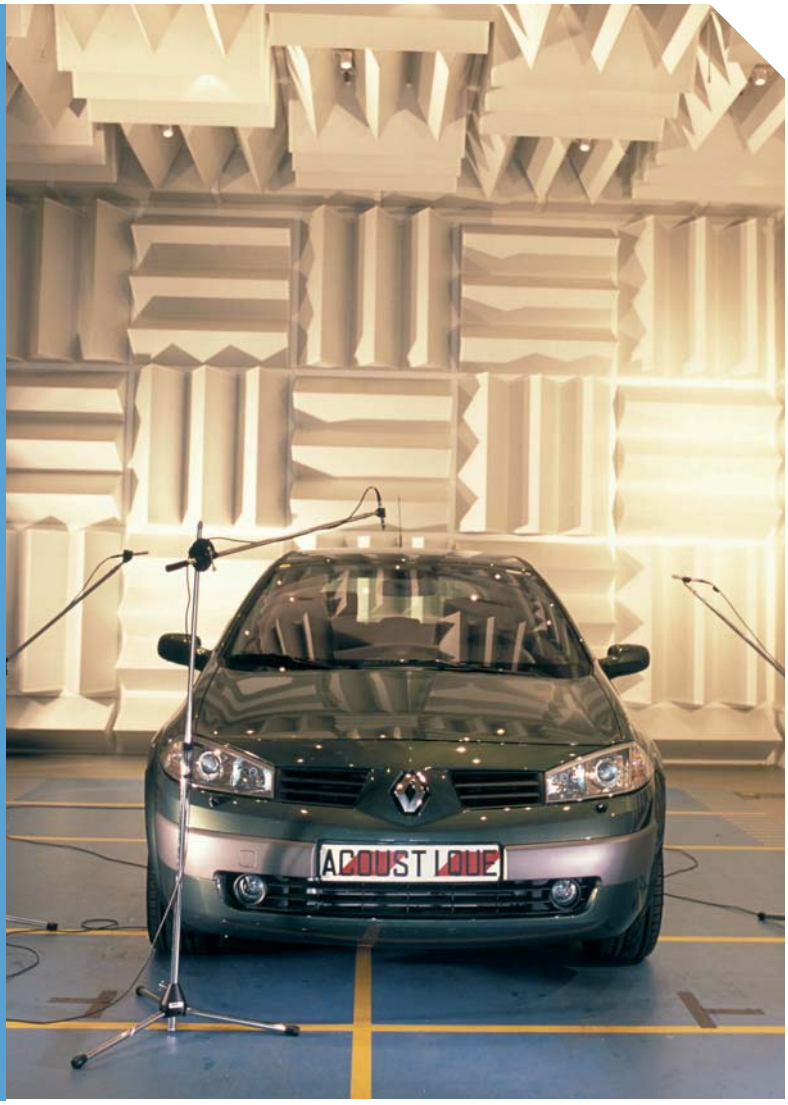
Life on board

Acoustics in the cabin

In general, acoustic comfort is a factor of safety. Driver and passengers arrive relaxed at their destination. This rule must however have a fine distinction: a passenger compartment which is too quiet deprives the driver of useful sensory information. It is all a question of dosage **to conserve useful information while at the same time removing nuisance noise.**



RENAULT COMMUNICATION

BASIC FACTS

The level (and type) of noise inside a car's passenger compartment has a considerable impact on comfort. Driver and passengers also often consider that the acoustics of a car is enough to reveal its overall quality and the care given to its design and manufacture.
However, mastering noise in the cabin is a highly complex issue. There are many sources of vibration, and hence noise, in a moving car. Although the engine alone is a significant source of noise owing to combustion phenomena and the movements of its many moving parts, it is far from being the only one. Aerodynamic noise due to the friction of air on the body appears as speed increases. Tyres also cause vibrations and rolling noise. Finally, the body itself may vibrate due to both aerodynamic and mechanical phenomena from the drive axle transmitted through the suspensions.

The noise present in the cabin can be divided into three major categories: low-frequency noise, medium-frequency noise and high-frequency noise.

Low-frequency noise corresponds to booming, which can be very tiring on long journeys. The engine is the primary source of this noise. Medium-frequency noise, more tolerable yet still a source of irritation, usually comes from mechanical elements such as the transmission and some engine components. Finally, high-frequency noise is often due to aerodynamic phenomena: whistling, air noise ● ● ●

in the air conditioning circuits, etc. This noise makes it difficult to have a conversation in the passenger compartment and to listen to the car radio.

Fighting the effects of these internal and external noise sources requires specific solutions for each problem.

IN SHORT

Controlling noise levels inside a car's passenger compartment calls on several skills. Aerodynamics, vibrational analysis and simulation are used to provide a specific response to each source of noise.

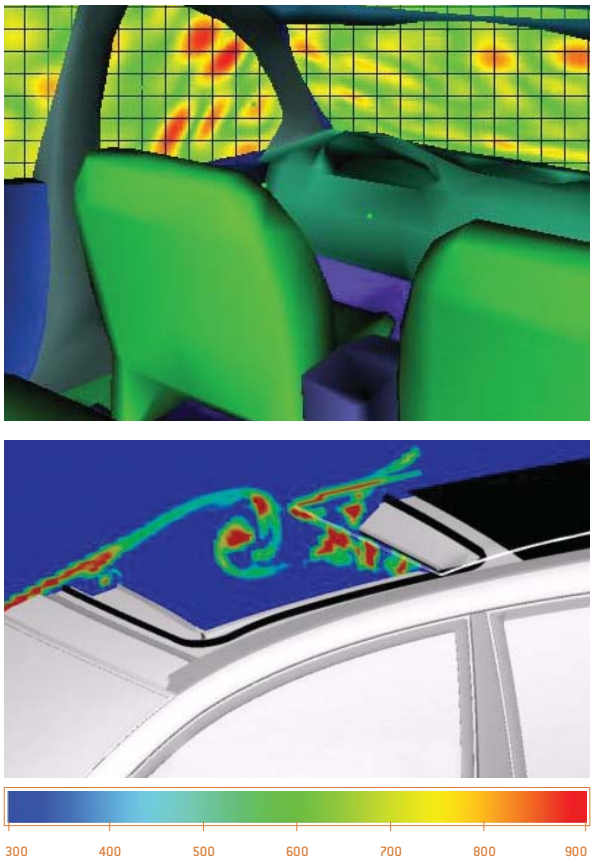
HOW DOES IT WORK?

Reducing noise from the engine means making changes to internal design, as well as installing elastomer parts which separate it from the vehicle and limit vibration from the transmissions. They are used to damp vibrations where the engine is in contact with the chassis of the car, hence limiting their transmissions to the cabin. Increasing the thickness of sound-proofing at the dashboard (the wall between the engine compartment and the passenger compartment) also reduces noise propagation, especially for medium and high frequencies.

For the drive axle, the use of elastomer parts enables the vibrations from the wheels to be filtered.

Mastering vibration in the body requires digital modelling combined with measurements taken on prototypes. Some problems can be resolved by adding reinforcements on the body, so as to increase its stiffness, or devices which provide structural insulation. To do so, the origin of this noise must be accurately identified. Digital modelling of the body is used to simulate vibrations by amplifying them until the points where it is possible to act are determined very precisely, and the effectiveness of the solution envisaged can be assessed. This is a particularly complex problem where any action on a component may cause harmful effects by generating new vibrations in another zone of the body. Hence, modelling is used to assess the impact of each intervention until a satisfactory solution is found.

Reducing high-frequency noise, and in particular air noise, requires many aerodynamic studies. For example, a door mirror may be a significant source of aerodynamic noise. As well as the whistling it may cause, it may transmit vibrations to the body through its attachment. Door mirrors are therefore subject to considerable aerodynamic modelling. Similar modelling is used for window or windscreen joints. They must effectively act as dampers for the windows and ensure air and water tightness, without breaking the continuity of body lines, which may cause noise-generating air swirls.



RENAULT COMMUNICATION

Below: simulation of the airflow above a sunroof (Mégane). Top: velocity field on the windows of a Laguna subjected to airflow.

All the air circuits for air conditioning are subject to aerodynamic studies, from the air inlets at the ventilation nozzles to the air propulsion fan, to ensure silent operation.

Air-conditioning/ automatic air-conditioning

In recent years, air-conditioning has shifted from being a luxury option, reserved for up-market saloons, to basic equipment requested as standard. What's more, **as well as the comfort provided, air-conditioning contributes to safety.** On the one hand, studies have shown that when the temperature in the cabin exceeds 28° C, driver behaviour tends to deteriorate, owing to discomfort and tiredness caused by the excessive heat. On the other hand, air-conditioning enables the air in the passenger compartment to be dried, preventing the formation of mist on the windscreen and windows.

RENAULT COMMUNICATION

BASIC FACTS

Air-conditioning is used to cool the air temperature. Automatic air-conditioning ensures optimal heat comfort whatever the external conditions, by both heating and cooling the air distributed in the passenger compartment ventilation circuit. Renault equips many of its models with automatic air-conditioning control by zone. The system acts on the temperature of the air blown from various air outlets according to the specific needs of each zone in the passenger compartment. Finally, on some vehicles with hands-free cards (see sheet), the air-conditioning parameters are automatically memorised. The personal settings of the driver are restored when the car detects his card.

IN SHORT

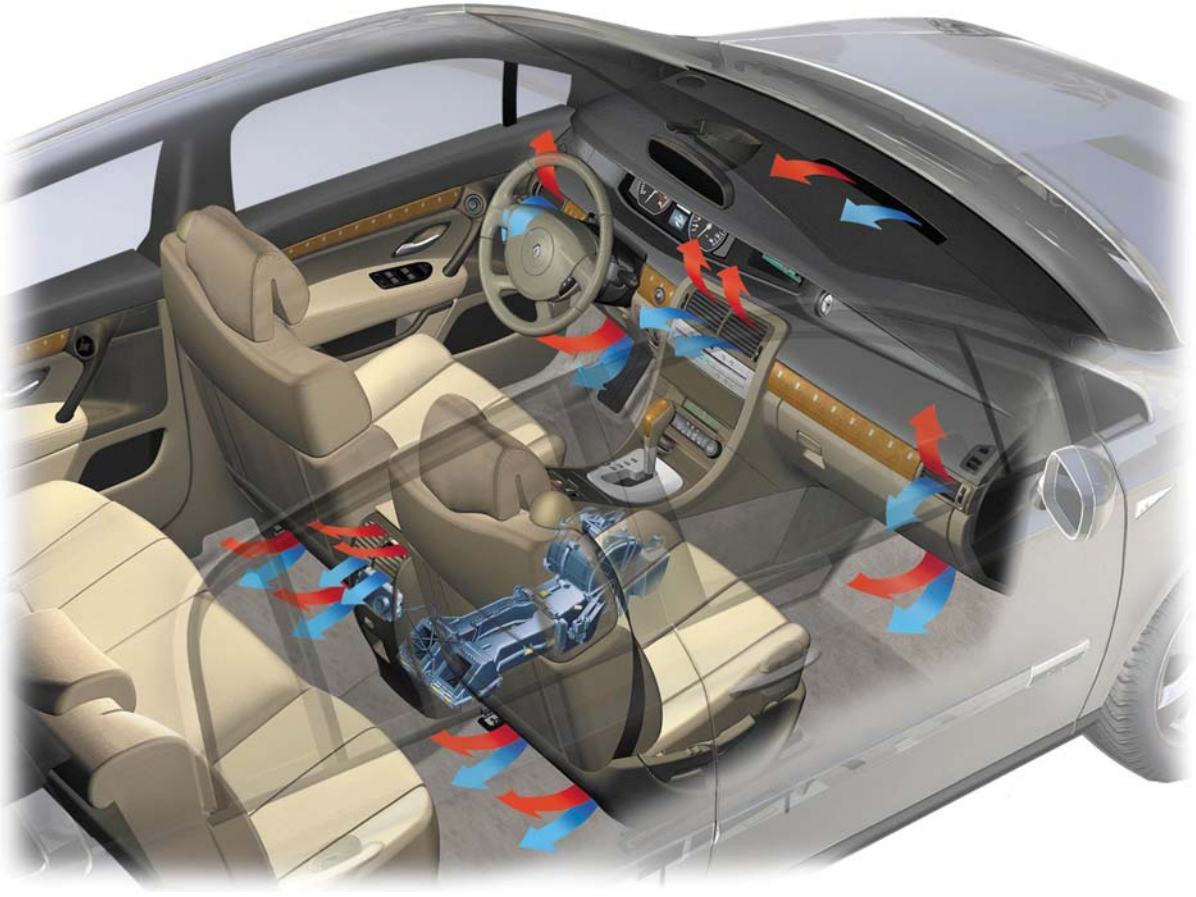
As well as providing comfort by maintaining a constant temperature in the cabin, air-conditioning also plays a role in safety, by preventing conditions which may lead to a drop in driver vigilance. In the winter, it also prevents the formation of mist on the windscreen and windows by drying the air in the passenger compartment.

HOW DOES IT WORK?

To carry out the task satisfactorily, a computer manages the automatic adjustment of the air-conditioning. It uses sunshine, temperature and air quality sensors. The first two enable it to regulate the temperature of the air that is distributed through the air-conditioning circuit, the third commands the switch-over to "recycling" mode as soon as it detects external air pollution. Note that recycling mode is also activated automatically after the car has remained stationary in the sun for a long time, to ensure rapid lowering of the cabin temperature. To simultaneously deliver both the heating and cooling of the air distributed throughout the cabin, the air-conditioning has a double circuit. These circuits are known as the "cold loop" and the "heat loop".

The cold loop functions by way of a system identical to that found in refrigerators and freezers. A compressor with variable cubic capacity (in order to be able to precision-manage the action of the air-conditioning) is driven by the car engine. It contains coolant at a pressure of approximately 20 bar. Under the effect of this compression, the temperature of the coolant, now in a gaseous state, rises to reach 100° C. The coolant then moves across a condenser in the form of a radiator placed in the car air intake grille and therefore subjected to the temperature of the ambient air. The fall in temperature which takes place in the condenser causes the coolant to liquefy. In liquid form, it reaches an expansion valve – a special valve that lowers the pressure of the coolant to within the neighbourhood of 3 bar as well as the temperature to approximately 2° C – then it moves through an evaporator which acts as a second radiator where once again, the coolant changes from a liquid state to a gaseous state, thanks to the heat exchange which takes place between the coolant and the air. The air yields its heat to the fluid, which allows it to change from a liquid state to a gaseous state. A fan then blows the air coming from outside, or else recycled air, through the evaporator and thus supplies cold air to the cabin.

The hot air loop uses the coolant circuit of the engine. A fan propels air through an auxiliary radiator, where it heats up. This process is comparable to that used by the traditional heating system of cars with no air-conditioning. However, because of the increase in the efficiency of current engines, and therefore a lessening of their release of heat, an auxiliary heating device using an electric resistance is often present to speed up the rise in cabin temperature. Lastly, to reduce misting of the windscreen and windows, the cold air-conditioning circuit can be used even in winter. Its function is then to dry out the cabin air by creating a "cold point" in its circuit where the moisture can condense. Renault has equipped some of its models with a cabin air moisture sensor to automate this demisting function.



RENAULT COMMUNICATION

Automatic parking brake

Much more than just a handbrake, the automatic parking brake is an element in driving comfort and pleasure. Its assistance is particularly appreciable when starting on a hill or leaving a parking space, for example. Its action ensures gradual and smooth departure of the car.

RENAULT COMMUNICATION

BASIC FACTS

The automatic parking brake is not just a motorised handbrake. Managed by a computer, it acts progressively and adapts to each situation. An electric motor, controlled by a computer, applies the brakes at the rear of the car – just the right amount – and releases them gently when the driver engages the clutch and accelerates enough to start the car moving. This mode of operation is of great assistance on hill starts. In this case, the computer assesses the road's gradient and deduces the minimum torque required to advance the vehicle. Hence, there is no risk of the car rolling back during starting, a situation which is often delicate especially when the road is very steep. In addition, as the system releases the brake gradually, the car always moves off gently and smoothly. The automatic parking brake is engaged as soon as the engine stops, applying as much brake pressure as required by the situation. For hill starts, the automatic parking brake is engaged by acting on a command. The computer automatically determines the brake pressure suited to the gradient of the road. The system releases the rear brakes when the engine and clutch provide enough torque to move the vehicle forward. Dynamically, the automatic parking brake also ensures an anti-blocking function.

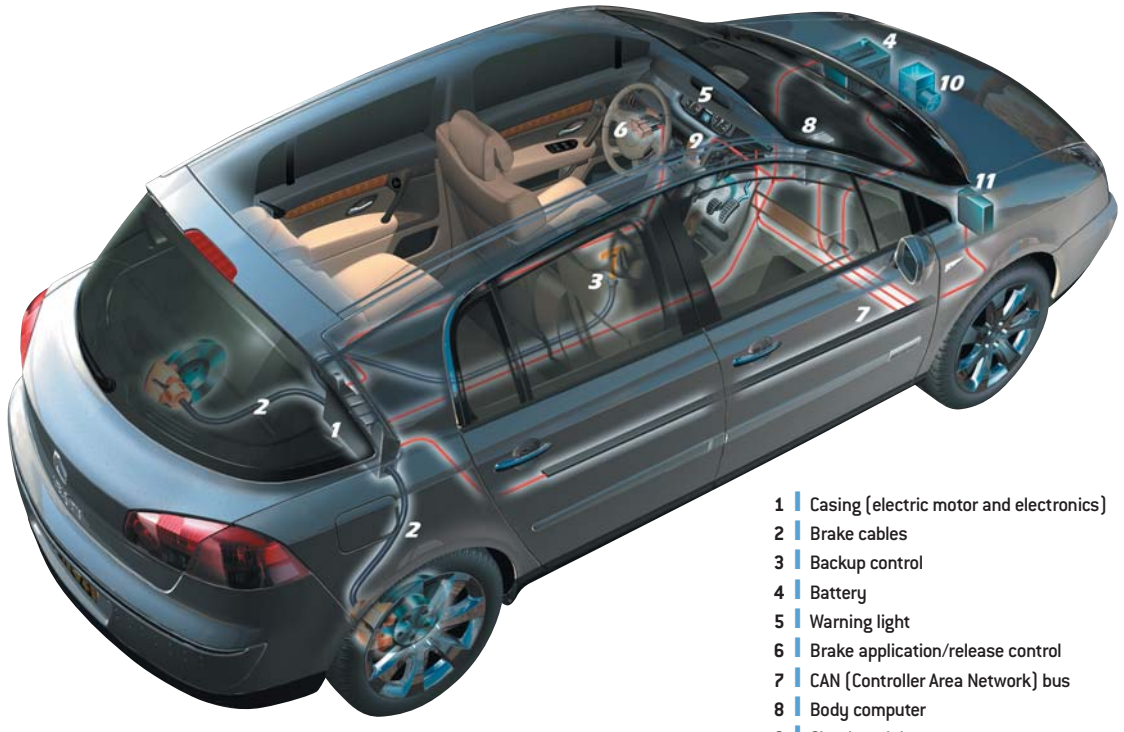
IN SHORT

Managed by a special computer, the automatic parking brake automatically applies braking pressure on the rear wheels adjusted to the gradient of the road. Acting progressively when releasing the brake, the system provides the driver with real assistance for hill starts.

HOW DOES IT WORK?

The active element of the automatic parking brake is an assembly based on an electric motor pulling the rear brake cables by means of a reduction gear: a set of gears to increase the torque of the electric motor and apply considerable force to the cables. It also includes a force sensor which constantly measures the traction applied on the cables. This whole assembly is managed by a computer. To accurately manage the required braking pressure, it is equipped with an inclinometer which indicates the gradient of the road. At the same time, two position sensors, one on the clutch pedal, the other on the gearbox, inform the computer that the driver intends to start driving. In addition, to manage hill starts, the computer analyses the torque applied to the wheels by the engine and the clutch.

Depending on this data, the computer applies a force suited to each situation to the rear brake control cables by operating the system's electric motor. It checks the force by means of the sensor. Finally, it informs the driver of these actions by displaying a message on the instrument panel.



1 Casing (electric motor and electronics)
2 Brake cables
3 Backup control
4 Battery
5 Warning light
6 Brake application/release control
7 CAN (Controller Area Network) bus
8 Body computer
9 Clutch pedal sensor
10 ABS computer
11 Injection computer

RENAULT COMMUNICATION

Cruise control with speed limiter

⁘ As its name indicates, this system has a dual function. It is used, on the one hand, to adopt a constant cruising speed and, on the other, **to fix a maximum speed** that cannot be exceeded.

RENAULT COMMUNICATION

⁘ BASIC FACTS

The cruise control with speed limiter combines comfort and safety functions. For example, on a motorway in cruise mode, the driver is no longer obliged to keep his foot on the accelerator. In addition, whatever the road configuration, maintaining a constant speed enables overall consumption to be reduced. During normal driving, the driver can never perfectly stabilise his speed. Acceleration phases are followed by imperceptible decelerations leading to over consumption. For its part, the speed control prevents the driver from exceeding a threshold speed, without realising it. However, this mode of operation does not determine a minimum speed and cannot therefore act as a speed stabiliser. Whatever the mode selected, the driver can immediately take over control of the speed, either manually or by pressing one of the car's pedals.

IN SHORT >>>
The cruise control ensures a constant cruising speed whatever the road configuration, and as well as providing driving comfort, it reduces the car's consumption.

IN SHORT >>>
The speed limiter signals when the speed fixed as the limit has been exceeded, by "hardening" the accelerator pedal.

: HOW DOES IT WORK?

1 THE PROTOCOL

The driver sets the reference speed using four commands located on the steering wheel. The system's ECU constantly compares this value with speed data either directly from the computer, or from the wheel tachometers sent by the ABS.

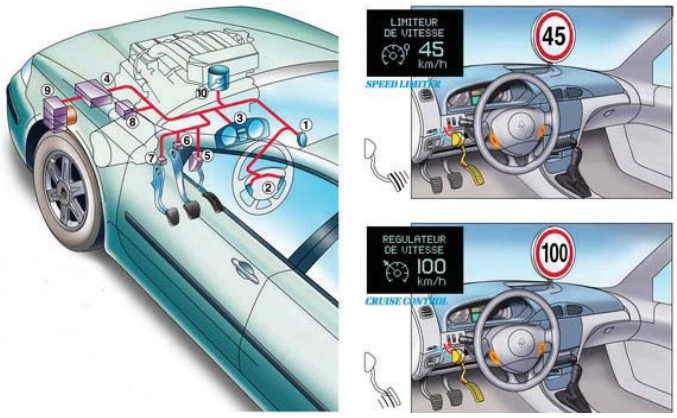
• **In cruise control mode,** the system acts on the micromotor of the gas throttle valve command, for a petrol engine, or on the injection pump for a diesel engine, to ensure a constant speed. Any action on the accelerator enables the fixed speed to be exceeded. The cruising mode is then automatically reactivated when, following deceleration, the cruising speed is reached once again. Inversely, any pressure on the brake pedal or clutch deactivates the system.

• **In speed limiter mode,** the system does not act directly on the cruising speed. However, when the threshold speed is reached, it activates a micromotor which creates a "hard point" on the accelerator. The pedal has a tendency to rise under the driver's foot. This constitutes a signal, but not a limit: greater foot pressure will enable this hard point to be passed to continue acceleration. This does not mean that the speed control function is deactivated. It takes up its role once again when the car's speed falls below the threshold value.

2 TWO FUNCTIONS WITH DISTINCT PURPOSES

The cruise control is above all an element used for comfort and to reduce the vehicle's fuel consumption.

The speed limiter contributes to safety by preventing the driver from accidentally exceeding a speed he has chosen as the limit.



1 On-off button
2 Steering wheel command
3 Dashboard
4 UCE motor
5 Accelerator pedal position sensor
6 Brake pedal switch
7 Clutch pedal switch
8 Automatic gearbox
9 ABS
10 Throttle valve unit

RENAULT COMMUNICATION

Customising the vehicle

Although a made-to-measure vehicle remains a dream, electronics, increasingly present in vehicles, is gradually bringing this concept closer. Already, the hands-free card is able to memorise certain elements of cabin ergonomics for several users and restore them when a new driver sits behind the wheel. Soon, suspension systems, steering, gearbox and even engine behaviour will be able to adapt to the driver's temperament.

RENAULT COMMUNICATION

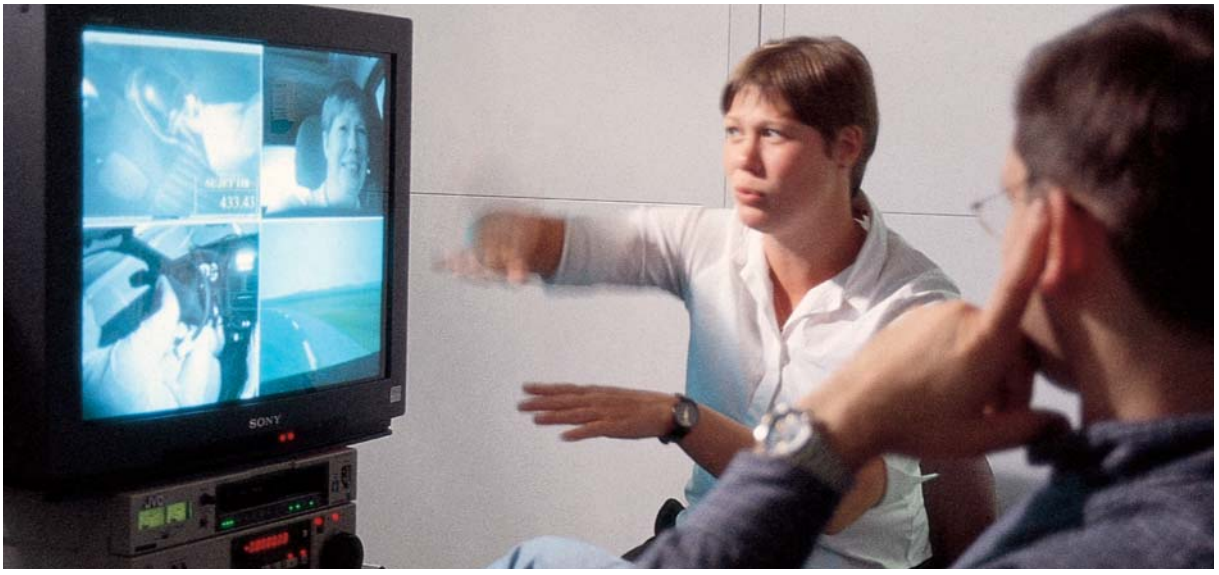
BASIC FACTS

Large-scale production remains the pivot of automobile economics. This type of production cannot therefore directly meet the manufacture of made-to-measure vehicles. However, the increasing use of onboard electronics will eventually enable many systems and functions, even vehicle behaviour, to be customised. The cabin has already benefited enormously from this evolution. Air conditioning or car radio settings can be memorised and called up without user intervention. But these are still only parameters based on physical comfort. Auto-adaptive gearboxes, such as DP0, SU1 or Quickshift, are anticipating the extension of customisation to the overall behaviour of the vehicle. They are able to modify their gear changing laws to the reactions of the driver. This customisation may soon also concern the behaviour of the engine and, more widely, the dynamics of the car, to adapt it to the driving style of each user.

IN SHORT

Increasingly present in cars, electronics will soon enable the personality of the vehicle to be adapted to the temperament of the driver. As well as cabin ergonomics, customisation will involve the very behaviour of the car.

HOW DOES IT WORK?



RENAULT COMMUNICATION

Whether it be the injection, the gearbox, braking, steering assistance or comfort functions, each component of the car is managed by a specific computer, or ECU. All ECUs base their decisions on "tables of law", themselves based on parameters stored in their memories. Modifying these basic parameters affects the decisions made by each ECU and consequently, directly influences the actions, or reactions, of a specific function. In addition, these ECUs are often interconnected and dialogue permanently. By acting also on this dialogue, the whole behaviour of the car becomes "modular".

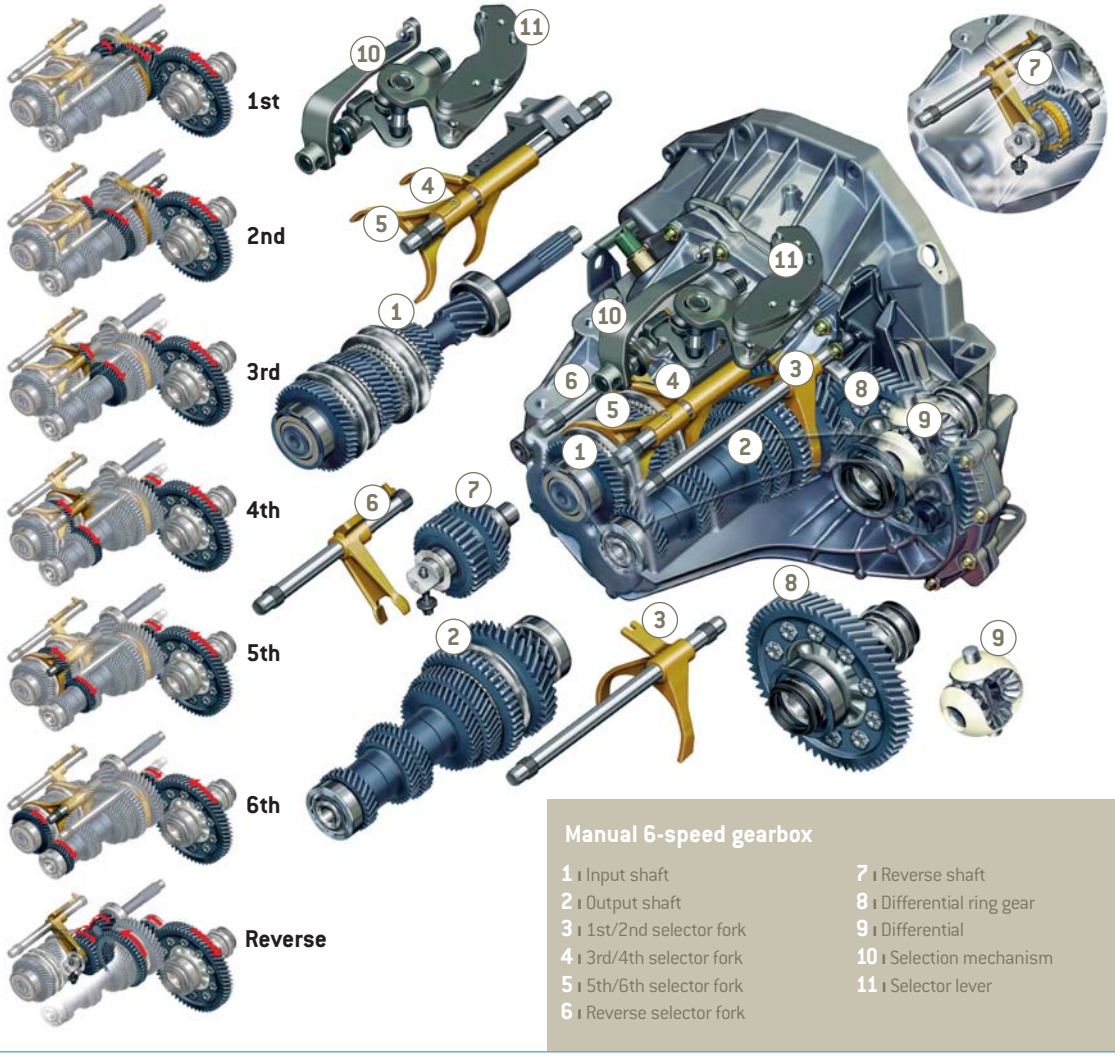
Hence, as well as that of the gearbox, the behaviour of the engine can be modified by means of the injection ECU, among others, to give it a more responsive, or inversely, a more flexible temperament, according to the desires of the user. The steering can also become either more direct or low-geared, by modifying the degree of response of its steering assistance. The stiffness of the suspensions is also accessible and, overall, the whole dynamic behaviour of the car becomes adaptable.

Finally, the arrival of "x-by-wire", where electrical connections replace the cables and belts and current hydraulic circuits, offer even greater customisation possibilities by separating the mechanics of the control elements, such as the pedals or the steering wheel, from those controlled.

Renault is equipped with extremely powerful driving simulators to better understand driver behaviour. These simulators are able to place drivers in very realistic driving situations to precisely analyse their reactions without risk. These extremely accurate analyses are being used to create the capacity for auto-adaptation of the vehicles of tomorrow.

The gearbox

The gearbox affects both the behaviour of a car and its engine. The length and number of gear ratios give the engine a temperament which may be **sporty, or more sedate and fluid** in the case of a touring car.



RENAULT COMMUNICATION

Manual 6-speed gearbox

1 I Input shaft
2 I Output shaft
3 I 1st/2nd selector fork
4 I 3rd/4th selector fork
5 I 5th/6th selector fork
6 I Reverse selector fork
7 I Reverse shaft
8 I Differential ring gear
9 I Differential
10 I Selection mechanism
11 I Selector lever

BASIC FACTS

Gearboxes can be classified into two major families, manual and automatic, and each family comprises several sub-divisions.

On manual gearboxes, the decision to change gears is left entirely to the driver, who can thus adapt the behaviour of the car just as he wants, stretching the gears for a sporty drive or, on the contrary, changing them early for a more economic drive. However, from its design, the gearbox predestines the vehicle for a specific type of behaviour. Short gears require frequent intervention from the driver, but they give the car greater "responsiveness" on acceleration. Inversely, tall gears improve comfort while reducing consumption on motorway journeys, for example. The only drawback of manual gearboxes is that they do not protect the powertrain and, in particular, the engine. As it is up to the driver alone to decide when to change gears, over-revving or under-revving may occur, which may compromise the lifespan or reliability of the engine.

RENAULT COMMUNICATION

●●● **Automated gearboxes,** managed by a computer, protect the engine from these sort of risks. Moreover, thanks to the appearance of fuzzy logic, the computer can occasionally modify gear change decisions, adapting them to a sports driving style, or, inversely, to motorway driving. The computer can also choose the best gear in order to reduce consumption. Currently, three major technologies share the automated gearbox market.

The robotised gearbox (see sheet) is a manual gearbox to which servo-mechanisms are added, i.e. a "robot" which changes the gears and manages the clutch according to the instructions received from the computer. It provides excellent efficiency, and hence does not lead to over-consumption. Its only drawback is a short break in engine torque when the gears are changed. The comfort obtained is similar to that of a car with a manual gearbox.

The automatic gearbox (see sheet) does not have this special feature. Able to change gears under load, i.e. without a break in engine torque, it provides a high level of comfort. However, this is offset by over consumption, in particular at the torque converter, which replaces the clutch.

CVT (Continuously Variable Transmission) removes the notion of changing gears. Its pair of conical pulleys, linked by a belt, allows continuous variation of its transmission ratio. In addition, by constantly adjusting the engine speed to driving conditions, it enables the best torque, maximum power or best efficiency to be exploited, for economical driving.

IN SHORT

The gearbox affects both the behaviour of a car and its choice of engine. Whether it be a manual or automatic gearbox, there must be consistency between the number and length of its gears and the vocation of the car: sports, urban, touring, economy.

The hands-free card

With the keyless access and starting system, **the "keyless go" card, sometimes known as a "badge", replaces the ignition key**. It can be customised by the user, memorising comfort data such as seat adjustment, air conditioning settings or the car radio preferences. Interactive, it will soon become the memory of the life of the car. Using a suitable reader, it can be consulted, enabling technicians in the Renault network to instantly obtain a report on the condition of the car (mileage, need for oil change, etc.), in order to optimise servicing times.

RENAULT COMMUNICATION

BASIC FACTS

After three years of development, the hands-free card, also called "badge", is able to replace both the traditional remote control locking command and the ignition key. When the driver is carrying the card, he only needs to place his hand on the door handle to unlock the car. He doesn't even need to take the card out of his pocket or bag. The card is equipped with a memory for vehicle and user data. Hence, everyone can adapt the ergonomics of the car to their size and personal tastes. For each driver, the position of the seats is memorised, as are other comfort elements such as air conditioning or car radio settings. Once the vehicle detects the presence of the card, and after checking that it is one of the cards attributed to it, the system computer "configures" the car according to the habits of the user. In addition, the car can only be started when the card is detected in the passenger compartment. Once again, the driver doesn't even need to take the card out of his pocket or bag. When the user leaves the car, it is just as easy and natural to lock it. The user just presses the button on the door handle and the computer commands locking of all the car's closures. Finally, there are buttons on the card for manual access to locking and unlocking of the doors and boot. Here, the card acts like a conventional remote control.

HOW DOES IT WORK?

As well as a transponder, the hands-free card contains electronic features for low-frequency communication. To ensure this radio link, the car contains several aerials dissimulated in the external door handles or in the roof trim. When the infrared sensor on a door handle is solicited, the computer emits a series of very short encoded bursts. When the card detects this emission, it sends back a code to signal its presence. An encrypted dialogue is then set up between the computer and the card. These two elements identify themselves to each other through a complex exchange of digital messages. Both the computer and card contain encryption algorithms based on mathematical operations. To check that the card is indeed the one attributed to the car, the computer sends a number to the card. At the same time, it calculates the reply to be sent using its own algorithm and encryption key. On receiving the number, the card calculates a result in turn and transmits it to the computer. As the card and the computer have the same algorithm and the same key, the two results must be identical. If they are, the computer is certain that it has identified the card. This dialogue only takes 80 milliseconds. Door unlocking and engine starting are then authorised. In order to prevent accidental unlocking if the user remains near the car, this operation is only effective if the user takes hold of one of the door handles. The system detects this gesture using infrared sensors located in the handles and authorises unlocking. The command to lock the doors is given either when the user orders it by means of the remote control, or on some vehicles when the distance separating the card from the vehicle is too great for the radio link to operate. In this case, the computer detects an “absence of response from the card”.

To start the engine, the computer dialogues again with the card to confirm its presence in the passenger compartment. If such is the case, the engine is started by pressing the “start” button.

IN SHORT >>>

The hands-free card replaces both the infra-red remote control and the ignition key. It allows the vehicle to be entered and started without needing to take the card out of a pocket or bag. However, when the carrier moves away, it is impossible to start the car and the doors are automatically locked.

Hydraulic braking

Hydraulic braking constituted a significant advance in comfort and safety. The principle consists of replacing brake cables by a hydraulic circuit. As it is easier to act on fluid pressure than on cable tension, **this technology rapidly enabled the appearance of power-assisted braking,** also originally called "servo-brake", and then complex systems such as ABS and ESP.

RENAULT COMMUNICATION

BASIC FACTS

The basic concept of the hydraulic braking system is to replace the cables which originally connected the pedal to the brakes with a hydraulic system containing an oil of very low viscosity. This solution also enables wheel braking to be optimised and balanced. This was a delicate or impossible operation using cable systems. Finally, after the force boosters used in assisted braking, the hydraulic braking system has enabled current systems such as ABS and ESP (see sheets) to be developed. It is much easier for an electronic system to act on fluid pressures by means of solenoids (electronically controlled valves) than to pull on cables.

IN SHORT

In a hydraulic braking system, a fluid replaces the cables to transmit the force exerted by the driver on the brake pedal to the wheels.

HOW DOES IT WORK?

The heart of the system is the master cylinder. It is this cylinder which compresses the brake fluid when the driver presses on the pedal. It operates similarly to a syringe: compression is obtained by a moving piston. The system includes a special feature which enables automatic adjustment of wear on the brake pads or linings. As these parts wear down, their thickness diminishes. They have to be pushed "further and further" during braking. Again, as it is pistons which command this movement, this means that the quantity of brake fluid contained increases gradually as the wear on the pads or linings increases. Without an adjustment system, the driver has to push the brake pedal further and further to compensate for this wear in order to brake effectively. The automatic wear adjustment system is a response to this phenomenon. The end of the master cylinder, where the piston lies when the brake pedal is fully released, includes a light. It is connected to a small tank of brake fluid. Hence, when the pedal is fully released, the piston gives off light and, if necessary, the braking circuit automatically tops up the fluid.

In order to be effective and above all to ensure proper stability of the rear suspension, braking must be distributed unevenly between the car's front and rear wheels. Generally, the front wheels carry about 70% of braking and the rear wheels only participate 30%. A pressure distributor follows the master cylinder and adjusts the pressure applied on each suspension.

A set of rigid pipes and hoses carry the braking fluid to the wheels. If the wheels are fitted with disk brakes, pistons housed in the callipers move in to tighten the pads. For drum brakes, the principle is identical. The only difference is that here, the pistons operate the jaws.

Materials, forms and the importance of touch

As well as family or budget criteria, more subjective considerations are involved in choosing a car: emotions and senses come into play. With the visual aspect, one of the most significant senses that comes into play is touch. This is **a new design concept, on which several Renault departments are focusing their efforts.**

RENAULT COMMUNICATION

BASIC FACTS

When a potential customer discovers a new vehicle, at a motor show or in a dealership, after appreciating its volumes, he gets behind the wheel. He inspects the driving station, first visually, and then by touch, placing his hands on the steering wheel or trying out the controls. For the driver to come away from this inspection with a favourable opinion, there must be consistency between the visual perception of the passenger compartment and the feel of each of its elements. In order to better meet consumer expectations, a team of researchers at Renault is working in close cooperation with designers to characterise the tactile sensations provided by each component chosen.

IN SHORT

The specific aim of working on materials and forms is to develop passenger compartment elements which are attractive, pleasant to the touch and able to fulfil their given purpose perfectly.

: HOW DOES IT WORK?

In the quest for the pleasure of the senses, touch is the dominating factor. To attract buyers, several Renault departments (Research, Design, Quality, etc.) are working in two significant areas. They are ensuring that nothing spoils the tactile discovery of the vehicle, and they are also trying to improve the feel of various elements, by defining recommendations concerning the quality of elements in future vehicles. For example, a "silky" touch is sought for the plastics used in dashboards, door fittings and other handle elements.

These sensory considerations go very far. For example, still to maintain the consistency that should exist between visual appearance and our sense of touch, a soft-looking material must be warm to the touch. Inversely, an aluminium-looking element must be cold to the touch. For driving elements, touch can also provide information. A handbrake handle, for example, must have a feel which is unambiguous to the driver. The steering wheel, door handles and more generally, cabin fittings and equipment are the result of in-depth research, aiming at perfect consistency between their "expected feel" based on visual information, and the "perceived feel".

RENAULT COMMUNICATION

The growing importance of touch has led Renault to come up with a new concept: "touch design". The goal is to design parts whose shape, colour and material make them objects which are both pleasant to the senses and suited to their designed purpose. Visually, this also means strengthening a feeling of well-being, immediately marking interfaces by concentrating technological functions at specific points in the dashboard or the centre console. Touch design also aims at rendering complex onboard technology more simple, consequently reinforcing driving safety (functions immediately to hand).

Power units

At the heart of the car, **the engine alone is the subject of intense research**. Reliability, performance, driving pleasure, acoustics, consumption, respect for the environment, among other factors, are required of it.

RENAULT COMMUNICATION

BASIC FACTS

Long gone are the days when the choice of an engine was limited to the petrol or diesel alternative. The engine is not a component like any other: it establishes the personality of the vehicle. Not forgetting that when a user changes vehicle, he expects an engine of identical capacity to his previous vehicle to offer better performance thanks to technological advances.

An engine is not a single piece but a relatively modular collection of components, some of which can be modified without necessarily having to conduct long studies into their development from the start. Renault has gambled on this "flexibility" to develop the "K" family of engines. It enables numerous variations of the engine to be developed from a common base, both in petrol and diesel.

IN SHORT

Whether a petrol or a diesel unit, the engine establishes the temperament of a vehicle. Renault has developed the notion of engine families, which, by adapting engine "flexibility", enables several versions of the same basic engine to be offered, not only in terms of fuel (petrol or diesel) but also with different capacities and characteristics.

HOW DOES IT WORK?

A family of engines is not defined by its capacity nor by the type of fuel used (petrol or diesel), but by a dimension: the centreline distance. The centreline distance is the distance that separates the centre of two cylinders. This separation conditions many engine parameters, such as its overall dimensions, the thickness of the "jackets" (walls separating each cylinder) and, above all, the equipment required to produce it.

To manufacture an engine, the centreline distance determines the characteristics of the production line. In particular, it fixes the specifications of the tools required to machine the jackets. A production line is extremely costly.

Another solution exists to modify the capacity and temperament of an engine without changing the centreline distance. This consists of changing the piston stroke: the greater the stroke, the higher the capacity. It is this solution that was chosen by Renault to produce its "K" family. In this case, production modifications are limited to the crankshaft and the length of the connecting rods.

For the petrol series, two different strokes, 70 mm and 80.5 mm, means that 1.4 L and 1.6 L versions can be proposed using the same engine base. In the diesel version, a single stroke of 80.5 mm was retained; the modifications are limited to increasing the height of the cylinder casing, essential to house a piston head with integrated combustion chamber larger than on petrol versions.

Finally, numerous "peripherals", such as the turbocharger or camshaft angle variator offer other possibilities for modifying engine performance. Engines in the "K" series are thus available on many Renault models.

Road handling

Road handling plays an essential role in the relationship of trust that is built up between the driver and his car. As well as "road holding" in the traditional sense, **the vehicle must not react in disconcerting way**, or give the sensation of becoming difficult to control during acceleration or braking, for example.

RENAULT COMMUNICATION

THE BASICS

The dynamic behaviour of a car involves extremely complex phenomena. The notion of weight transfer on each wheel is used. For example, on acceleration, the rear axle will be subjected to a greater vertical load than when the car is stopped or driving at a constant speed. The acceleration to which the vehicle is subjected modifies the initial distribution of the vertical forces between the front axle and the rear axle. It is as if an additional vertical force is applied to the rear axle, and an equivalent force is removed from the front axle, hence the name weight transfer. Inversely, on braking, this weight transfer occurs on the front axle. Similarly, in a bend, depending on direction, the weight transfer occurs on the left or right wheels of the vehicle (inside or outside the bend). The problem gets even trickier when cornering is combined with acceleration or braking. The longitudinal and lateral weight transfer are combined, which sometimes leads to considerable weight transfer on a single wheel.

●●● **The phenomena involved are complex,** and so are studies of the dynamic behaviour of a car. Mechanical solutions which are satisfactory during a static study may prove to be unsatisfactory if not ineffective for the dynamic behaviour of the car.
Finally, the overall architecture of the car also considerably affects weight transfer phenomena and consequently, the vehicle's handling. Hence, the issue is relatively different on a passenger van or a saloon, or even a coupé.

IN SHORT ⁘⁘⁘
The dynamic behaviour of a car is essential in order to establish a relationship of trust between it and the driver. Unfortunately, no universal technical solution exists. Renault is therefore conducting numerous studies to find the configuration best suited to each type of vehicle – MPV, saloon or sports model.

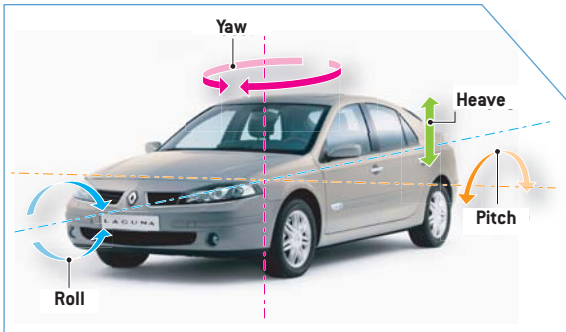
⁘ HOW DOES IT WORK?

Usually, the aim is to find innovative solutions whose primary function is to control the movements of the wheels in relation to the vehicle body. A first approach lies in optimising suspension systems and dampers. Among other things, Renault has developed variable damping systems able to combine comfort on low displacement amplitudes and better control of body movements in the case of greater displacement.

The rear suspension of the Espace contains hydroelastic mountings and a Panhard bar, a long, very stiff transversal bar, able to resist considerable lateral forces to provide good guidance of the rear wheels in a bend without hindering longitudinal or vertical flexibility, essential for a high level of comfort.

Still for the rear wheels, the trigonal suspension system (see sheet) equipping Vel Satis ensures perfect control of the wheel movements in the three axes (vertically, laterally and longitudinally), while being particularly compact.

On some sports models, the front suspension with independent pivot enables the handling of the vehicle to be adapted to strong accelerations. Steering remains light, ideally calibrated and hardly affected by high engine torques.



The various movements of the body

WAG

Sunroofs and folding roofs

A window on the sky, transparent and increasingly panoramic, **the sunroof floods the cabin with light** at the slightest ray of sunshine and contributes to a feeling of comfort and freedom.

RENAULT COMMUNICATION

BASIC FACTS

By freeing the passenger compartment from the barrier of the roof, the sunroof provides a sensation of space and opening on the outside world. With its opening, which may be manual or automatic, the sensation of freedom is further enhanced. It can be likened to that of a cabriolet.

On the Mégane II coupe-cabriolet, Renault has taken this concept to its extreme. Its rigid glass roof is entirely retractable. When closed, its transparency limits the so-called "cap" effect related to the lowness of cabriolet roofs, and it can be opened in just 22 seconds.

IN SHORT

The sunroof provides the passenger compartment with unsurpassed luminosity and a feeling of space.

HOW DOES IT WORK?

Opening and closing the roof of the Mégane II coupé-cabriolet are fully automated. A hydraulic mechanism, controlled by an ECU, folds it in a "V" and hides it in the boot of the car. As well as allowing opening or closing of the sunroof only at low speed to prevent damaging the mechanism, the ECU also controls all the locking mechanisms. The roof can also be opened and closed without intervention by the driver. Renault studied this system in partnership with the equipment manufacturer Karmann, which was a first for a European vehicle.

RENAULT COMMUNICATION

The trigonal rear suspension

For the comfort and dynamics of a car, the rear suspension is just as important as the front. Combined with reduced dimensions, the trigonal rear suspension provides **very high-quality directional functions**, far better than those provided by conventional "H" rear suspensions.

RENAULT COMMUNICATION

BASIC FACTS

The rear wheels of a car do not only move vertically. Practically, in relation to the car, the rear wheels move in three axes (longitudinally, transversally and vertically). These movements are used to optimise the vehicle's dynamics.
The trigonal suspension enables these movements to be perfectly controlled. It is thus a solution able to provide a high-quality service. The complex design of the trigonal suspension, which has led to numerous patents filed by Renault, offers dynamic safety combined with a level of comfort which restricts its use to top-range cars.

IN SHORT
By providing perfect control of the movements and turning of the car's rear wheels, the trigonal suspension offers a top-quality level of comfort and handling. In addition, its reduced overall dimensions preserve the spaciousness of the vehicle.

: HOW DOES IT WORK?

The trigonal suspension is composed of three connecting rods and a quadrilateral arm. It belongs to the family of suspension known as multi-arm, whose features are the most efficient on the market. Its layout provides high transversal stiffness, necessary for good road holding, while at the same time enabling longitudinal flexibility to ensure comfort. The major feature of the trigonal suspension is its kinematics, using various connecting rods pivoting in several axes. The combination of the different axes enable wheel parallelism and camber to be adjusted separately, which is not the case for all multi-arm axles. This produces a stabilising effect (known as understeer) in bends or when the brakes are applied. Finally, a major advantage of the trigonal suspension is its compactness (greater than the competition), while maintaining significant wheel travel, necessary for suspension comfort.

RENAULT COMMUNICATION