

Vehicle systems

Lecture notes

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Historical view

- There were two major barrier for steam engine powered cars which were:
 - Heavy steam engines
 - Poor road conditions
- Developments had taken place by the end of 19th century
 - Use of oil/paraffin instead of coal
 - More compact boiler designs

Historical view

- By the end of the 19th century Practical steam-powered road vehicles started to appear in small numbers, and indeed for commercial vehicles, the line of development was not finally terminated until the 1950s.



A Stanley steam car of 1905.

Historical view

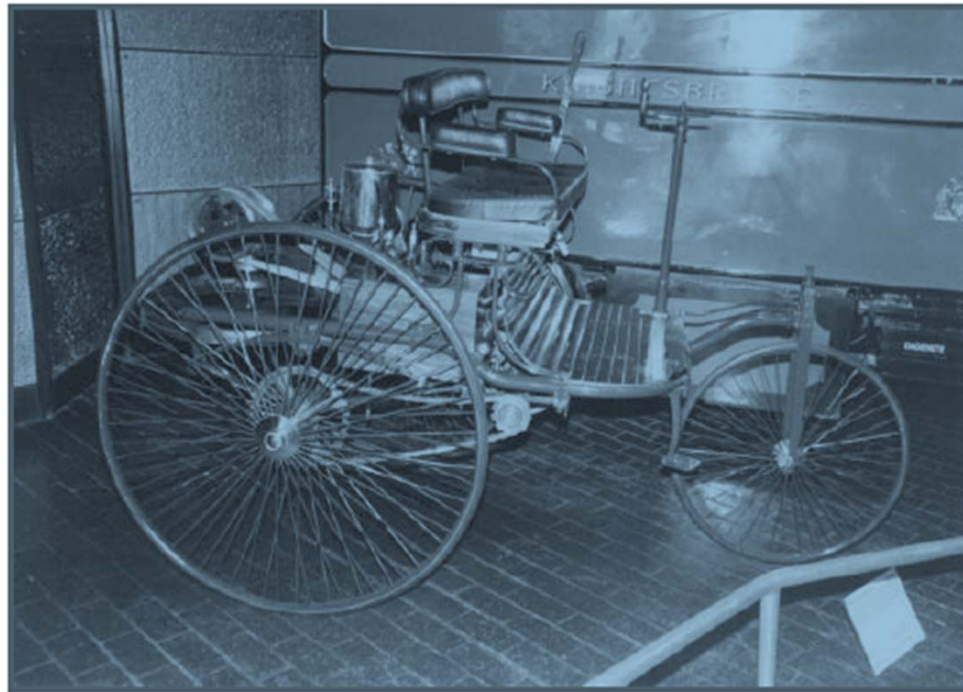
- Two major drawbacks to automotive steam propulsion were:
 - the long start-up time required, and the
 - high rate of water consumption

Historical view

- A major change of direction and a spur to progress, occurred in the 1870s with the appearance of gas-fuelled reciprocating internal combustion engines, notably those patented and produced by Dr. A.N. Otto in Germany.
- Gas engines were originally used as static units for driving machinery, and usually ran on the common domestic or 'town' gas, but several engineers started experimenting with the use of vaporized petroleum spirit instead, as this offered the possibility of a mobile engine.
- Petroleum spirit was at that time a somewhat useless by-product of the process of manufacturing paraffin which was widely used in lamps.
- In 1885 Gottlieb Daimler modified an Otto four-stroke gas engine to run on petroleum vapour, One year later, he modified a horse carriage to produce what is now generally recognized as the forerunner of the modern motor car.

Historical view

- Following the introduction of the petrol engine, road vehicle technology progressed rapidly, but it was the development of mass production techniques rather than any technical innovation that provided the next major step.



An 1896 Benz tricycle replica where the influence of bicycle technology is clearly evident.

*Julian Hapian-Smith, An Introduction to Modern Vehicle Design, Butterworth-Heinemann, ISBN 07506 5044 3, 2002

Benz's first car



- Most early car manufacturers adopted the construction methods of horse-drawn carriages for the upper bodywork, but bicycle technology was also used to some extent, and the wire-spoked cycle type wheels eventually replaced the wooden-spoked carriage wheels. a wooden chassis, light wooden framework that was covered with a skin of sheet metal wood or fabric.
- The largely wooden construction was less suitable for motor vehicles that travelled at much higher speeds, thereby giving rise to higher shock loads.
- The motor vehicles also had to sustain the loads and vibrations of the engine and transmission, and therefore, a much more substantial metal chassis frame was usually employed.
- The combination of steel chassis, wooden framework and sheet metal skinning was used for most vehicles, whether mass produced or coachbuilt, until the late 1930s.



Historical view

- Most early cars were produced by the same techniques of hand craftsmanship that had been used for centuries for the construction of horse-drawn carriages. Cars required the manufacture of a large number of components, and each item was individually made and fitted by skilled craftsmen. Unlike the modern processes of assembly that simply rely on joining items by bolting or welding, fitting usually involved using hand tools to cut or file components to make them fit together.
- The great leap in automotive production engineering came when **Henry Ford started to develop the techniques of mass production**. Ford did not invent the idea; indeed it had been used many years earlier during the American Civil War for the production of rifles. The vehicle that really launched his advanced approach **was the Model T, which first appeared in 1909**.
- Ford had produced many previous models, working his way through the alphabet from the Model A, and had been gradually honing his production methods. The Model T was one of the first cars whose design was primarily dictated by the requirements of manufacture, and thus it represents an early major example of the application of the concept of 'design for production'.

• The Ford Model T

Body type	4/5 seater tourer
Number of doors	2
Wheelbase	2540
Track/tread (front)	1422
Track/tread (rear)	1422
Kerb weight	544 kg
engine type	Naturally aspirated petrol
Engine manufacturer	Ford
Cylinders	Straight 4 & 2.9 litre
Capacity	2896 cc
Bore × Stroke	95.25 × 101.6 mm
Bore/stroke ratio	0,94
Valve gear	side valve (SV) 2 valves per cylinder 8 valves in total
maximum power output	20.3 PS (20 bhp) (14.9 kW) at 1200 rpm
sump	wet sumped
Fuel system	1 carburettor
Engine coolant	Water
Unitary capacity	724 cc
Aspiration	Normal
Power-to-weight ratio	27.42 kW/tonne
Gearbox	2 speed manual



Historical view

The principle of mass production is that each worker only has to perform either one, or a very limited number of tasks, usually involving very little skill: bolting on the steering wheel for example. To keep the workers continuously busy, the volume of production has to be large.

There must always be another vehicle just ready for its steering wheel. Interestingly, although hand-crafting is always associated in the public's mind with high quality, mass production actually requires higher standards of accuracy and consistency of dimension, because in mass production, all similar parts must be completely interchangeable. Hand-built cars may look superficially identical, but there are often large differences in the dimensions of individual components. **It was the achievement of dimensional accuracy and interchangeability that made mass production possible.**

Ford initially assembled the vehicles on fixed stands, but in 1913 he opened his large new Highland Park plant in Detroit, and this featured another major innovation, **the moving production line**. Workers no longer had to move from one task to another; the vehicles simply came to them along a track at an unending steady stream, thereby taking control of the rate of assembly away from the shop-floor workers.

Historical view



Early mass production at Ford's Highland Park plant in Detroit in 1914: the fuel tank assembly station. The chassis are moved on a track, and the cylindrical fuel tanks are supplied to the assemblers from an overhead store.

Design philosophy of Model T

- Design for production
- Design for maintainability
- Ergonomic considerations
 - Simplicity: no clutch pedal or gear lever, easy maintenance (self made no need for mechanic)
 - The bodywork was minimal
 - Only the one basic chassis was produced
 - Limited colour scheme, finally only black (Due to fast drying)
 - Vanadium steel chassis for lightweight
 - Much cheaper than rivals
 - Easy to drive
 - Cheap price

Drawbacks of mass production

- Hard and repetitive work created dissatisfaction.
- The huge plants became organizationally complex and bureaucratic.
- Worker dissatisfaction made itself apparent in a rash of strikes. Resentment generated an us-and-them war between shopfloor and management that resulted in some workers taking pleasure in poor workmanship and occasionally, in deliberate sabotage.
- The resulting products though relatively cheap, were of poor quality, and by the early 1970s, most cars were badly finished, unreliable and prone to rusting.
- To make matters worse, manufacturers adopted the principle of built-in obsolescence, believing that the faster a vehicle deteriorated, the quicker its owner would need to buy a replacement, thereby increasing sales.

VW Beetle

- This vehicle was designed by Ferdinand Porsche in the late 1930s at the behest of Hitler, and although innovative in many respects, it had little in the way of refinement.
- By the 1970s, its styling was quite antiquated, and its air-cooled engine noisy, yet it sold in extremely large numbers throughout the world.
- Despite its lack of refinement, the Volkswagen had two great virtues, it was mechanically reliable, and it did not rust quickly.
- Other manufacturers were slow to learn the lessons, but eventually it became apparent that **systematic quality control was of major importance in automobile manufacture.**

Performance

0-60mph: 47.6 secs

Top speed: 66.0mph

Power: 24.5bhp

MPG: 34.0mpg

Engine

Engine Location: Rear

Configuration: Boxer 4

Aspiration: Normal

Fuel: Petrol

Fuel delivery: carburettor

Chassis

Drivetrain: Rear-Engine RWD

Bodyframe: chassis and separate body

Transmission: Four-speed manual

Dimensions

Length: 4070mm

Wheelbase: 2400mm

Width: 1540mm

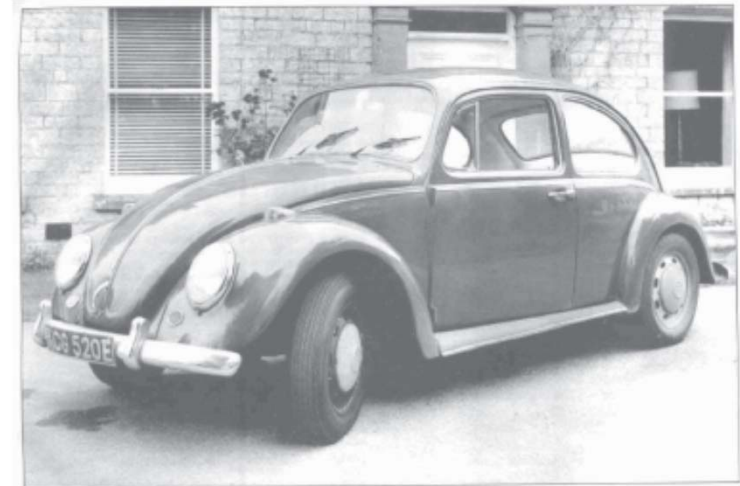
Height: 1500mm

Weight: 892kg

Production Years for

Series : [1938 - 1980](#)

Price : \$1,600-\$2,400



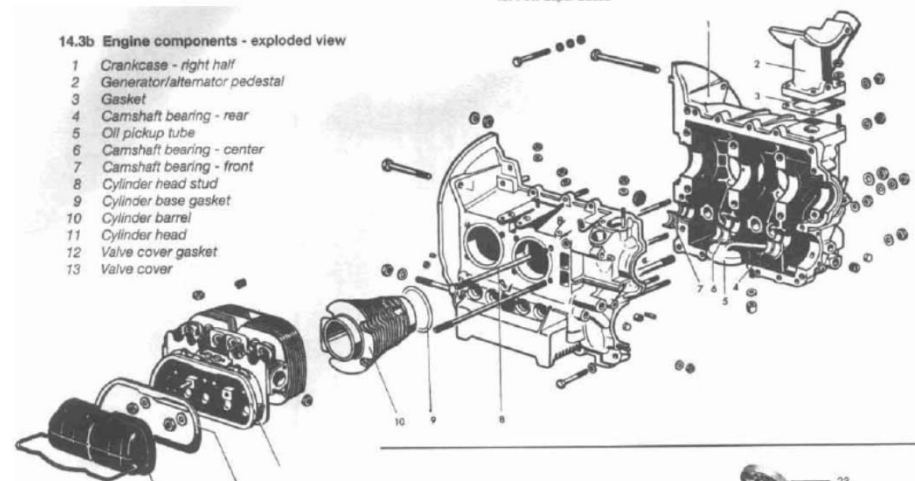
1967 VW Beetle



1974 VW Super Beetle

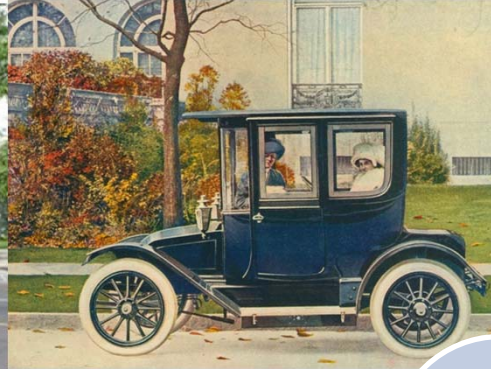
14.3b Engine components - exploded view

- 1 Crankcase - right half
- 2 Generator/alternator pedestal
- 3 Gasket
- 4 Camshaft bearing - rear
- 5 Oil pickup tube
- 6 Camshaft bearing - center
- 7 Camshaft bearing - front
- 8 Cylinder head stud
- 9 Cylinder base gasket
- 10 Cylinder barrel
- 11 Cylinder head
- 12 Valve cover gasket
- 13 Valve cover



A major production quality improvement: Japanese cars

- The growing Japanese penetration of the traditional American and European markets, starting roughly in the 1960s, was initially ascribed to low wage rates, automation and a disciplined society.
- All of these aspects were important factors, but a major component in the Japanese success story was the adoption of a new system of production, where workers instead of being assigned to a single task, worked collaboratively in teams. Production was also flexible, and machinery could be rapidly switched from one task to another. Quality became paramount, and the system used made it financially beneficial to the workers to get the job right first time, rather than pass off poor work that would later have to be rectified.
- The philosophy and techniques of this system, which is often now referred to as 'lean' production, were introduced and developed by the Toyota company to cover not just the basic manufacture, but all aspects of automotive production, including the relationships between assembler and component suppliers, which were more cooperative.
- A major feature of this flexible approach to manufacture is that it is possible to have relatively short production runs, and a wide range of models and variants can be accommodated.



Unibody designs

Body-on-frame

Horse carriage
heritage

Bycle driven designs

Highlights of motor vehicle history

- 1688 Ferdinand Verbiest, missionary in China, made a model steam carriage using the steam turbine principle.
- 1740 Jacques de Vaucansen showed a clockwork carriage in Paris.
- 1765 Watt developed the steam engine.
- 1765 Nicholas Joseph Cugnot, a French artillery officer, built a steam wagon which carried four people at a speed of 2.25 mile/h. It overturned in the streets of Paris and Cugnot was thrown into prison for endangering the populace.
- 1859 Oil was discovered in USA.
- 1865 The Locomotive Act of 1865 (the Red Flag Act) was pushed through by the railway and coach owners. One of the stipulations was that at least three people must be employed to conduct the locomotive through the streets, one of whom had to walk 60 yards in front carrying a red flag. Speeds were restricted to 2–4 mile/h. This legislation held back the development of the motor vehicle in Great Britain for 31 years, allowing the continental countries to take the lead in this field.

Highlights of motor vehicle history

- 1885 Karl Benz produced his first car. This is recognized as being the first car with an internal combustion engine as we know it.
- 1886 Gottlieb Daimler also produced a car.
- 1890 Panhard and Levasser began making cars in France.
- 1892 Charles and Frank Duryea built the first American petrol-driven car, although steam cars had been in use long before this.
- 1895 First motor race in Paris.
- First Automobile Club formed in Paris.
- 1899 Jenatzy set world speed record of 66 mile/h.
- 1900 Steering wheel replaces tiller.

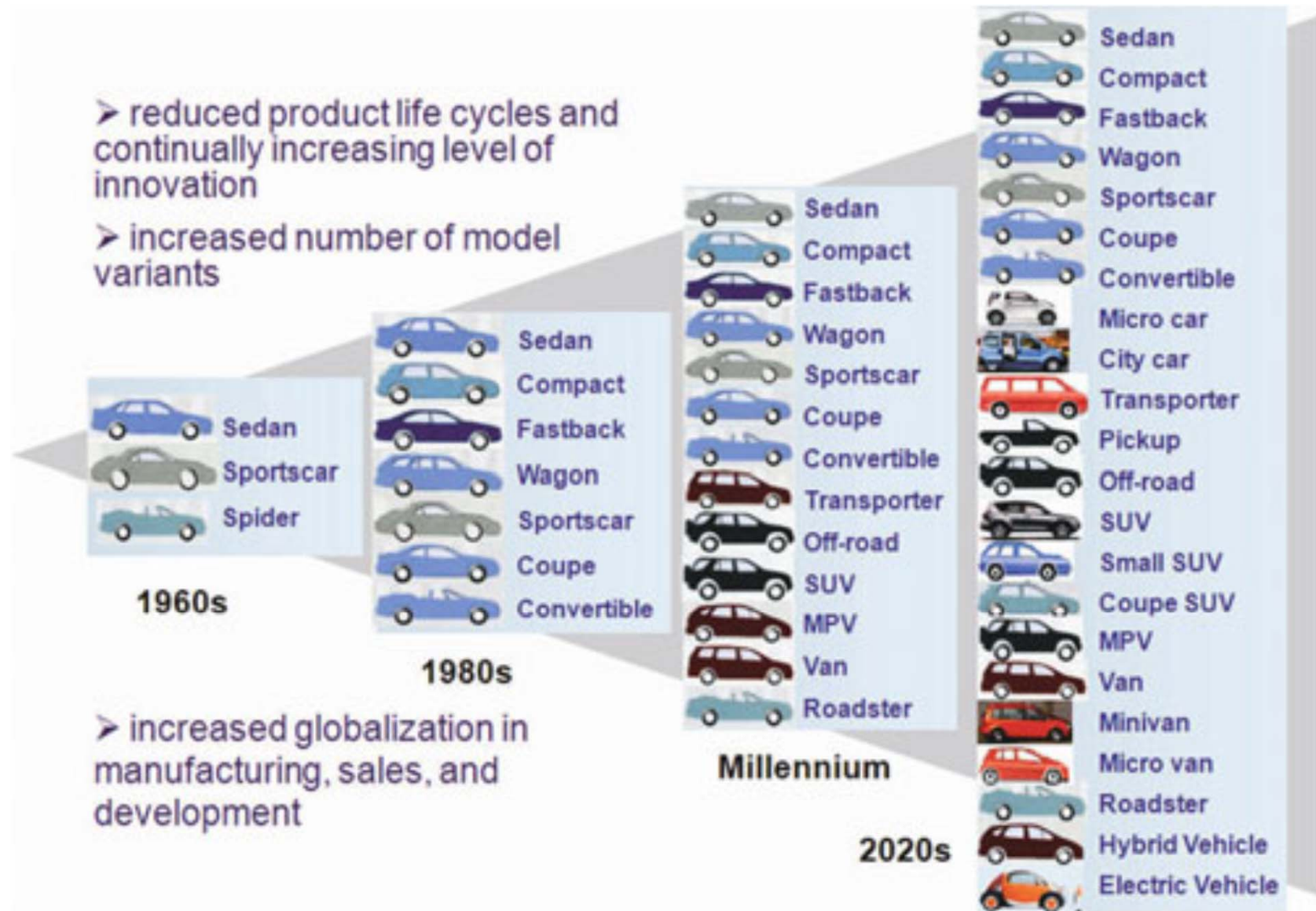
Highlights of motor vehicle history

- Frederick Lanchester produced his first car, a 10 hp model. Front-mounted engine.
- Mercedes car produced.
- 1902 Running board. Serpollet did a speed of 74 km/h in a steamcar.
- 1903 Pressed steel frames.
- First windshield.
- Folding windshield.
- Closed saloon-type body.
- A petrol car reached 100 mile/h and, in the same year, a Stanley steam car achieved a speed of 127 mile/h. Rolls-Royce exhibited their first car in Paris.

Vehicle classification

- A vehicle's class is determined by its purpose and external dimensions. 25 years ago, vehicles could be organized into a relatively small number of categories:
 - compact sedans, mid-sized sedans, and premium sedans. In addition to these, variants such as station wagons, fastbacks, coupes, convertibles, and sports cars could be defined.
- In order to avoid creating an entirely new chassis for every variant, automakers use so-called “module” or “platform” strategies. Every OEM has a limited number of chassis and powertrain configurations which can be modified for the track width, wheelbase, and wheel loads of individual models.

Vehicle classification



Vehicle classification

- A comparison analysis of vehicle dimensions shows that the various vehicle classes are differentiated mainly by the following “comfort dimensions”
 - Shoulder width for front-seat occupants
 - Rear legroom
 - Overall vehicle interior length
 - Trunk volume

Vehicle classification

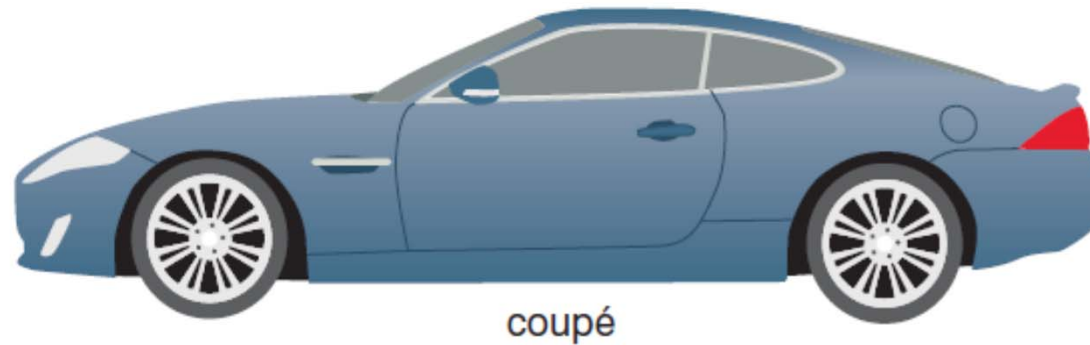
Segment		Current European vehicle examples
1	SUPERMINI	Citroen C1, Daimler Smart, Fiat Panda, Renault Twingo, Seat Aroso, Toyota Aygo, VW Lupo
2	SUBCOMPACT	Audi A2, Fiat Uno, Ford Fiesta, Opel Corsa, Renault Clio, Peugeot 207, Toyota Yaris, VW Polo
3	COMPACT	BMW 1-Series, Ford Focus, MB A-,B-Class, Opel Astra, Renault Megane, Toyota Auris,VW Golf
4	MIDSIZE	Alfa 156, Audi A4, BMW 3, Ford Mondeo, MB C-Class, Citroen C5, Opel Vectra, VW Passat
5	UPPER MIDSIZE	Alfa 167, Audi A6, BMW 5-Series, Opel Signum, MB E-Class, Renault Vel Satis, Volvo S80
6	LUXURY	Audi A8, BMW 7-Series, MB S-Class, Maybach, Rolls Royce, VW Phaeton, Bentley
7	SPORTSCAR	Audi TT, BMW Z8, 6-Series, MB SL, SLK, Porsche 911, Boxster, Opel Tigra, VW Eos
A	VAN	MB V-Class, Opel Combo, VW Multivan
B	MINIVAN	Citroen Berlingo, Fiat Doblo, Opel Combo, Renault Kangoo, Toyota Hijet, VW Caddy
D	TRANSPORTER	MB Sprinter, Fiat Ducato, Ford Transit, Opel Vivaro, Toyota Hiace, Peugeot Boxer, VW T5
F	SUV	Audi Q7,Q5, BMW X3, X5, MB M, GKL Class, Toyota RAV, Land Rover, VW Touareg, Tiguan
G	PICKUP	Ford F-series, Ranger, Toyota Hilux, Dodge Ram, Dakota
M	MPV	Fiat Ulysse, Ford Galaxy, Peugeot 807, Renault Espace, VW Sharan

Body styles-Saloon/Sedan



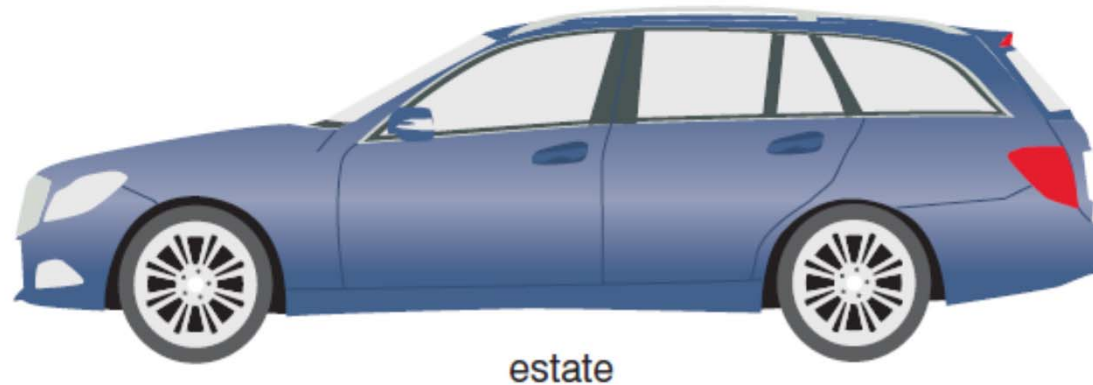
Saloons are fully enclosed two- or four-door cars for four or more people. The common shape of body shell is based on three 'boxes'; the front box forms the engine compartment, the centre box the passenger capsule and the rear box a storage space, called a boot (trunk), for the luggage. The three boxes are blended together to give a pleasing appearance and are shaped to enable the car to move through the air with the minimum drag.

Body styles-Coupes



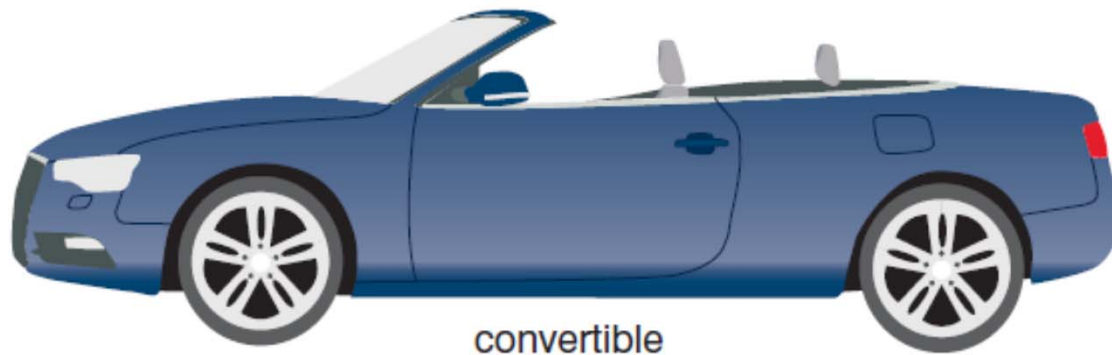
Coupés are generally two-door cars and can have a rigid roof or a foldaway metal roof. Usually they offer two seats for the driver and passenger, but can have two small seats in the rear.

Body styles-Estate



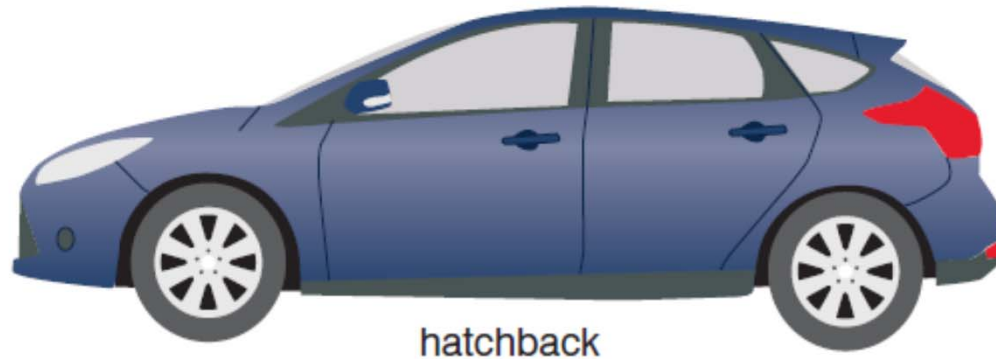
- Also known as a shooting-brake, station-wagon or sports wagon, the estate car has the roof extended to the rear to enlarge the internal capacity. Stronger suspension springs are generally fitted at the rear to support the extra load and, in some cases, the suspension is self-levelling to ensure the vehicle is stable when carrying extra loads.

Body styles-Convertible



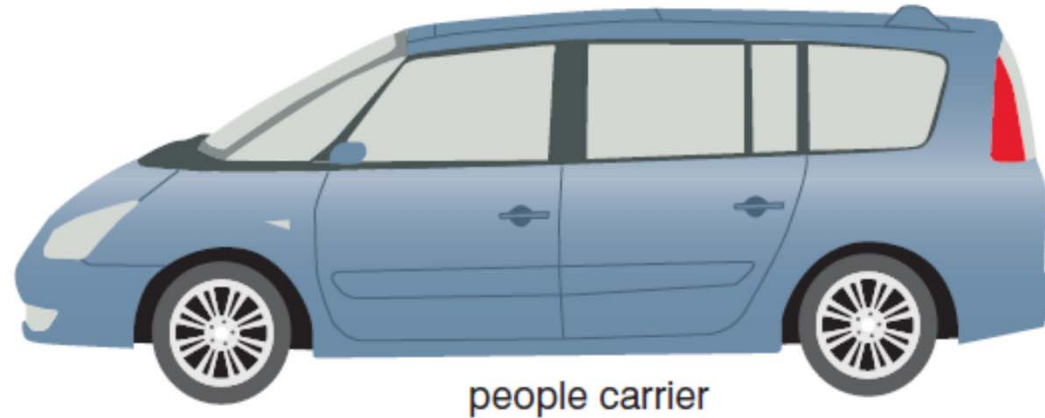
- Convertibles are also known as cabriolets and drophead coupés. They can be converted into an open car by either removing a rigid roof or lowering a fabric or foldable steel collapsible roof.

Body styles-Hatchback



Hatchbacks are halfway between a saloon and an estate car. Counting the tailgate as one door, they are made in three- and five-door versions. As with the estate, the rear seats fold down to give a flat floor for the transportation of luggage or other objects. A parcel shelf normally covers the luggage space. Hatchbacks are popular today as they provide a very flexible transport solution for most drivers due to the ease of access to the rear luggage space and the ability to fold the rear seats flat to make more room for larger items. They are often based on the manufacturers' saloon models and are therefore large enough to seat four or five people comfortably during normal operation. Both small and sporty hatchbacks also exist.

Body styles-People carriers and minibuses



People carriers were commonly known as minibuses in their earliest designs. Minibus construction came from manufacturers using the light commercial van, and then modifying the vehicle by increasing its visibility around the rear panelled areas and adding additional seating to provide up to 16 seats, including the driver. These vehicles are still widely used to transport people around with a good level of safety and comfort. However, with the demand for manufacturers to produce a more versatile range, the 'people carrier' was born. Most variants come from manufacturers modifying the body designs of their smaller car platforms to increase the passenger-carrying capacity to seven seats. These types of vehicle are sometimes referred to as MPVs (multi-purpose vehicles) and they are very popular across a number of manufacturers due to their versatility.

People carriers or mini-buses



The term mini-bus was traditionally used to describe vehicles that carried up to 13 people including the driver. In recent years, vehicles carrying from five to eight people have usually been referred to as people carriers, with the term mini-bus now referring only to larger passenger carriers. As is the case with light commercial vehicles, people carriers also fall into different categories. Many of the recent, smaller sized people carriers are in fact a passenger car platform onto which a different body shell has been attached. However, larger people carriers and mini-buses are more closely related to the medium-sized vans.

- The larger people carriers are generally of unitary construction but with very little sourced from passenger cars, apart from possibly the engine and transmission.
- Mini-buses can be of unitary construction but as is the case with the larger vans, chassis-based designs are also available.



SUVs

- Sports utility vehicles (SUVs, off-road vehicles) are defined as vehicles that feature more than 50mm of ground clearance, all-wheel-drive, and an approach angle of up to 40°. At the light end of this range the vehicle is classed as a van.



Light and medium commercial vehicles

- These small commercial vehicles are used for the conveyance of relatively light goods, usually over short distances.
- Vans often utilize many of the components used by a similar-sized car in the manufacturer's range.



Light and medium commercial vehicles

- When fitting new parts, however, it should be taken into account that components such as clutches, braking systems and suspension units are uprated when they are used on commercial vehicles; this ensures that the parts can withstand the extra stresses. van components have been strengthened to take account of hard commercial use. Most vans have a load-carrying capacity of about 0.5 tonnes. Since low-cost operation is an essential factor, these vehicles are often fitted with a diesel- (compression-ignition) type engine

Pick-ups

- A light vehicle having this partly enclosed body is called a pick-up



Medium sized vans

- Larger vehicles, such as light trucks and minibuses, need to carry heavier loads, so they require a stronger construction and have to be specially designed to suit the application
- Medium-sized vans can come with either a separate chassis or a monocoque arrangement. Manufacturers generally provide a base chassis, but offer many alternative body types, including variations in length and height and the option for open or closed carrying areas to fit with specific needs

Medium sized vans



Heavy Vehicles

- A medium-sized vehicle has a maximum authorized mass of between 3.5 and 7.5 tonnes, while a large goods vehicle is constructed to carry or haul goods where the maximum authorised mass exceeds 7.5 tonnes.
- There is a maximum gross vehicle weight for large HGVs of 44 tonnes. These have at least six axles.

Trucks

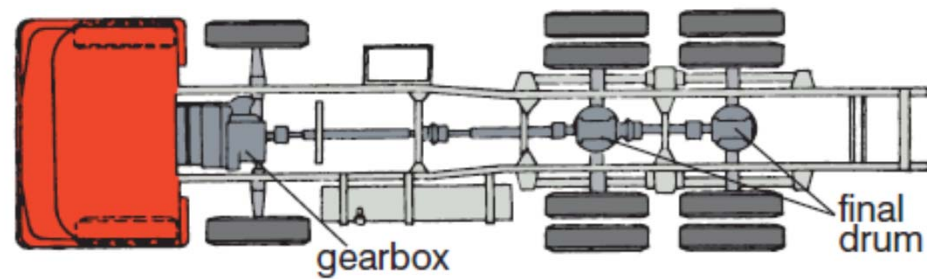
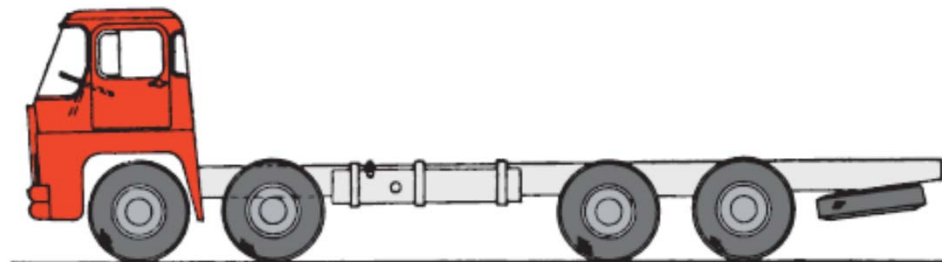
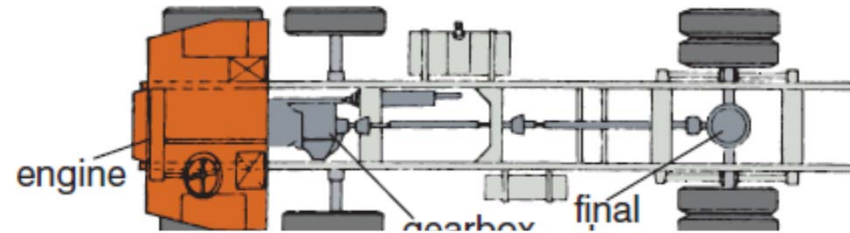
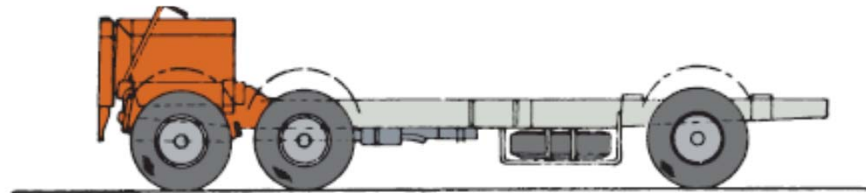
For long-distance transportation of goods a truck is usually used and these come in various shapes and sizes. A large flat platform is needed to carry the load. In many earlier designs this chassis was only provided above wheel height; no special effort was made to lower the frame, which usually consisted of two straight and deep side-members joined by several cross-members. This frame then supported the main components of the vehicle as well as the platform, which formed the basis of the body, and the driver sat in a cab at the front of the vehicle. Today's trucks often have lower frames to bring the centre of gravity down and make the truck more stable and aerodynamic. The engine is usually a compression-ignition, diesel engine. It is fitted at the front and the driver sits high up at one side of it, with a seat for a passenger at the other side. To carry heavy loads the rear wheels either have twin tyres, fitted side-by-side, or special wide-section single tyres. Vehicles exceeding a certain total loaded weight are required to have six wheels carried on three axles, while even heavier vehicles are required to have eight wheels, two on each of four axles. These legal requirements are laid down in the Construction and Use Regulations drawn up by parliament.

Trucks

- When six wheels are used, the two extra wheels may be carried on an additional axle at the rear of the
- These extra wheels are usually, but not always, driven, but no provision is made for steering them.



Trucks



Trucks

- Trucks are allowed to tow a trailer on which an additional load can be carried. There is, in addition, a type of vehicle that consists of two parts: a four- or six wheeled tractor (which does not itself carry any load) to which is attached, by a special turntable coupling, the front end of a semi-trailer, having two or four wheels at its rear end. In this way, some of the weight carried by the semi-trailer is supported by the tractor.
- The combination of tractor and semi-trailer is called an articulated vehicle. The trailer has retractable wheels on which its front end can be supported: this enables the tractor to be uncoupled and used with another trailer while its former trailer is being loaded or unloaded.



Busses

- Buses are designed to transport large numbers of passengers. Up to about 40 passengers may be carried on a single floor or deck. In order to make room for the front entrance, the engine is often laid on its side below the frame, as shown in the illustration of the chassis

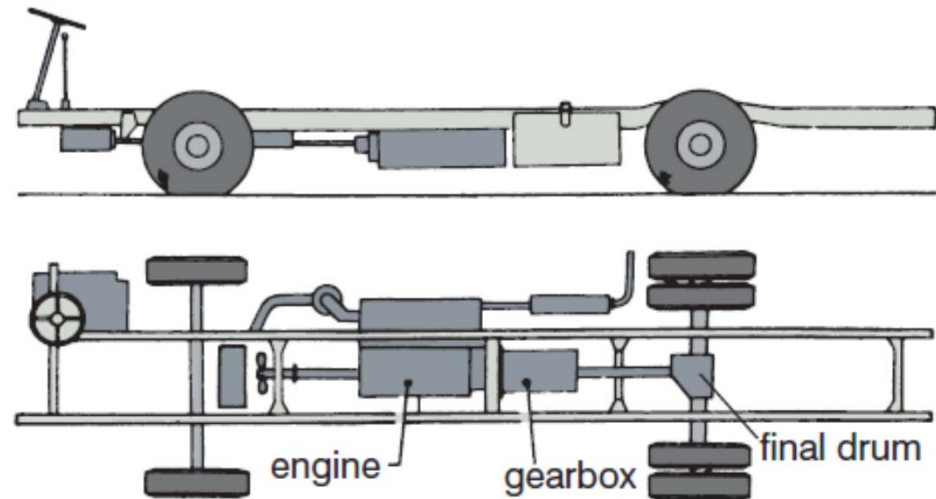


Figure 1.32 Single-decker bus chassis with engine laid on its side

Coaches



- Vehicles of this type are designed to carry between 30 and 40 passengers over fairly long distances, in greater comfort than is provided in buses. Speed of loading and unloading is less important, but a larger amount of luggage accommodation is required due to the long-haul routes these types of vehicles travel.

Vehicle classification-USA

Class 1 Motorcycles		Class 7 Four or more axle, single unit	
Class 2 Passenger cars		Class 8 Four or less axle, single trailer	
			
			
			
Class 3 Four tire, single unit		Class 9 5-Axle tractor semitrailer	
			
			
Class 4 Buses		Class 10 Six or more axle, single trailer	
			
		Class 11 Five or less axle, multi trailer	
Class 5 Two axle, six tire, single unit		Class 12 Six axle, multi-trailer	
			
		Class 13 Seven or more axle, multi-trailer	
Class 6 Three axle, single unit			
			
			

Vehicle classification-USA

Gross Vehicle Weight Rating (lbs)	Federal Highway Administration		US Census Bureau
	Vehicle Class	GVWR Catagory	VIUS Classes
<6,000	Class 1: <6,000 lbs	Light Duty <10,000 lbs	Light Duty <10,000 lbs
10,000	Class 2: 6,001 – 10,000lbs		
14,000	Class 3: 10,001 – 14,000 lbs	Medium Duty 10,001 – 26,000 lbs	Medium Duty 10,001 – 19,500 lbs
16,000	Class 4: 14,001 – 16,000 lbs		
19,500	Class 5: 16,001 – 19,500 lbs		
26,000	Class 6: 19,501 – 26,000 lbs	Heavy Duty >26,001 lbs	Light Heavy Duty: 19,001 – 26,000 lbs
33,000	Class 7: 26,001 – 33,000 lbs		Heavy Duty >26,001 lbs
>33,000	Class 8: >33,001 lbs		

Vehicle classification-USA

Gross Vehicle Weight Rating (lbs)	EPA Emissions Classification			
	Heavy Duty Vehicle and Engines			Light Duty Vehicles
	H.D. Trucks	H.D. Engines	General Trucks	Passenger Vehicles
<6,000 6,000	Light Duty Truck 1 & 2 <6,000 lbs	Light Light Duty Trucks <6,000 lbs	Light Duty Trucks < 8500 lbs	Light Duty Vehicle < 8500 lbs
8,500	Light Duty Truck 3 & 4 6,001–8,500 lbs	Heavy Light Duty Trucks 6,001-8,500 lbs		
10,000	Heavy Duty Vehicle 2b 8,501–10,000 lbs	Light Heavy Duty Engines 8,501 lbs–19,500 lbs	Heavy Duty Vehicle Heavy Duty Engine >8,500 lbs	Medium Duty Passenger Vehicle 8,501–10,000 lbs
14,000	Heavy Duty Vehicle 3 10,001–14,000 lbs			
16,000	Heavy Duty Vehicle 4 14,001–16,000 lbs			
19,500	Heavy Duty Vehicle 5 16,001–19,500 lbs			
26,000	Heavy Duty Vehicle 6 19,501–26,000 lbs	Medium Heavy Duty Engines 19,501–33,000 lbs		
33,000	Heavy Duty Vehicle 7 26,001–33,000 lbs			
60,000	Heavy Duty Vehicle 8a 33,001–60,000 lbs	Heavy Heavy Duty Engines Urban Bus >33,001		
>60,000	Heavy Duty Vehicle 8b >60,001			

Class One: 6,000 lbs. or less



Full Size Pickup



Mini Pickup



Minivan



SUV



Utility Van

Class Two: 6,001 to 10,000 lbs.



Crew Size Pickup



Full Size Pickup



Mini Bus



Minivan



Step Van



Utility Van

Class Three: 10,001 to 14,000 lbs.



City Delivery



Mini Bus



Walk In

Class Four: 14,001 to 16,000 lbs.



City Delivery



Conventional Van



Landscape Utility



Large Walk In

Class Five: 16,001 to 19,500 lbs.



Bucket



City Delivery



Large Walk In

Class Six: 19,501 to 26,000 lbs.



Beverage



Rack



School Bus



Single Axle Van



Stake Body

Class Seven: 26,001 to 33,000 lbs.



City Transit Bus



Furniture



High Profile Semi



Home Fuel



Medium Semi Tractor



Refuse



Tow

Class Eight: 33,001 lbs. & over



Cement Mixer



Dump



Fire Truck



Fuel



Heavy Semi Tractor



Refrigerated Van



Semi Sleeper



Tour Bus

Passenger car size classifications World wide

Homework

Vehicle classification in Turkey

Homework