The occupants are retained in the car by the inner plastic membrane.

Laminated windscreen - L, HLE,S and HLS
Metro L, HLE, S and HLS models all have laminated screens. As well as protecting in an accident these screens will chip rather than craze if hit by a flying stone.

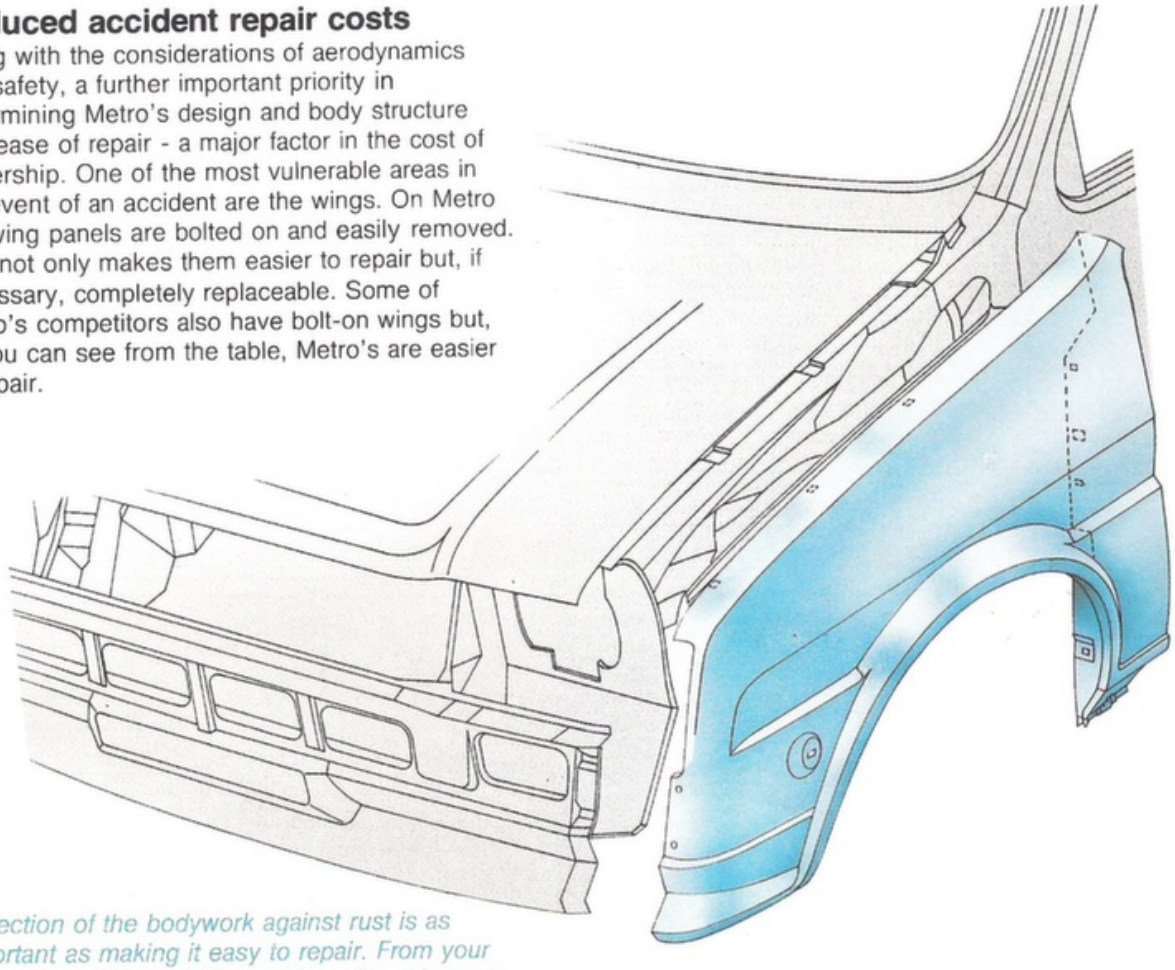
Base models have toughened glass, which fractures into relatively harmless crystals in an accident.

Front wing panel replacement time

	Panel fixing	Total incl. handling hrs. mins.
Metro	**Bolt-on**	**3.45**
VW Polo	Bolt-on	4.15
Datsun Cherry	Bolt-on	4.15
Honda Civic	Bolt-on	4.15
Ford Fiesta	Welded	6.00

Reduced accident repair costs

Along with the considerations of aerodynamics and safety, a further important priority in determining Metro's design and body structure was ease of repair - a major factor in the cost of ownership. One of the most vulnerable areas in the event of an accident are the wings. On Metro the wing panels are bolted on and easily removed. This not only makes them easier to repair but, if necessary, completely replaceable. Some of Metro's competitors also have bolt-on wings but, as you can see from the table, Metro's are easier to repair.



Protection of the bodywork against rust is as important as making it easy to repair. From your knowledge of Book 1: Shared Benefits, what are the three major anti-corrosion processes applied to the majority of Austin Morris cars?

1. The electroprime, using anti-corrosive paint.
2. The sealing of the entire underbody with a chip-resistant coating.
3. Wax-injection of box sections.

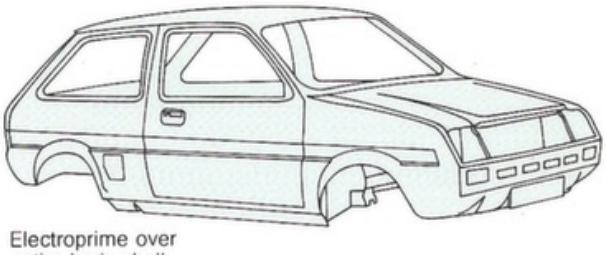
Anti-corrosion

Austin Morris has always been at the forefront of manufacturers who build their cars to last. Metro benefits from similar anti-corrosion treatments to those which have proved themselves over the years on other Austin Morris models and which have undergone further refinement, in keeping with Metro's advanced production standards. The new computerised body assembly plant has built-in temperature controls and special conveyors to ensure that the panels remain perfectly dry and clean along the welding lines. The new paint plant has been designed to provide only the best quality finish, and includes a series of anti-corrosion processes that have been tailor-made for Metro. The end result is that Metro benefits from standards of anti-corrosion treatment and finish that are among the highest applied to any car in its class.

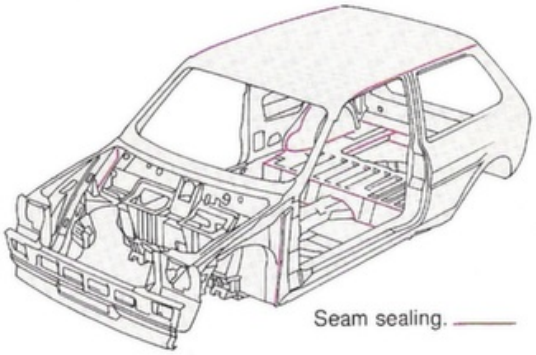
Seam sealing

In addition to the three anti-corrosion measures covered in Book 1, Metro benefits from a seam sealing process which gives it extra protection from moisture. The extensive use of plastic based sealants inside Metro's bodywork seams before welding ensures that the welds are completely waterproof. In addition, sealant is applied over the completed weld, so that any water which might accumulate on the surface cannot initiate corrosion.

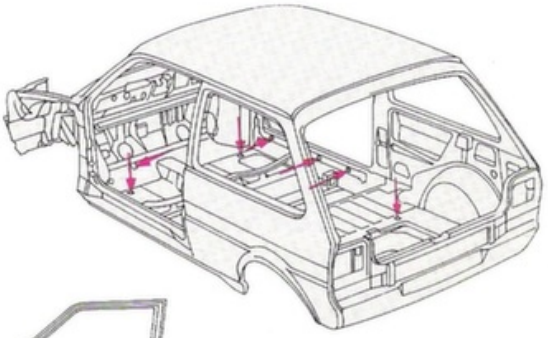
What aspect of Metro's body design makes a major contribution to reduced accident repair costs?



Electroprime over entire body shell.

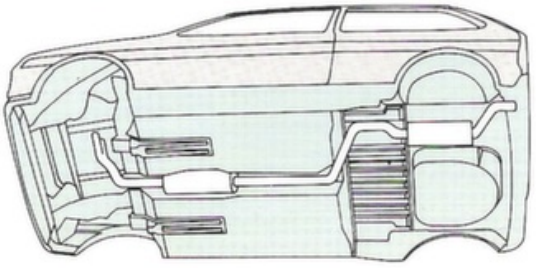


Seam sealing.



← Wax injection of box sections and doors.

Chip-resistant coating to underbody.



Bolt on front wing panels.

Metro quality

You will know, from the intensive coverage that has been given to Metro's production, that it has been designed to achieve the very highest standards of manufacturing quality. Obviously, the real importance of these standards is what they will mean to your customers in terms of the benefits of the product they are buying. These pages identify the major benefits, and how they are achieved.

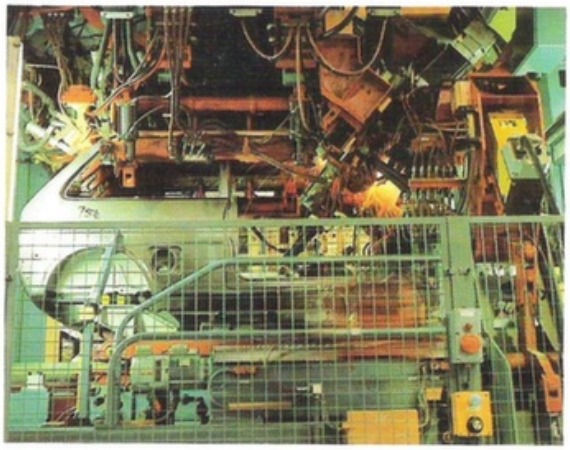
Care and storage of body panels

Metro is built in one of the most modern body manufacture plants in Europe. Costing £27 million to build, £81 million to equip, and using the most advanced technology in the industry, these facilities have been designed with the aim of ensuring accurate, consistent and efficient production to make a high quality car.

Body panels arrive on covered wagons along a railway track which leads directly into the buiding, where they are unloaded under cover. The pallets are of an advanced design to prevent panels from being damaged, and the contents have to pass a rigid inspection before being conveyed to panel storage. Each pallet has a special label which allows information on each part to be read by a light pen and fed straight into the computer, where it is then held and processed throughout the build programme. The panels are stored in a giant automated warehouse controlled by seven mini-computers.

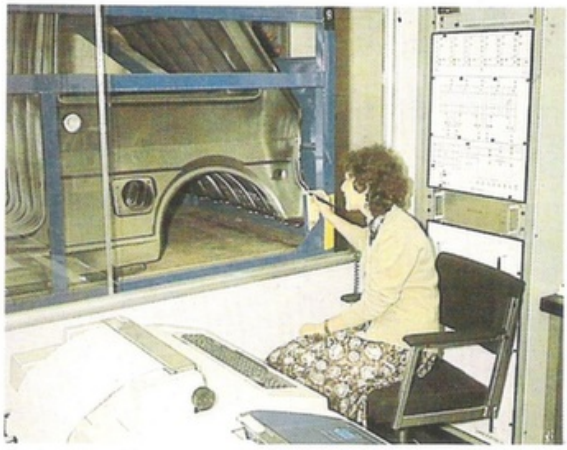
Computer controls continuously monitor stock levels, and are programmed to rotate material on a 'first in - first out' basis. The automated cranes can deliver pallets from any of the 3,000 storage racks within 57 seconds.

In addition to the three anti-corrosion measures described in Book 1, what additional rust protection does Metro receive?



Metro body assembly

Pallet unloading area



Body assembly computer control centre

The sealing of all seams with a plastic sealant.

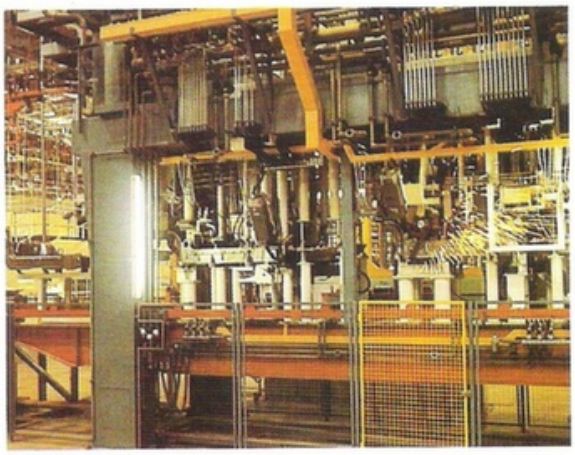
Welding precision
Metro underfloor assemblies are manufactured on Kuka multi-welders, which are computer controlled to monitor the sequence of manufacture. High weld accuracy is ensured by the automatic measurement of the current, to maintain the weld temperature within the right margins. The computer can also be used to diagnose and locate electrical faults accurately, to keep down-time to a minimum.

Dimensional accuracy
Before being welded, the underfloor, front end, side and tailgate aperture assemblies are tagged and clipped together. The assembly then passes to the Automated Body Framing Lines (ABFs), which add the roof and construct the final body shell. At this critical stage, the tagged body assembly is checked by electrically operated probes for exact dimensional accuracy, before progressing to two lines of fourteen robot welders.

The completed car bodies are subjected to further stringent checks when they pass through specially illuminated light booths, which reveal the tiniest flaws to a team of experienced inspectors.

The exhaustive on-line checking is reinforced by the random selection of bodies and panel assemblies from each shift for inspection by the LK 3-axis measuring machine. Here, a series of 124 dimensional checks, which would manually take 3-4 days, are carried out in under 4 hours, to give a computerised readout against the design specifications.

On which Metro models is a laminated windscreen standard?


Kuka multi-welder


Robot welders


LK 3-axis measuring machine

L, HLE, 1.3 S and 1.3 HLS.

Total quality control

Tests and checks become, if anything, more stringent as Metro nears the end of the production line. The water test subjects the car body to a barrage of water jets from above and below, and water-tightness is tested for a second time in the car wash during the intensive final valeting process.

As a part of the electrical test, a computer VDU gives specific instructions for each check, which depends on the model (for example, the 1.3 S has more electrical circuitry than the Base). In the sequence of about 40 different checks, absolutely nothing is missed because the computer will not move on to the next check until it has registered the results of the previous one. Most important, even non-visual items are checked - such as the headlamp current - and the smallest faults identified and diagnosed immediately.

All Metros then undergo the rolling road test, which carries out rigid quality checks on drive-line components (gears, clutch and engine) and on brakes and steering.

Finally, in the 65,000 sq.ft. final inspection, rectification and valeting area, every Metro passes through completely new washing and waxing booths, paint inspection and rectification plant, and final valeting lines, so that it can be passed on to the customer in absolutely top class condition.

Final assembly

Rolling road tests

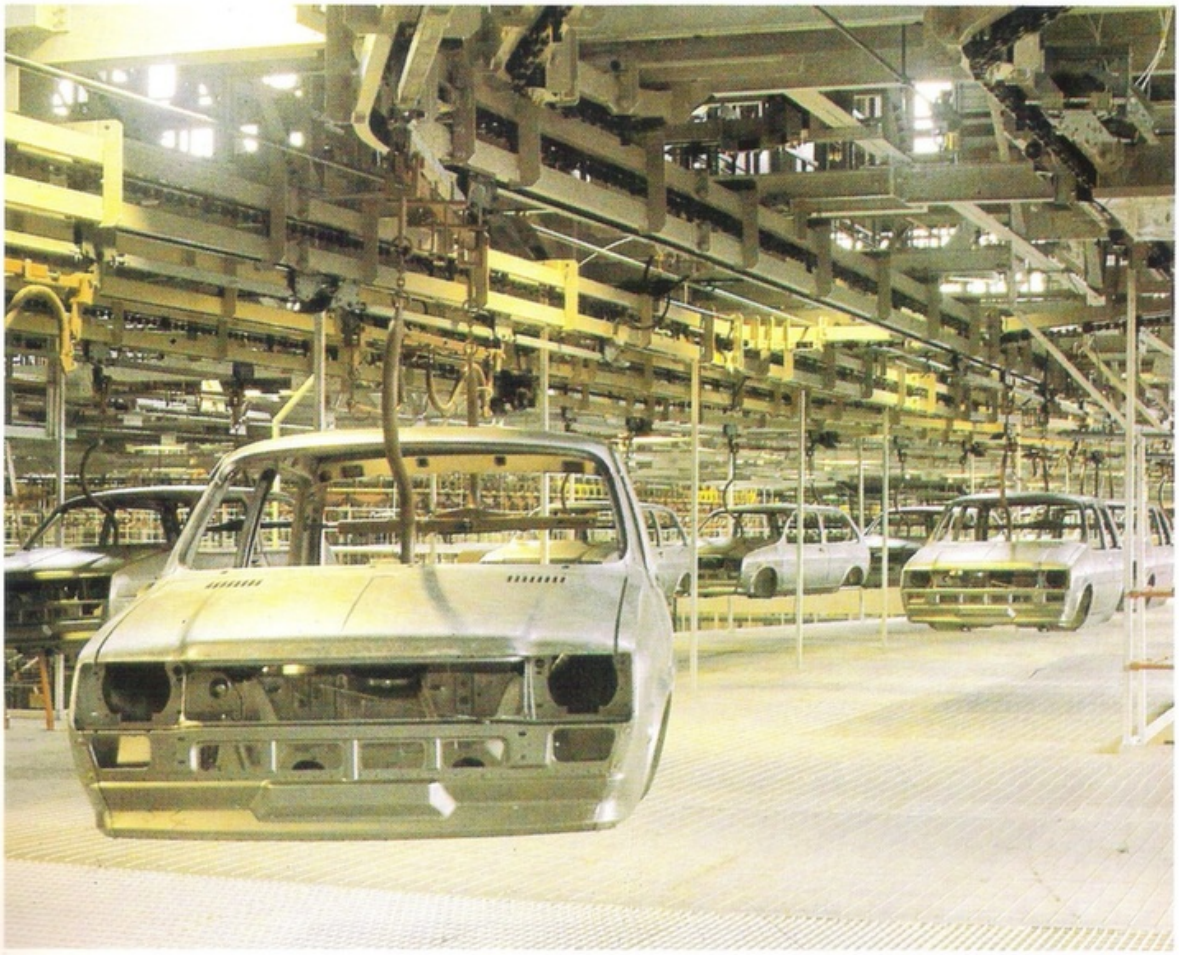
Valeting area

Top quality cars

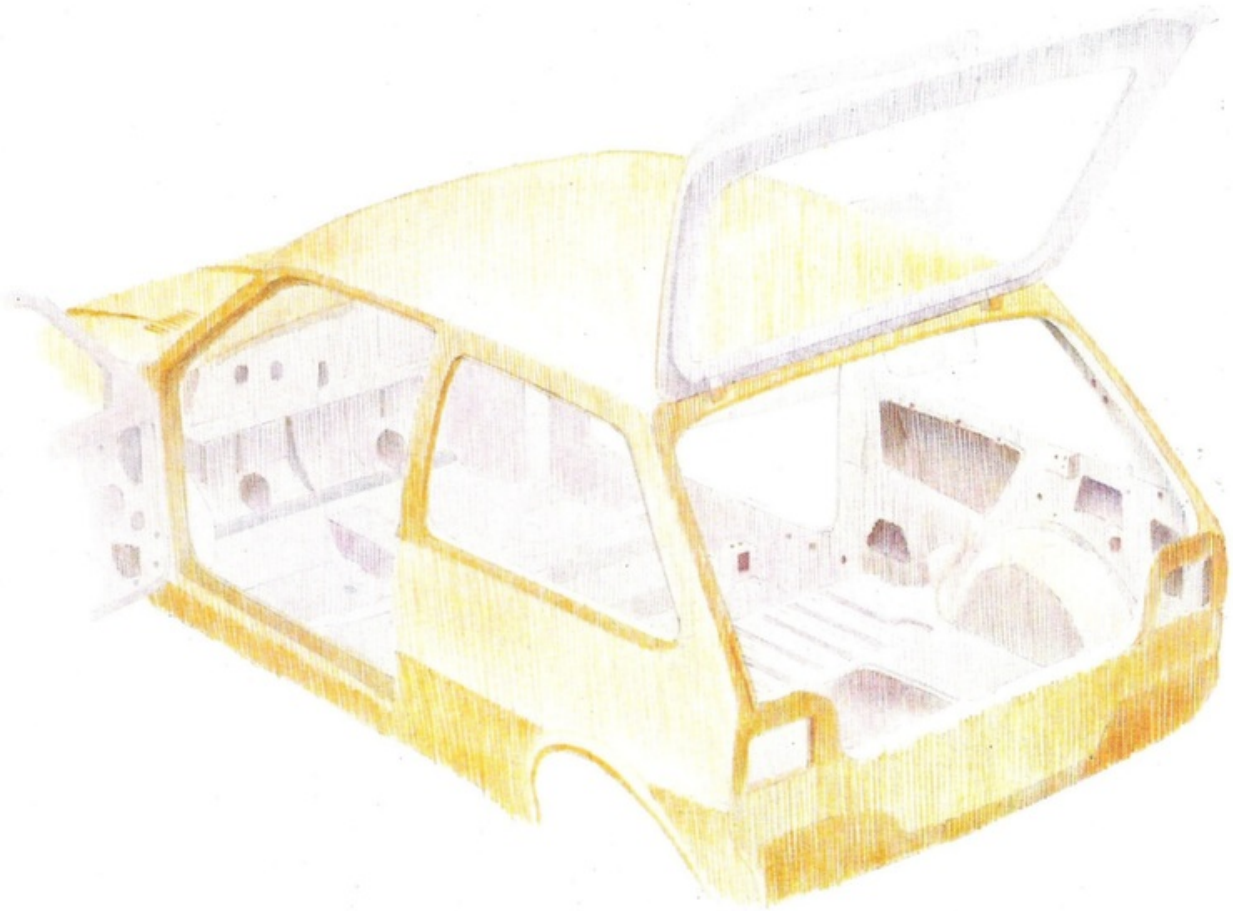
The Metro achievement is the result of a manufacturing process which was designed with quality control as the first objective. The entire system is geared to providing continuous information on every part of every car, and to monitoring and checking every single stage of the production process; in this way, the smallest fault can be identified and rectified long before there is a risk of disrupting production.

Never before has so much effort gone into ensuring a quality build. And never before have production workers expressed so much justifiable confidence in the plant and equipment they are using.

Computer control centre



Now that you have covered every key aspect of Metro's structural safety, body design and anti-corrosion treatments, check your knowledge by completing the following test. The test will also question you on your knowledge of the range structure. You should ensure that you get all the answers correct before continuing with the book.



End of Section Test

1.a) How many models are there in the Metro range?
b) What are they?

2. What four main benefits result from Metro's good aerodynamic styling?

3. What two major aspects of Metro's body styling ensure good aerodynamics?

4. Which two major underbonnet features on Metro help to cut down the source of noise?

5. On Metro, in what two ways has vibration been reduced?

6. What major action has been taken to block noise out of Metro's passenger compartment?

7. Which types of windscreen are fitted on the Metro range, and in what models?

8. What are the four major features of Metro's anti-corrosion programme?

9. What feature contributes to Metro's cheaper accident repairs?

Answers

1.a) How many models are there in the Metro range? b) What are they?	a) Five b) Base, L, HLE, 1.3 S, 1.3 HLS.
2. What four main benefits result from Metro's good aerodynamic styling?	i) Improved performance. ii) Better economy. iii) Greater stability. iv) Reduced wind noise.
3. What two major aspects of Metro's body styling ensure good aerodynamics?	i) Raked front end. ii) Front spoiler.
4. Which two major underbonnet features on Metro help to cut down the source of noise?	i) Electric fan. ii) Acoustic air filter.
5. On Metro, in what two ways has vibration been reduced?	i) Rubber mountings for engine and subframes. ii) Bitumastic sheets fused to body.
6. What major action has been taken to block noise out of Metro's passenger compartment?	By the use of sound insulation materials.
7. Which types of windscreen are fitted on the Metro range, and on what models?	i) Toughened on baseline. ii) Laminated on other models.
8. What are the four major features of Metro's anti-corrosion programme?	i) The electroprime, using anti-corrosive paint. ii) The sealing of all seams with a plastic sealant. iii) The sealing of the entire underbody with a chip resistant coating. iv) Wax injection of box sections.
9. What feature contributes to Metro's cheaper accident repairs?	Bolt-on front wings.

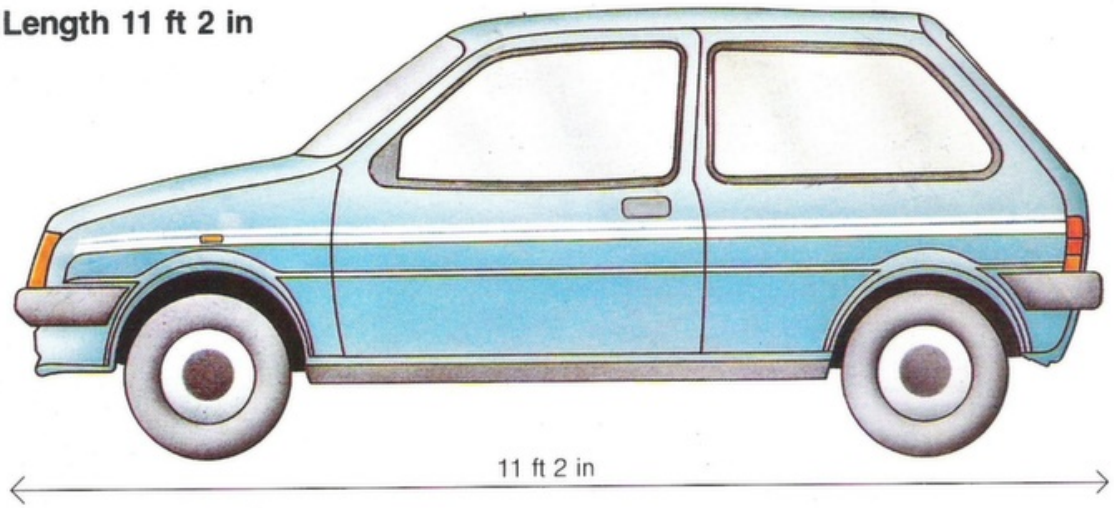
3
DIMENSIONS

The small car sector was the first to recognise the importance of space-efficiency, and on this priority alone Metro is a clear leader. No other hatchback is as effective in offering so much within so little. Within its overall length of 11 ft 2 in, it offers just as much passenger space as many larger competitors, and has more room than any rival of similar size.

With so much emphasis on space-efficiency, versatility is at a premium. Again, Metro offers an ingenious solution which multiplies its effectiveness as a family hatchback.

With its innovatory asymmetric split rear seat, Metro can offer a wider range of loadspace configurations, and more total loadspace volume, than any other car in its class. The Metro is therefore uniquely adaptable to the varying needs of a typical family.

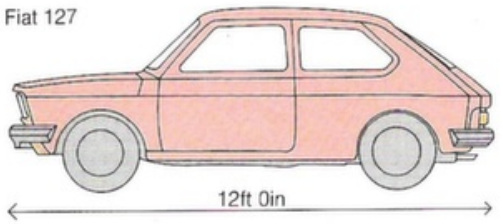
Length 11 ft 2 in

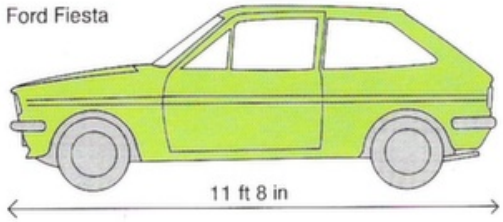


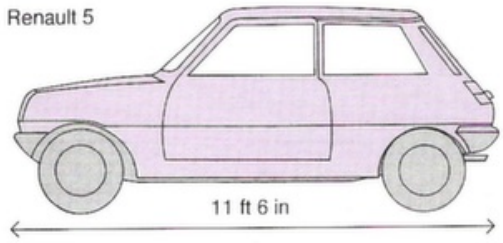
From the outside, Metro is a remarkably compact car, especially in relation to its interior package. It is 4 inches shorter than its smallest rival, the Renault 5, and has already been hailed as "the most space efficient volume car in history" (Car Magazine).

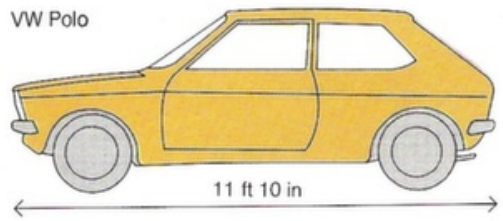
Several three door hatchbacks are more than a foot longer yet have no more room inside - all those extra inches taking up room in the garage, making parking more difficult, and using up more petrol but giving the owner no real benefit.

On the next few pages we will see how much Metro offers within its 11 feet 2 inches.



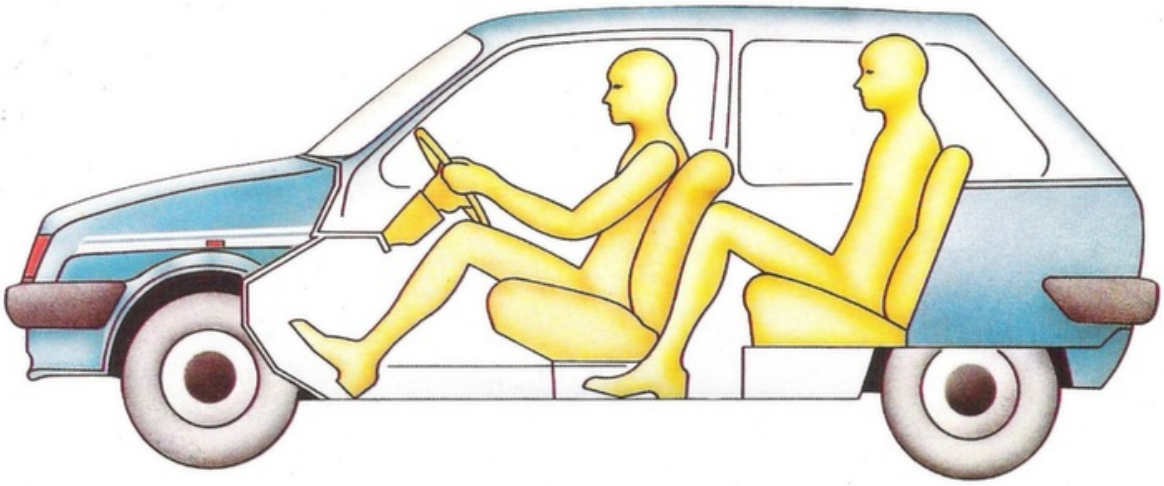






How much longer than Metro is Fiesta?

6 inches.



Passenger space

As you know, all manufacturers of small hatchbacks have placed great emphasis on securing the maximum possible interior space within compact external dimensions. As a result, the majority of Metro's competitors already offer very generous passenger accommodation; the Fiesta, for example, has two inches more total legroom than the much larger Citroen GS.

It is all the more remarkable, therefore, that despite being significantly shorter than any of its competitors, Metro has more interior space relative to its overall length than any of them. The transverse engine and front-wheel drive layout is shared by several competitors but none of them are as successful in exploiting its full potential.

You can see from the comparison that Metro's total legroom figure is three inches greater than the Renault 5 and is practically identical to that of its other major competitors, all of which are at least six inches longer. Moreover, Metro's total legroom is more thoughtfully distributed to give back seat passengers more room than usual without penalising front seat occupants.

Metro provides impressive passenger space within compact dimensions. How long is it overall?

The illustration shows two identical 6 ft 1 in people comfortably seated in Metro. The front seat is at its rearmost position leaving plenty of space in the rear without sacrificing driver comfort and there is more than enough headroom in both front and rear compartments.

	Legroom total	Front max.	Rear min.
Metro	**71.6**	**38.1**	**33.5**
Fiat 127	72.0	39.2	32.8
Ford Fiesta	71.7	40.1	31.6
Renault 5	68.6	35.9	32.7
VW Polo	72.2	39.9	32.3

To ensure accuracy of information the legroom figures used here are all based on a method of measurement which has been internationally approved by the Society of Automotive Engineers. This standard, known as SAE J1100, ensures that all comparative figures are worked out on an identical basis and avoids the many inconsistencies which can occur in figures obtained by the Motoring Press.

11 ft 2 ins.

Efficient use of space

Package engineering in the world's motor industry has rapidly grown in importance over the last decade and, with the trend worldwide towards more lightweight, compact cars,to give better fuel economy, ensuring the most efficient use of the restricted space available has become a very advanced and keenly competitive science.

The Passenger Space Efficiency Ratio, developed by the American Motor Industry, is one way of measuring just how efficient a car is at accommodating people. It expresses the total passenger space in both front and rear compartments as a percentage of the overall length of the car - so the higher the figure the more successful the car is at making the most effective use of the available space. As you can see from the table the results clearly demonstrate that, once again, Metro is notably better than its competitors.

Width 5 feet 1 inch

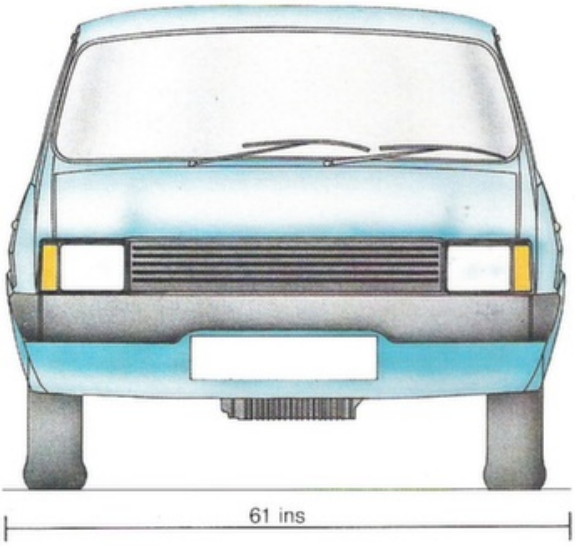
Metro's overall width of 5 ft 1 in is again exploited to the full to provide as much passenger space as possible. Both front and rear seat passengers have 50.6 inches of shoulder room - more than the majority of the competition, and as much as larger saloons like Alpine and Renault 14.

	Overall width (in)	Shoulder room Front (in)	Rear (in)
Metro	**61**	**50.6**	**50.6**
Fiat 127	60	48.3	47.5
Ford Fiesta	62	50.3	50.0
Renault 5	60	48.8	47.5
VW Polo	61	50.5	51.1

Which of the Metro competitors shown here is actually wider than Metro but offers less shoulder room?

To calculate the Passenger Space Efficiency Ratio the couple distance (which is the distance between the hip positions of front and rear seat occupants) is added to the maximum front legroom. This is then expressed as a percentage of the overall length of the car.

Passenger space efficiency ratio	
Metro	**50.0**
Fiat 127	47.2
Ford Fiesta	48.9
Renault 5	47.4
VW Polo	47.1



Ford Fiesta.

Passenger access

The penalty of a small three door car can all too often be difficult access, particularly for passengers getting into the rear. With this potential problem in mind, Metro's designers set about making access easy. The doors were an obvious first consideration; the second was the design of the front seats.

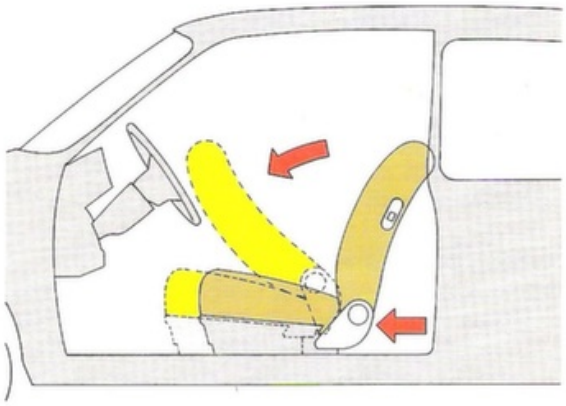
Wide doors

Entry to front and rear seats is made easy by Metro's wide doors, and their wide opening angle. Again the designers have come up with another plus point over the competition. Although Metro is shorter than the competitors it has wider doors to give ease of access into its large interior.

Door width (max)	Inches
Metro	**46.0**
Fiat 127	41.0
Ford Fiesta	45.5
Renault 5	46.0
VW Polo	41.0

Controlled forward movement seats

The front seats of Metro are mounted on the ingenious double slide mechanism first introduced on two door Allegros. While one slide sets the fore and aft adjustment the other automatically slides forward when the seat back is released, giving excellent access to the rear seats. So rear seat passengers can avoid the undignified scramble required to negotiate entry into Metro's less accommodating competitors.



The location of the release catch on the side of the front seat enables it to be operated by back seat passengers as well.

How wide is Metro?

5 ft 1 in.

Load accommodation

The essence of the hatchback design is the interchangeability of the rear passenger compartment and loadspace area, and in this respect Metro has achieved an outstanding flexibility. As a four seater, Metro offers generous bootspace whilst maintaining excellent legroom for rear seat passengers. As a two seater it is still at the top of its class both in carrying capacity and sheer practicality.

Usable bootspace 7.5 cu.ft

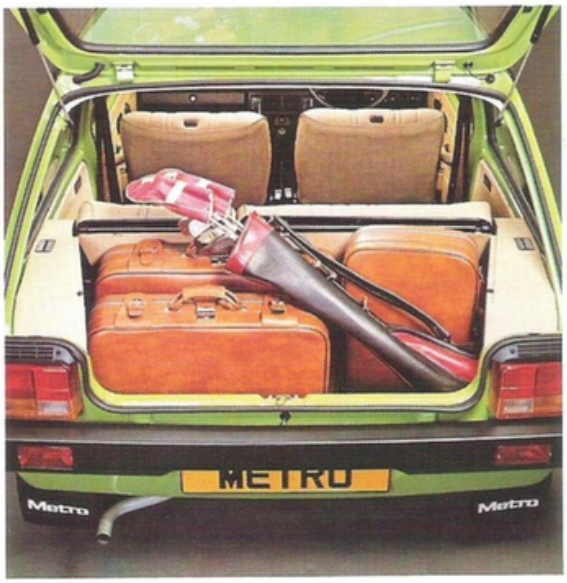
All Metros have a parcel shelf which lifts up with the tailgate for easy loading. Enclosed below it is a secure boot with a usable volume of 7.5 cu.ft. This is 20% larger than both the Renault 5 and VW Polo, practically identical to the much longer Fiat 127 and, most significantly, 0.4 cu.ft. greater than that of its most successful competitor the Ford Fiesta.

Usable bootspace volumes	cu.ft.
Metro	**7.5**
Fiat 127	7.6
Ford Fiesta	7.1
Renault 5	6.3
VW Polo	6.1

Folding parcel shelf

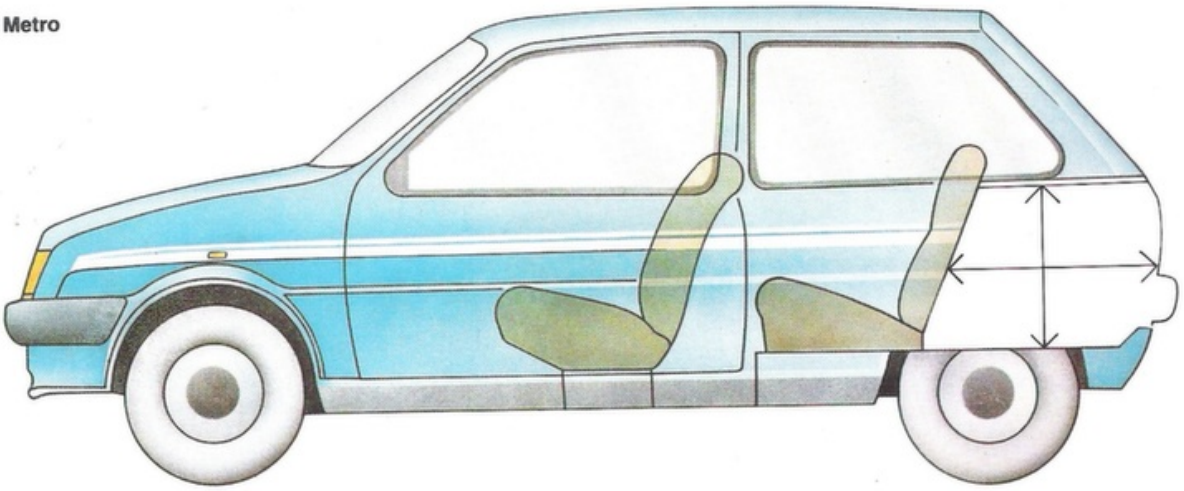
If extra height is required, the parcel shelf folds neatly behind the rear seat, and can be clipped in position - it is not necessary to remove it as it is in some competitive vehicles. This gives an overall height of 34 ins. All the boot dimensions are shown in the illustration.

You can also see that the boot is a practical square shape which gives as much usable space as possible.



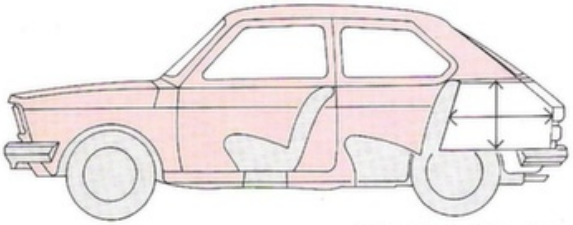
Passenger access is aided by Metro's wide doors. What other feature improves access to the rear seats?

Metro



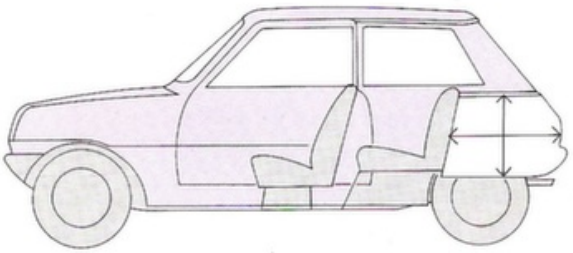
19 ins high 22 ins deep

Fiat 127



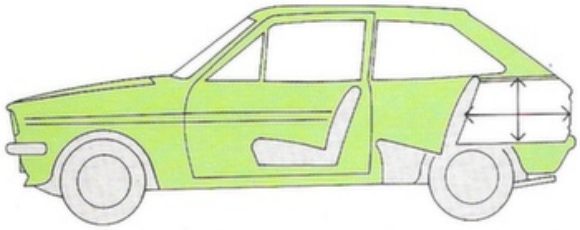
16ins high 29ins deep

Renault 5



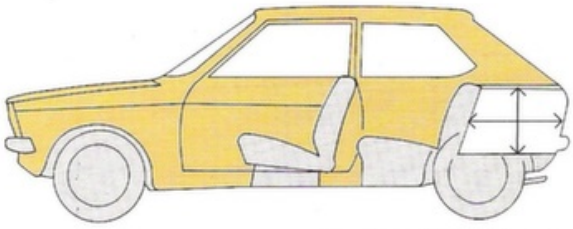
19ins high 25ins deep

Ford Fiesta



16ins high 24.5 ins deep

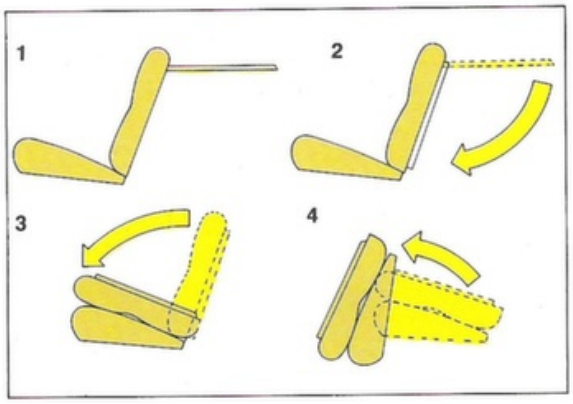
VW Polo



16ins high 25ins deep

Controlled forward movement of front seats.

Loadspace capacity - 45.7 cu.ft.
With the back seat folded down, Metro becomes the biggest load carrier of any small car on the road. The seat folds forward with a jack-knife mechanism, which ensures that the loadspace floor is flat, and the resulting loadspace volume is 45.7 cu.ft. - more loadspace than any competitor; 3 cu.ft. more than Fiesta, 13 cu.ft. more than Renault 5 or Polo.



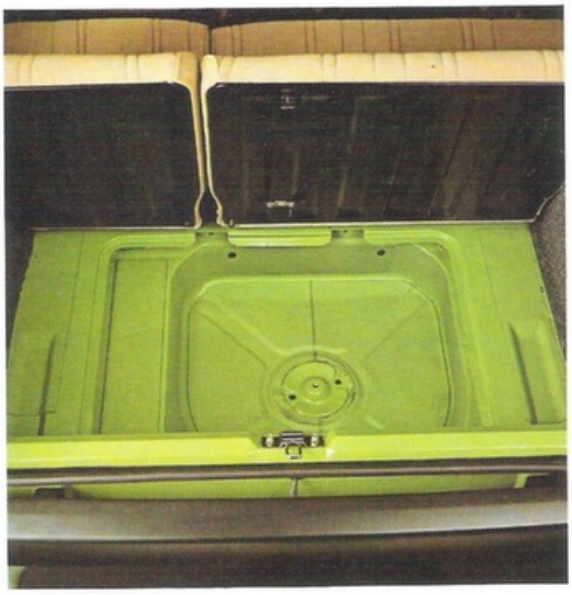
You can see from the illustrations opposite that Metro's minimum loadspace width exceeds by several inches all the competitors, and both length and height are larger than Fiesta.

The loadspace is also very conveniently shaped, with no intrusion by suspension units and only shallow wheelarches. The sides are lined with PVC-covered board in all but the baseline model, and the HLS has a loadspace carpet.

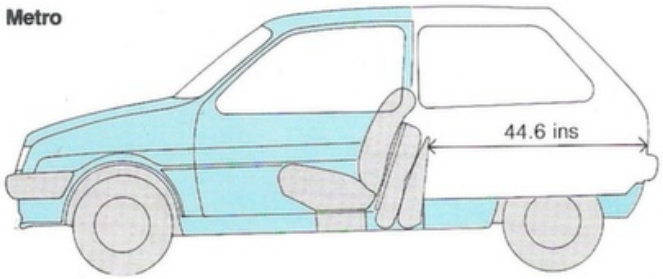
The spare wheel is housed in a special well below the loadspace floor, with its own board cover. If the Denovo run-flat tyre option is taken up, then this space is also available for luggage.

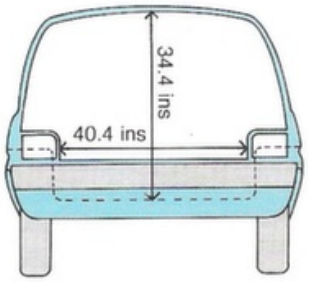
Metro's loadspace is 45.7 cu.ft., what is the usable bootspace?

Loadspace volumes - cu.ft.	
Metro	**45.7**
Fiat 127	37.8
Ford Fiesta	42.6
Renault 5	32.0
VW Polo	31.8

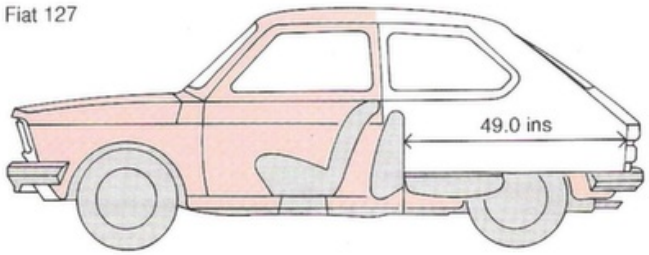


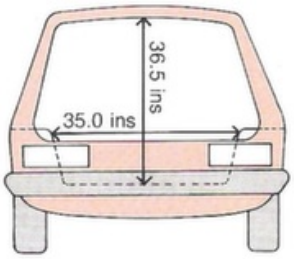
Metro



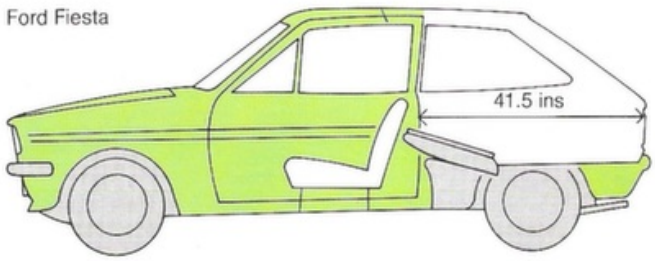


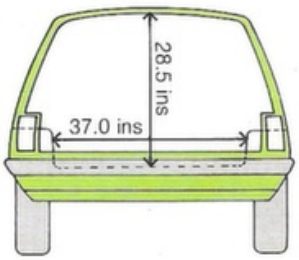
Fiat 127



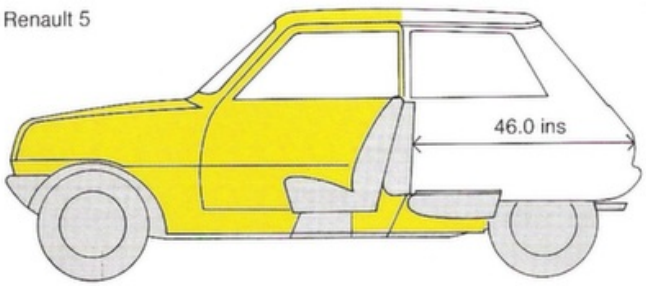


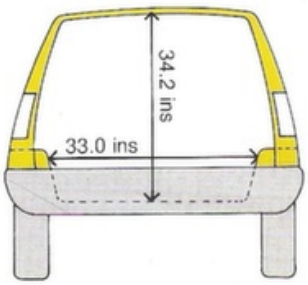
Ford Fiesta



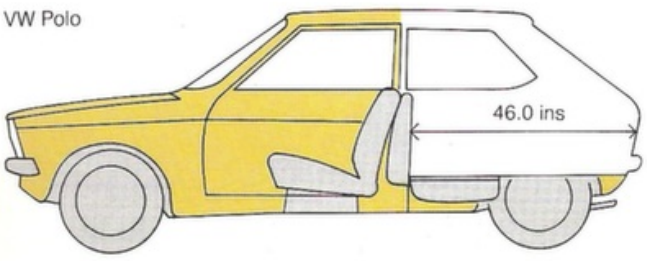


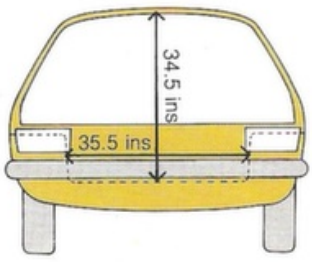
Renault 5





VW Polo





7.5 cu.ft.

Loadspace access

Having designed Metro with the biggest loadspace in its class, a further priority of the designers was to make the space easy to get at. Two factors determine the ease of access to loadspace areas - the size of the tailgate and the height of the sill.

1. Large tailgate

The tailgate opens right down to bumper level and lifts up high out of the way on gas assisted struts. The opening is 34 inches high and has a maximum width of 42 inches giving plenty of room to load large or awkward objects.

The catch locks automatically when the tailgate is shut, so it is impossible to leave the load area unlocked once the tailgate is fastened - a useful security feature.

2. Low sill

The sill lip is just 23 inches from the ground - lower than most competitors - and a great help when stowing heavy items. The rear sill makes an important contribution to the vehicle's structural strength.

Sill height	(in)
Metro	**23.0**
Fiat 127	25.0
Ford Fiesta	22.0
Renault 5	23.5
VW Polo	30.0

Interim Test

1. How long is Metro?

2. How wide is Metro?

3. What two features ensure easy passenger access to Metro?

4. What is Metro's usable bootspace capacity?

5. What is Metro's loadspace capacity with the rear seat down?

Answers

1. How long is Metro?	11 ft 2 ins
2. How wide is Metro?	5 ft 1 in
3. What two features ensure easy passenger access to Metro?	i) Wide doors ii) The controlled forward movement seats.
4. What is Metro's usable bootspace capacity?	7.5 cu.ft.
5. What is Metro's loadspace capacity with the rear seat down?	45.7 cu. ft.

Loadspace versatility

In working on how to make the best possible use of Metro's biggest possible loadspace, the designers came up with a unique and unprecedented solution - a rear seat split in two different sized sections with a jack-knife folding mechanism.

Asymmetric split rear seat

All hatchback cars are designed to be versatile, but none can match the adaptability of Metro's asymmetrically split rear seat, which is standard on all but the base model. The seat is divided into two unequal sections, each of which folds right down separately in the same way as the whole seat.

Two of Metro's loadspace configurations, available from the L upwards, are a) one-third rear seat folded down and b) two-thirds rear seat folded down. What are the other three configurations available on all Metro models?

With one-third of the rear seat down, long loads can be fitted in but there is still room on the back seat for two children - an ideal arrangement for a family camping holiday.

Folding two-thirds of the rear seat down gives a load area nearly as large as many competitor's total area, but in Metro there is also ample room for an adult in the back seat too.