid or mitigate collisions at intersections. A steering wheel operation assist function that helps avoid lane departures, and collision mitigation technology to avoid or mitigate collisions with vehicles approaching from the rear were introduced.

Table 8 Main Ordinary and Light-Duty Automobiles Technology Trends and Market Launches in Japan in 2020 (cont.)

Date of launch	Vehicle model	Brand	Purpose	Technological aspect	Main technologies
October 12	Elgrand	Nissan	Partial redesign		The design was revamped. At the same time, the 360-degree safety assist feature that provides driving support from all directions and includes functions such as Intelligent Forward Collision Warning (FCW), which provides an alert for avoiding the preceding vehicle, Intelligent Blind Spot Intervention (BSI), which assists steering operation to avoid vehicles approaching from the rear, Blind Spot Warning (BSW), and Rear Cross Traffic Alert (RCTA) have been made standard equipment on all models. The ability to detect no-entry, speed limit, and stop signs has been added to the Traffic Sign Recognition function.
October 15	Xbee	Suzuki	Refinement	Safety	The Suzuki Safety Support system was enhanced with a lane keeping assist, adaptive cruise control with all-speed tracking, and Dual Camera Brake Support with nighttime pedestrian detection.
October 15	Levorg	Subaru	Complete redesign		<p>The new BOLDER design concept audaciously accentuates the individuality of the vehicle to produce a design expressing the “joy of control as intended” and “innovation”.</p> <p>Station wagon functionality delivers superior touring comfort and a practical cargo space with a power liftgate and a large-capacity sub trunk. The high quality of the interior and the advanced digital cockpit further enhance its value as a high performance station wagon.</p> <p>It is equipped with the newly developed 1.8-liter direct-injection turbocharged DIT engine, which provides easy day-to-day handling and uses lean combustion to achieve environmental friendliness.</p> <p>The Subaru Global Platform combines with a full inner frame construction to enhance overall safety performance. The platform offers a comfortable ride through improved handling performance and reduced noise and vibration, while the construction raises frame continuity and uses structural adhesive that suppresses deformation to achieve high rigidity and reduce weight.</p> <p>The next-generation EyeSight has been made standard equipment on all models. The system achieves 360-degree sensing using a newly developed stereo camera with a wider angle and four front and rear radars to provide forward warning assist, forward pre-collision braking, collision avoidance steering control, vehicle approaching from the rear warning when changing lanes, and steering control to prevent lane departure.</p> <p>EyeSight X, which uses satellite information and 3D high-precision map data to expand driver support functions, is available on expressways that meet certain conditions. The model is also equipped with hands-off assist and launch assist in traffic jams which, respectively, allows the driver to let go of the steering wheel and automatically starts the vehicle under such conditions, speed control when entering a curve, which provides appropriate speed control in a curve, speed control when approaching a toll gate, which controls slowing down and speeding up again at toll gates, active lane change assist, which helps the driver change lanes when the turn signal is activated, and driver emergency support system that slows the vehicle down to a stop when it detects a driver emergency while the vehicle is in motion.</p> <p>The Subaru Starlink connected service that communicates with the call center in the event of a collision, driver illness or other problem, and sends a notification when the theft alarm system or warning lights are activated, has been adopted.</p> <p>The vehicle is also equipped with dual SRS airbags, SRS side airbags and SR curtain airbags in the event of a side collision, a driver SRS knee airbag to protect the lower limbs, and a passenger SRS seat cushion airbag that enhances the seat belt restraint protection for a total of eight occupant protection airbags. A pedestrian protection airbag is also provided to mitigate the impact in the event of a collision with a pedestrian.</p>
October 22	Forester	Subaru	Additional model	Performance	A model featuring the newly developed 1.8-liter direct injection turbocharged DIT engine has been added. Models equipped with the e-Boxer electric technology benefit from the motor-assisted e-active shift control.
October 22	Lexus UX 300 e	Toyota	Additional model	Environment	<p>This first Lexus commercial electric vehicle model strives to complement the distinctive design, high level of convenience, and ease of handling that define the compact crossover UX with high-quality driving and quietness, superior functionality and ease of use, and the highly reliable electric technology cultivated through HVs.</p> <p>The battery pack is mounted on a parallel cross-shaped steel underframe and fixed to the floor surface, and the front side members are connected by cross members to achieve well-balanced body rigidity. The center of gravity of the vehicle has been optimally lowered, providing high quality ride comfort, handling, and quietness.</p> <p>Acceleration pitch control is employed to achieve a smooth sense of acceleration and deceleration, and coordinated hydraulic and motor regenerative braking during deceleration achieves a highly secure brake feeling.</p> <p>A high-capacity battery and increased major component efficiency ensure a WLTC cruising range of 367 km. A high output, compact electric water heater, dedicated EV air conditioning system with two-layer recirculation control, and coordinated seat heater control provides a comfortable interior space while reducing electricity consumption. Connected technologies enable the user to check the remaining battery level, the distance that can be traveled when the air conditioner is turned on or off, the charge notification, the time until charging completes, as well as the location, hours of operation and occupancy of nearby charging stations.</p>

Table 8 Main Ordinary and Light-Duty Automobiles Technology Trends and Market Launches in Japan in 2020 (cont.)

Date of launch	Vehicle model	Brand	Purpose	Technological aspect	Main technologies
November 2	Crown	Toyota	Refinement	Safety	The Toyota Safety Sense suite has been supplemented with Driver Emergency Stop Assist, which brings the vehicle to a stop and provides support for obtaining early emergency medical assistance if the driver is no longer operating it due to a sudden deterioration in physical condition, Curve Speed Reduction, which suppresses speed in curves, Low-Speed Acceleration Control, which detects oncoming vehicles when making a right-turn at an intersection and pedestrians in both left and right turns and suppresses acceleration if a pedestrian or cyclist is detected while traveling at low speeds, as well as Emergency Steering Assist, which assists evasive steering by the driver in an emergency. The Plus Support function, which suppresses acceleration when the driver mistakenly presses the accelerator, is also available.
November 5	Lexus IS	Toyota	Complete redesign		This compact front-engine, rear-wheel drive follows the "Agile & Provocative" sports sedan concept to deliver the vigorous and daring allure of a low center of gravity. It can be equipped with a naturally-aspirated (NA) V6 3.5-liter engine that offers power and environmental performance through Dual VVT-i (intake VVT-iW) and D-4 S, an L4 2.0-liter turbocharged engine that employs a twin-scroll turbocharger, Dual VVT-i (intake VVT-iW) and D-4 ST that achieves optimum combustion efficiency, or a hybrid system that pairs a high-torque motor with a 2.5-liter engine that with Dual VVT-i and D-4 S. The AWD system, which achieves both excellent rough road performance and quietness, uses a Torsen LSD (center differential gear) to transfer torque. An additional 55 spot welding points on the body, laser screw welding, and adhesives were used to reduce weight and increase rigidity, providing both safe steering and quiet operation. The monocular camera and millimeter wave radar-based Lexus Safety System+ active safety package includes nighttime pedestrian and cyclist detection, collision-avoidance and evasive steering support that detects oncoming vehicles when turning right at an intersection, as well as pedestrians when making left or right turns, lane keeping assist that also provides support in curves, lane departure warning and prevention that prevents moving out of the lane, radar cruise control (with all-speed tracking) to maintain a safe distance and assist with following, stopping and starting in traffic jams, Road Sign Assist (RSA) to display speed limit, no passing, no entry, and stop signs, Traffic Movement Notification (TMN) to alert the driver that the vehicle ahead has started moving, Parking Support Brakes (PKSB) to avoid collisions with stationary objects when moving forward or back, and with vehicles approaching from the rear left or right when backing up, and Blind Spot Monitor (BSM) to detect vehicles in the rear. The vehicle is also equipped with D-Call Net to speed up fire department response and emergency transport a hospital in the event of an accident, Secondary Collision Brake (SCB) to mitigate secondary damage after a collision, and the Helpnet driver emergency support system.
November 19	Lexus LS	Toyota	Complete redesign		This flagship model continues its efforts to deliver surprise and excitement through impressive quietness, ride comfort, and precise construction. In an initiative to address the four main types of accidents (rear-end collisions, pedestrian collisions, road departures, and collisions at intersections), the Lexus Safety System+ A is installed as a standard feature on all models. Functions that help avoid collisions with oncoming vehicles going straight ahead when turning right at an intersection, with pedestrians crossing the street when turning right or left, or with pedestrians and cyclists in front of the vehicle at low speeds, radar cruise control (with all-speed tracking), which recognizes curves based on sensor information and limits the vehicle speed, and Plus Support (sudden acceleration suppression), which prevents acceleration in the event of pedal misapplication, were added. Advanced Park, which assists natural parking by controlling steering, shifting, acceleration and braking with a simple switch operation, was introduced in the Lexus Teammate. The vehicle is equipped with the BladeScan® Adaptive High-beam System (AHS), which shines the light from LEDs on blade mirrors rotating at high speed to finely control light distribution and extend the high-beam illumination range.
November 19	N-One	Honda	New model		Built on the circle, square, and trapezoid shapes design inherited from the N360 and following the "fulfilling day-to-day with N" vision, this model seeks to become a passenger vehicle acting as an everyday partner that never becomes boring and remains appreciated for a long time. The patented center tank layout technology derived from the M/M concept carried over from the N360, results in a low floor and comfortable interior space. In the Honda Sensing advanced safety driving support system the eight features of Collision Mitigation Braking System (CMBS), False Start Prevention, Pedestrian Collision Mitigation Steering, Lead Car Departure Notification, Traffic Sign Recognition, Road Departure Mitigation, Adaptive Cruise Control (ACC) with Low-Speed Follow, and Lane Keeping Assist System (LKAS), have been complemented by the addition of False Backward Start Prevention and Auto High Beam. The vehicle features a parking sensor system that detects objects behind the car using four sonar sensors mounted on the rear bumper, an automatic brake hold function that keeps the vehicle stationary even if the driver releases the brake pedal, and an electronic parking brake.

Table 8 Main Ordinary and Light-Duty Automobiles Technology Trends and Market Launches in Japan in 2020 (cont.)

Date of launch	Vehicle model	Brand	Purpose	Technological aspect	Main technologies
November 24	Note	Nissan	Complete redesign		<p>A new platform was designed and the systems revamped under the concept of “advanced compact car brimming with driving comfort and fun surpassing preconceptions of compact cars”. The body frame consists 1,470 MPa-class ultra-high-tensile steel (ultra-high-tensile steel sheets used in cold pressing) to achieve both weight reduction and passive safety.</p> <p>The e-Power has evolved into its second generation, with a completely new motor and inverter. The torque and output of the have been increased by 10% and 6%, respectively. The inverter has been made 40% smaller and 30% lighter, and increased engine efficiency enhances quietness without sacrificing either acceleration performance or fuel economy.</p> <p>The provided advanced safety technologies use the 360-degree safety support approach to improve safety in all directions. The ProPilot (with navigation link), which links the ProPilot system that assists with driving operations on the highway to the navigation system, and adds support for responding to changes in the speed limit and driving in curves, has also been installed.</p> <p>The announcement of the e-Power 4 WD came on December 23. It is equipped with a full-fledged electric four-wheel drive system that uses powerful 50 kW motors in the rear to drive and control all four wheels in all speed ranges. Technology providing precise and instantaneous control of the independent front and rear motors provides powerful, stable, and comfortable driving on dry, wet, icy, and snow-covered roads.</p>
November 25	Solio	Suzuki	Complete redesign		<p>The larger body offers a spacious interior and also expands luggage space while retaining ease of handling.</p> <p>The Suzuki Safety Support active safety technology has been enhanced and features Dual Camera Brake Support, a collision damage mitigation brake that uses a stereo camera capable of detecting pedestrians at night, false start prevention, lane departure warning, swerving warning, lead vehicle departure notification, and high beam assist to automatically switch between high and low beams. A color head-up display that shows information necessary for driving has been adopted, and adaptive cruise control (ACC) with tracking has been added to all models. Extensive safety features have been provided by equipping all models with six airbags as standard equipment.</p> <p>The power sliding door has a reservation lock function, and a slim circulator has been adopted to enhance user-friendliness and comfort.</p>
December 4	Eclipse Cross	Mitsubishi	Complete redesign		<p>Under the “Daring Grace” design concept, overall length was extended and the front and rear were redesigned to into a sleeker, high-quality form that reinforces the dynamism of an SUV. A new twin-motor 4 WD PHEV model, which features one high-output motor at both the front a rear, a large-capacity battery and a 2.4-liter MIVEC engine is also offered.</p> <p>The 13.8 kWh drive battery has an EV operating range of 57.3 km, and the system automatically switches between EV Drive Mode, in which the vehicle is driven only with electric power, Series Hybrid Mode, in which the vehicle is driven by the motors using electricity generated by the engine, and Parallel Hybrid Mode, in which the vehicle is driven by the engine and assisted by the motors based on driving conditions.</p> <p>High body rigidity and the optimized front and rear suspensions give the PHEV model an optimized front-rear weight balance and low center of gravity due to the placement of the large-capacity drive battery in the center of the underfloor, while S-AWC uses a twin-motor 4 WD capable of freely changing the front-rear drive distribution to achieve ride comfort and handling stability. In the gasoline model, S-AWC coordinates the electronically-controlled 4 WD that optimizes torque distribution to the front and rear wheels, the active yaw control (AYC) that adjusts the braking force of the front wheels to increase cornering force, and the ABS and active stability control (ASC) that control braking force.</p> <p>The available drive modes are NORMAL, which provides appropriate maneuverability and stability, SNOW, which stabilizes vehicle behavior on slippery surfaces such as snow-covered roads, and GRAVEL, which provides better driving performance and stability on rough roads. The PHEV model additionally offers TARMAC mode, which provides both cornering performance and stability on dry paved roads.</p>
December 8	Chiffon	Subaru	Refinement	Safety	<p>A Smart Assist system with an upgraded stereo camera has been made standard equipment. The performance of the collision warning function and collision avoidance support brakes has been improved, and the vehicle is equipped with a road side departure warning function and a swerving warning function. The speed range of the adaptive cruise control with all-speed tracking has been extended in grades with turbocharged engines.</p>
December 9	Mirai	Toyota	Complete redesign		<p>Guided by the “EDGE for Fun Future” development catchphrase, the unit design, including the platform and mounting position was revised, and a plan to develop a car that people really want was devised.</p> <p>The front-engine, rear-wheel drive GA-L platform was adopted, and capacity was set to five occupants. Overall length and width were increased without increasing height to give the vehicle a wide and low stance. The FC stack and other main power units were placed in a compartment under the hood instead of under the front seats, balancing roominess with an optimized layout that lower the center of gravity and achieves an ideal front-rear weight distribution (50:50).</p> <p>(continued on next page)</p>

Table 8 Main Ordinary and Light-Duty Automobiles Technology Trends and Market Launches in Japan in 2020 (cont.)

Date of launch	Vehicle model	Brand	Purpose	Technological aspect	Main technologies
					<p>(continued from previous page)</p> <p>The layout of the FC system was completely redesigned, increasing the number of high-pressure hydrogen tanks to three to extend cruising range, with one tank set vertically in the tunnel, the power unit centered on the fuel cell (FC) stack was moved to the front, and the motor moved from the front to the rear. Reducing weight and increasing body rigidity through the optimal placement of aluminum and ultra-high-tensile steel (hot-stamped material) in the main frame components as well as sound insulation measures combine with the motor-based drive to offer improved handling stability and controllability and other aspects of driving performance, as well as an impressive level of quietness.</p> <p>The next-generation Toyota Safety Sense active safety package has been made standard equipment. The included pre-collision safety system (collision avoidance support with pedestrian (day/night) and cyclist (daytime) detection function/millimeter wave radar + monocular camera system) features Intersection Support (pedestrians and oncoming vehicles), which detects oncoming vehicles when turning right at an intersection pedestrians crossing and pedestrians coming from the opposite direction the street when turning right or left, as well as Emergency Steering Support, which provides steering support for evasive maneuvers and Low-Speed Acceleration Control, which prevents collisions when driving at low speeds.</p> <p>Radar cruise control (with all-speed tracking) has a curve speed management function to reduce speed in curves, and the performance of Lane Tracing Assist has been improved.</p> <p>Intelligent Clearance Sonar (with Parking Support Brakes (Stationary Objects)) detects walls and vehicles in parking lots, Blind Spot Monitor (BSM) detects vehicles approaching from the rear, Rear Cross Traffic Auto Brake (Parking Support Brakes (vehicles approaching in the rear, pedestrians in the rear)) detects vehicles or pedestrians approaching from behind when backing out of a parking space, Plus Support (sudden acceleration suppression) to prevents acceleration in the event of pedal misapplication, and Emergency Driving Stop System to stop the vehicle safely when the system detects a driver emergency.</p> <p>It is equipped with Intelligent Transport Systems (ITS) Connect, which supports safe driving by communicating with roadside infrastructure and other vehicles.</p>
December 24	Delica D:2	Mitsubishi	Complete redesign		<p>Overall length was extended, expanding luggage space while improving the comfort in the rear seats. The adopted mild hybrid system delivers torque from a low-speed range and is combined with a 1.2-liter engine and CVT for a smooth and powerful driving experience.</p> <p>Mitsubishi e-Assist, an active safety technology, now includes adaptive cruise control with all speed tracking, and a traffic sign recognition function that recognizes and displays road signs to them going unnoticed. Vehicle information is displayed on the head-up display to reduce driving fatigue, and SRS curtain airbags have been made standard equipment on all models.</p>
December 25	C+pod	Toyota	New model		<p>This environmentally friendly two-seater targets corporate users and local governments looking into ways to popularize EVs strives to achieve a high level of per-person energy efficiency.</p> <p>The compact body has a length of 2,490 mm, width of 1,290 mm, and height of 1,550 mm, with a minimum turning radius of 3.9 m. The lithium-ion battery is mounted in the underfloor at the base of the seats, resulting in a low flat floor. The motor is set in the rear, and the highly rigid, lightweight body and independent suspension provide a high-quality ride and a stable driving feel. It meets the newly established safety standards for ultra-compact mobility, and also features a pedestrian injury reduction body that mitigates damage to pedestrians.</p> <p>A pre-collision safety system capable of detecting vehicles (day and night), pedestrians (day and night) and cyclists (daytime) have been made standard equipment. Intelligent Clearance Sonar (with Parking Support Brakes (Stationary Objects)), which helps avoid collision with walls and other objects, or reduces damage in such collisions, is also available.</p>

Note: Table based on information from the public relations website of the manufacturers.

equipped with environmentally friendly engines as well as revamped and new models featuring improve hybrid or plug-in hybrid functionality.

3. 2. Safety Performance

The Safety Support Car incentive program that targets elderly (65 or older) drivers and promotes the purchase of vehicles with active safety systems, was launched on March 9 in the context of public-private sector initiatives aimed at making the Safety Support Cars that offer advanced safety technology to help drivers

drive more safely more widespread as part of measures for the prevention of traffic accidents. As in the previous year, completed vehicle manufacturers therefore continued to introduce Safety Support Car and Safety Support Car S-compliant vehicles eligible for those incentives in the market.

In 2020, automakers also released revamped versions of models that had their current safety systems upgraded to the latest advances in addition to new models featuring state-of-the-art advanced safety and driver sup-



(Source: Honda Motor Co., Ltd. website)

Fig. 2 Honda Fit



(Source: Daihatsu Motor Co., Ltd. website)

Fig. 5 Daihatsu Taft



(Source: Nissan Motors website)

Fig. 3 Nissan Note



(Source: Toyota Motor Corporation website)

Fig. 6 Toyota Yaris Cross



(Source: Suzuki Motor Corporation website)

Fig. 4 Suzuki Hustler



(Source: Toyota Motor Corporation website)

Fig. 7 Toyota Harrier

with its modern and simple facial expression.

It is interesting to see those three vehicles make their mark in the ever vigorous Japanese compact car market with completely different design approaches that suggest the intended design of the individual manufacturers has been realized.

The SUV category continues to boom not just in Japan, but worldwide.

In the mini-vehicles segment, Suzuki and Daihatsu launched SUV models in a tall wagon packaging. The second generation of the hit Hustler (Fig. 4) model has a design that is recognizable at first glance, and gives a tougher, active impression thanks to elements such as a two-tone roof reminiscent of hardtops and a square form.

The Daihatsu Taft (Fig. 5) also presents a squarer silhouette, with features such as the way plastic parts are inserted simultaneously evoking both toolbox-like toughness and a fun sense of playfulness. Despite the lack of common elements, it brings the earlier Naked model by the same manufacturer to mind.

In the compact car segment, the above-mentioned Yaris and Fit each added an SUV to their lineup. The

Yaris Cross (Fig. 6) may be a Yaris in name, but its extended total length and width, large diameter tires, and different panels make it a completely different car. The stable stance resulting from the four large wheels and the form emphasizing the front and rear fenders exude vigor, while the forceful front face, which differs from that of the Yaris, draws interest with its sleek and calm expression.

In the next higher category, Toyota has also upgraded its Harrier urban SUV (Fig. 7). The various design elements of the previous model are skillfully carried over and incorporated for a final impression that clearly distinguishes the vehicle as a new model. Its silhouette also reflects the fine balance achieved between the personality exhibited by European premium coupé SUVs and the luggage-carrying role of an SUV.

New models of passenger cars such as the Toyota Mirai and the Subaru Levorg were also released. Although its first incarnation had a distinctive design recognizable at a glance, the new version of the Mirai (Fig. 8) has a handsome coupé-like silhouette with a wide, low stance that gives it a beautiful and inviting design.



(Source: Toyota Motor Corporation website)

Fig. 8 Toyota Mirai



(Source: Subaru Global Media Site)

Fig. 9 Subaru Levorg



(Source: Honda Motor Co., Ltd. website)

Fig. 10 Honda N-One



(Source: Lexus website)

Fig. 11 Lexus IS

The Levorg (Fig. 9), which falls in the now minority category of station wagons, combines a silhouette that conveys the luggage-carrying role of station wagons with a sharp and solid form that embodies the “bolder” design concept of the manufacturer to project an impression that transcends its category.

New models of the Honda N-One and Lexus IS were released.

The completely redesigned N-One (Fig. 10) uses the panels of its N360 predecessor and features a design that inherits the timeless value of previous generations.

A partial redesign of the Lexus IS (Fig. 11) nevertheless involved significant changes, featuring a wider and lower stance that applies considerable polish to the sportiness of its predecessor.



(Source: Ford press site)

Fig. 12 Ford Bronco



(Source: Chrysler press site)

Fig. 13 Jeep Grand Wagoneer



(Source: GMC press site)

Fig. 14 GMC Hummer

With an approach that differs from the concept of new models constantly calling for changes or new features, this redesign provides a sense of the importance of visual changes in design, and of the diversity in mindsets surrounding its significance.

3 SUVs Exuding Their Intrinsic Appeal

Turning to markets outside Japan, one trend gaining momentum is the promotion of vehicles offering the full gamut of SUV appeal within the now premium market segment represented by such vehicles. In 2019, the Land Rover Defender became the first new model in 71 years. In 2020, new models of the Ford Bronco (Fig. 12), the Jeep Grand Wagoneer (Fig. 13) and the GMC Hummer EV (Fig. 14) were launched in the United States. They differ in character from the group of SUVs that have turned into alternatives to passenger cars.

With its high ground clearance, a body with a short overhang, and very large wheels, the first new Ford Bronco model in 24 years has proportions that instantly



(Source: GMC press site)

Fig. 15 Cadillac Lyriq



(Source: Audi press site)

Fig. 17 Audi e-tron Sportback



(Source: Volkswagen press site)

Fig. 16 Volkswagen ID.3



(Source: BMW press site)

Fig. 18 BMW iX

mark it as an off-road vehicle. Its appeal lies in the expectations of a special experience created by its clear intent to emphasize an outdoor adventure design.

It inherits the character and proportions of the original model while adopting a modular design enabling various customizations. This approach blends with the history and recreational aspects of the vehicle and is likely to deepen the connection between users and the customized vehicles market.

4 Expanding EVs and Their Design —

There are differences in approaches to EV design based on market conditions. In the U.S., emergent EV manufacturers, notably Tesla, have been drawing attention, and often approach design expression in a way that obviously differs from that of manufactures with an existing lineup of internal combustion engine vehicles.

Among established manufacturers, Cadillac announced the Lyriq (Fig. 15), the first EV for the brand. Its low and wide proportions, and front face exhibiting various expressions, reflect the use of a new design language for the brand.

Similarly, in Europe, established manufacturers are rapidly advancing their EV strategy, and seem to be focusing on finding ways to provide a new expression for EVs while preserving their brand identity. The iD3 using Volkswagen's new design language (Fig. 16), the Audi e-tron Sportback (Fig. 17), BMW iX (Fig 18), are examples of models with a silhouette that retains the dis-



(Source: Nissan Motors website)

Fig. 19 Nissan Ariya



(Source: Honda Motor Co., Ltd. website)

Fig. 20 Honda Honda-e

tinctiveness of their brand while expressing differences from the internal combustion engine models through evolved details or expressions.

Dedicated EVs have also been announced and introduced in the Japanese market, and can currently be said to be taking a middle road between those two approaches.

The Nissan Ariya launched in 2021 (Fig. 19) embodies its manufacturer's new design slogan of "Timeless Japanese Future" and, like the Note released after it, offers a simple and smooth flowing reflection that evokes the smooth running of a pure EV.



(Source: Mazda Newsroom)

Fig. 21 Mazda MX-30



(Source: provided by Honda Motor Co., Ltd.)

Fig. 23 Honda Honda-e



(Source: Subaru Global Media Site)

Fig. 22 Subaru Levorg



(Source: Mercedes-Benz press site)

Fig. 24 Mercedes-Benz S-Class

The Honda e (Fig. 20) launched in Japan in 2020 similarly presents a friendly form and face through an extremely simple configuration, while incorporating an unassuming attention to detail that gives a futuristic impression worthy of a pure EV.

Although primarily centered on the hybrid line in Japan, the Mazda MX-30 (Fig. 21) follows the “Human Modern” design concept with a structural motif giving it a surface quality presenting a modern and simple expression that differs from the previous *Kodo* design.

It will be interesting to see what expressive approaches EV manufacturers other than those presented above will take.

5 Growing Importance of Infotainment in Interior Design

Focusing on on-board infotainment with connectivity technology has become a key point in the evolution of interiors, and fitting the increasingly larger displays has become one of the challenges in interior design.

Positioning displays horizontally at the same line-of-sight height as the instrument panel has become mainstream, but the Subaru Levorg (Fig. 22) has a vertical display in the center panel offering a layout designed to for easy readability of the navigation screen. For its part, the Honda-e (Fig. 23) display includes the images from the side mirrors and fill the entire width of the instrument panel.

The Mercedes-Benz S-Class (Fig. 24) introduced one

possible direction for the vehicle human-machine interface (HMI) and operation systems. It is equipped with a very high resolution display that enables control through highly accurate voice and gesture recognition, and the instrument panel that used to require many switches now seems sleeker. The supplier of the GPU used in that AI cockpit system, NVIDIA, has stated (in its official blog) that eliminating 27 switches or buttons has secured space for additional functions. In addition, the head-up display uses AR to show the navigation function, presenting a potential alternative course for the vehicle graphical user interface (GUI) as well.

There are concerns that such technologies may be more difficult to use than the physical switches apt to provide intuitive control, but as technology advances and accuracy improves, they have the potential to turn into standard operation systems.

6 Upcoming Car Design

The Vision-S concept car (Fig. 25) announced by Sony at CES 2020 typifies the accelerating switch toward EVs due to more stringent global environmental regulations, as well as the promotion of the connected, autonomous, shared, and electric (CASE) concept that are impacting all aspects of the automotive industry and providing an opportunity for participants from other fields to enter the fray.

During this period of transformation, it is not only cru-



(Source: Sony press site)
Fig. 25 Sony Vision-S

cial for automakers to flexibly respond to changes, but also critical not to lose sight of the intrinsic value of automobiles as a passenger vehicle.

In addition to being a tool for movement, automobiles also offer the freedom to move around as desired and help support the experiences attained at the desired destination.

Even as CASE and mobility-as-a-service (MaaS) bring advances in automated driving and its attendant services, the intrinsic appeal of automobiles will never change, and design plays a tremendous role in conveying that appeal.

It is important for designers to accept new ideas adapted to evolving technologies and changing needs while also expressing, and conveying, both emotional and experience value aligned with the feelings of users.

❁ ❁ ❁ ❁ ❁ ❁ ❁ ❁ ❁ **Body Structures** ❁ ❁ ❁ ❁ ❁ ❁ ❁ ❁ ❁

1 Circumstances Affecting the Automobile

In 2020, record high temperatures were recorded worldwide, and the average global temperature rose by 1.25 degrees compared to pre-industrial revolution levels (average for 1850 to 1900) to its highest level in history. The COVID-19 pandemic caused road traffic volume to drop drastically worldwide, but the change in global CO₂ emissions stopped at -5.8%, highlighting just how difficult the carbon neutrality goal set by various countries will be to achieve.

The governments of various countries have announced bans on the sale of gasoline and diesel vehicles (electrification of vehicles), shining the spotlight on the development of BEVs. However, well-to-wheel CO₂ emissions considerations also make it necessary to study powertrains in combination with the power generation situation of those countries.

Under these circumstances, the vehicle body structure field is pursuing the development of platforms (P/F) adapted to electric vehicles while concurrently focusing more than ever on weight reduction aimed at mitigating the increase in vehicle weight.

The spread of the COVID-19 pandemic has significantly boosted remote work and online activities, as well as the growth of virtual technologies, while also raising expectations concerning safe and comfortable personal mobility. Cameras and radars are leading to marked advances in advanced safety technologies. At the same time, increasingly stringent regulations on body strength,

the last bastion of occupant protection, as well as on protecting pedestrians and cyclists are also leading to advances in increasing the strength of members, the use of multi-materials, and structural optimization.

This section presents the vehicle body technologies observed in models sold in 2020 based on the above circumstances.

2 Technological Trends Concerning Performance Requirements

2.1. Stability and Controllability

Technology that enhances handling stability and controllability not only gives the driver a sense of joy and security, but also assists in the accurate and natural operation of driving support functions such as lane keeping or automatic lane changing. In the Toyota Yaris, refinements to the joining of the annular structure at the front cowl, door openings, and rear, and of the main frame, have improved torsional rigidity by 30% compared to the previous structure. The Subaru Levorg complements the Subaru Global Platform with the addition of a full inner frame that effectively increases rigidity. It also inserts a resin foam reinforcement inside the back door opening frame to secure continuity between torsional rigidity improvements and rigidity (Fig. 1).

2.2. NVH

For xEVs with a motor-only running mode, measures against noise are emphasized due to the prominence of wind noise and the sound of stones hitting the inside of the wheel housings or the underfloor. In the Lexus UX 300e, the underfloor battery has also been given sound

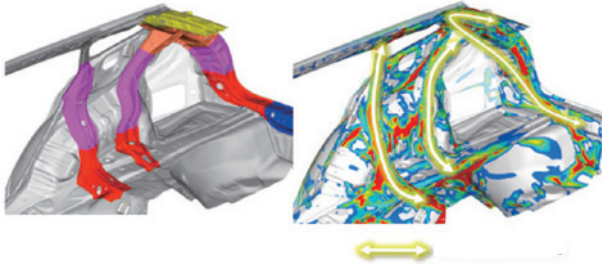


Fig. 1 Rear Body Frame of the Subaru Levorg



Fig. 2 Honda Accord Pop-Up Hood⁽⁷⁾

insulation properties.

In response to stricter vehicle exterior noises regulations in Europe, measures such as switching to sound absorbing material for the underfloor undercover and fender liner, and the addition of such material in the engine compartment, are being taken.

In addition to optimizing the eigenvalue of the vehicle body, anti-vibration measures include adopting adhesives that reduce panel vibration, or provide a vibration damping effect, and using other technologies aimed at reducing occupant discomfort.

2. 3. Safety

There has been striking progress in advanced safety functions, with camera and radar-based active safety systems evolving in leaps and bounds. At the same time, regulations and information disclosure standards concerning passive safety are becoming more stringent, and there is stronger demand to mitigate damage to the other party in a collision, including pedestrians and cyclists.

The Honda Accord features a pop-up hood that lifts the back end of the hood in the event of a collision with a pedestrian to secure space away from the engine and mitigate the strength of the impact (Fig. 2). The pillar and other hard parts in the Subaru Levorg include pedestrian protection airbags to mitigate impacts.

2. 4. Electrification

The dedicated EV body of the Honda e increase the design flexibility of the front frame by mounting the drive motors in the rear to realize a nimble urban com-



Fig. 3 Honda e⁽⁷⁾⁽⁹⁾



Fig. 4 Mazda MX-30 EV Model⁽¹⁰⁾

muting vehicle (Fig. 3). In contrast, the Mazda MX-30 is an HEV model rather than an EV (Fig. 4). The P/F frame concept and transportation criteria have been made the same to enable mixed production, making it possible to offer a choice of power unit matched to the market.

3 Technological Trends in Weight Reduction

3. 1. Steel Sheets

Steel remained the most prevalent structural material in 2020. The use of 1.5 GPa class hot stamped material (HS material) or of 1.2 GPa class ultra-high tensile strength steel sheets for the frame of the cabin, which plays a crucial in protecting occupants, is expanding.

Hot stamping is a technology that achieves high strength by rapidly cooling material heated at 900°C or more during forming. It offers high forming stability, and can be combined with effective localized reinforcement through patchwork blanks, or tempering based on adjusting the cooling temperature or the use of laser irradiation to vary the strength within a single part, thereby raising its functionality. However, compared to cold forming it requires complex and extensive facilities such as

heating furnaces and cooling equipment for the dies. While existing equipment is anticipated to be usable for ultra-high tensile strength steel sheets intended for cold pressing, the higher pressure required for forming results in stronger spring back, which imposes shape restrictions. Selecting materials and manufacturing processes based on location and shape will help reduce costs.

In the Toyota Yaris, the use of HS material in the center pillar and the upper part of the front pillar, and of 1.2 GPa class cold formed ultra-high tensile steel sheets in the rockers provides a cabin strength ensuring ample safety even in a light-duty vehicle. The Nissan Note is the first vehicle in Japan to use 1.5 GPa class ultra-high tensile steel sheets in the floor cross members. The reinforcement of the Toyota Harrier center pillar uses hot stamping technology that adjusts the temperature during forming to create differences in strength within a single part. The same technology is used in the rear frame of the Honda Civic, contributing to reducing the number of parts and making the vehicle lighter. For the center pillar of the Subaru Levorg, materials with different strengths after hot stamping were joined prior to forming, and integrated forming was applied to produce variations in strength within the part and control the deformation mode.

In general, the use of materials with a class higher than 1.2 GPa must be carefully validated as such materials are subject to delayed fracturing caused by hydrogen embrittlement, liquid metal embrittlement (LME) cracking if zinc plating is added, and other issues not perceived as problematic in low strength steels.

3. 2. Low Specific Gravity Nonferrous Metals

Aluminum is the prototypical low specific gravity nonferrous metal in vehicle bodies. Vehicles such as the Chinese NIO ES6 and ES8 with a body made almost entirely of aluminum are being introduced, but examples of using it for outer panels attached with bolts such as the hood, side doors, or back doors, or in bumper beams, are more common. Outer panels mainly used 5000- or 6000-series rolled alloys, while bumper beams and other locations requiring higher strength use 7000-series extrusion materials.

The use of die-cast aluminum in frame members was first observed in Europe and the U.S., but has also found its way in Japanese vehicles. Die casting achieves complex shapes with a single part, therefore offering the ad-



Fig. 5 Lexus LC Convertible⁽⁵⁾

vantage of reducing the number of parts and streamlining structures.

Aluminum is used in part of the front suspension tower of the Toyota Mirai, Lexus LS, and other vehicles built on the GA-L P/F. In the Lexus LC convertible, the use of a rigid member combining extrusion and die casting in the rear bulkhead, along with a large integrated die cast component in the rear suspension tower brace, mitigates the increase in weight while securing vehicle rigidity (Fig. 5).

The Land Rover Defender uses aluminum for 98% of its BIW, 30% of which consists of recycled 5000-series material, thereby contributing to reducing CO₂ during manufacturing.

3. 3. Composite Materials

Despite being known as a lightweight, high strength material, carbon (CFRP) sees limited use due to its cost and low productivity. Nissan has developed a process (the C-RTM process) that reduces the time required for forming by 80% compared to the standard RTM process. The inner door panel and inner trunk lid of the Lexus LC, as well as the roof panel of the Toyota Yaris GR, use short carbon fiber C-SMC panels.

3. 4. Joining Technologies

Building stronger vehicle bodies and adopting multi-materials cannot be achieved without advances in joining technologies. Broadly speaking, the necessary technologies can be divided into more advanced resistance (spot) welding, continuous joining, and the joining of dissimilar materials.

Conventional spot welding is limited to joining two or three sheets, and locations where four or more sheets overlap imposed restrictions such as setting a notch or escape hole in one of the parts on the joining of frame parts to one another.

In the Subaru Outback (North American specifications)

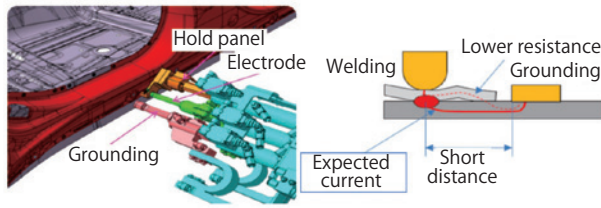


Fig. 6 Single-side SPW welding

the number of joining points for frame parts connected to one another was increased by setting the outer panels on the frame after assembling it and developing technology to weld from the electrode on a single side. This approach avoid the wasteful setting of holes or notches (Fig. 6).

For the Lexus LC, a technology called root welding, which welds four sheets by changing the current value gradually rather than in square waves, was developed and applied.

Using high strength material and making thinner members to decrease weight is prone to reducing vehicle rigidity. Shortening the spot weld interval between parts can improve rigidity, but too narrow an interval causes poor welding due to split current or distortion due to the heat. European vehicles are leading the way in the use of structural adhesives as a continuous joining technology. Japanese manufacturers are increasingly following suit and adopting this technology not only in luxury vehicles, but in a wide range of models including mini- or compact vehicles such as the Honda N-One or the Suzuki Solio.

As multi-material use gains traction, the joining of steel with dissimilar materials requires avoiding direct contact with those dissimilar materials to prevent galvanic corrosion.

4 Trends in Development Methods

Environmental measures centered on electrification and the need to adapt to connectivity and automated

driving are increasing the complexity of vehicle development, and commensurate initiatives to cut costs and streamline structures are expected in the field of vehicle body development. This section presents examples of such initiatives.

4.1. Platform Integration

In the past, each manufacturer established and developed its own P/F, but examples of platform sharing between OEMs have been increasing. This Nissan Note uses the CMF-B P/F shared with Renault. That P/F is also used in the Juke (European specifications), as well as the Renault Clio (Lutecia) and Captur. Volkswagen shares the MQB P/F for ICVs with other group manufacturers such as Audi, Skoda and SEAT. Shared P/F go beyond reducing costs through the use of common parts. They also increase development efficiency by defining design rules, and aim to enable the effective and rapid introduction of new models to the market.

4.2. Topology Optimization

Topology optimization is an analysis method that retains the elements necessary to the characteristics required by a given design space, and calculates the most effective distribution of materials to achieve them. Applying it in the initial stages of the design concept to phases or locations with a relatively high degree of freedom can result in proposals for lightweight structures. In addition, its scope has extended beyond part shapes to also encompass the optimization of spot point positions or adhesive position, leading to its application in streamlining the structure of the entire vehicle.

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