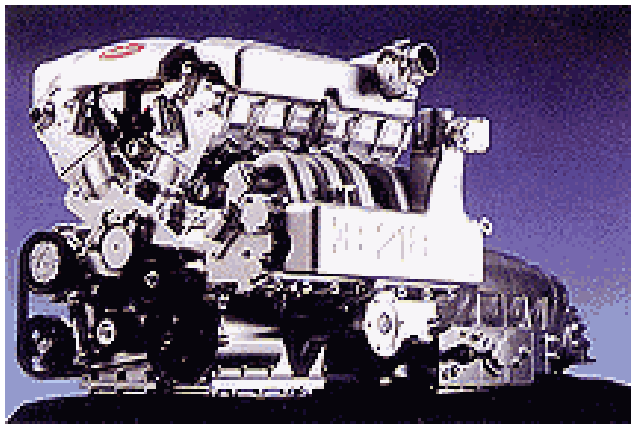
CAR TECHNOLOGY WORKSHOP
TECHFEST 2004, IIT BOMBAY
(www.techfest.org)

Engine:



Automotive production down the ages has required a wide range of energy-conversion systems. These include electric, steam, solar, turbine, rotary, and different types of piston-type internal combustion engines.
The reciprocating-piston internal -combustion system, operating on a four-stroke cycle, has been the most successful for automobiles, while diesel engines are widely used for trucks and buses.

The gasoline engine was originally selected for the automobile due to its flexibility over a wide range of speeds. Also, the power developed for a given weight engine was reasonable; it could be produced by economical mass-production methods; and it used a readily available, moderately priced fuel--gasoline. Reliability, compact size, and range of operation later became important factors.

Internal combustion engine:

An internal combustion engine burns a mixture of fuel and air in an enclosed space. This space is formed by a cylinder that's sealed at one end and a piston that slides in and out of that cylinder. Two or more valves allow the fuel and air to enter the cylinder and for the gases that form when the fuel and air burn to leave the cylinder. As the piston slides in and out of the cylinder, the enclosed space within the cylinder changes its volume. The engine uses this changing volume to extract energy from the burning mixture.

The process begins when the engine pulls the piston out of the cylinder, expanding the enclosed space and allowing fuel and air to flow into that space through a valve. This motion is called the intake stroke. Next, the engine squeezes the fuel and air mixture tightly together by pushing the piston into the cylinder in what is called the compression stroke. At the end of the compression stroke, with the fuel and air mixture squeezed as tightly as possible, the spark plug at the sealed end of the cylinder fires and ignites the mixture. The hot burning fuel has an enormous pressure and it pushes the piston strongly out of the cylinder. This power stroke is what provides power to the car that's attached to the engine. Finally, the engine squeezes the burned gas out of the cylinder through another valve in the exhaust stroke. These four strokes repeat over and over again to power the car. To provide more steady power, and to make sure that there is enough energy to carry the piston through the intake, compression, and exhaust strokes, most internal combustion engines have at least four cylinders (and pistons). That way,

there is always at least one cylinder going through the power stroke and it can carry the other cylinders through the non-power strokes

Parts of engine:

Here's a quick description of each one, along with a lot of vocabulary that will help you understand what all the car ads are talking about.

Cylinder
The core of the engine is the cylinder. The piston moves up and down inside the cylinder. The engine described here has one cylinder. That is typical of most lawn mowers, but most cars have more than one cylinder (four, six and eight cylinders are common). In a multi-cylinder engine the cylinders usually are arranged in one of three ways:

1. Inline

2. V

3. Flat (also known as horizontally opposed or boxer)

Different configurations have different smoothness, manufacturing-cost and shape characteristics that make them more suitable in some vehicles.

Spark plug
The spark plug supplies the spark that ignites the air/fuel mixture so that combustion can occur. The spark must happen at just the right moment for things to work properly.

Valves
The intake and exhaust valves open at the proper time to let in air and fuel and to let out exhaust. Note that both valves are closed during compression and combustion so that the combustion chamber is sealed.

Piston
A piston is a cylindrical piece of metal that moves up and down inside the cylinder.

Piston rings
Piston rings provide a sliding seal between the outer edge of the piston and the inner edge of the cylinder. The rings serve two purposes:

- They prevent the fuel/air mixture and exhaust in the combustion chamber from leaking into the sump during compression and combustion.
- They keep oil in the sump from leaking into the combustion area, where it would be burned and lost.

Most cars that "burn oil" and have to have a quart added every 1,000 miles are burning it because the engine is old and the rings no longer seal things properly.

Combustion chamber
The combustion chamber is the area where compression and combustion take place. As the piston moves up and down, you can see that the size of the combustion chamber changes. It has some maximum volume as well as a minimum volume. The difference between the maximum and minimum is called the **displacement** and is measured in liters or CCs (Cubic Centimeters, where 1,000 cubic centimeters equals a liter).

Connecting rod
The connecting rod connects the piston to the crankshaft. It can rotate at both ends so that its angle can change as the piston moves and the crankshaft rotates.

Crank shaft
The crank shaft turns the piston's up and down motion into circular motion just like a crank on a jack-in-the-box does.

Sump
The sump surrounds the crankshaft. It contains some amount of oil, which collects in the bottom of the sump (the oil pan).

Safety:

1. **Structural crash worthiness – passenger car**:
To ensure that passengers in the car are safe it is essential to evaluate the crashworthiness performance of the vehicle. The goal is to come up with the design so that the energy gets absorbed smoothly inflicting minimum injury to the passengers inside. A finite element model of the entire vehicle was built with all the necessary aggregates with proper inertia and stiffness representations. The stress-strain behavior of the materials of all the components was input for analysis. LS-DYNA software was used to simulate this dynamic event where the vehicle hits a rigid barrier at a defined speed. The intrusion of the steering wheel survival space in the compartment after the crash event is over is some of the critical parameters, which are the focus items.

2. **Airbags:**

Inflating in a fraction of a second immediately after a serious crash occurs, airbags are inflatable cushions that protect you from hitting the interior parts of your car, or in some cases objects outside your car (i.e. other vehicles or trees). There are several types of airbags. Most vehicles have airbags that deploy in frontal crashes to protect front seat occupants; these are stowed in the steering wheel (driver) and the instrument panel (front passenger). Increasing numbers of vehicles also have airbags that deploy in side impact crashes. These may protect either front or rear seat occupants, and may be stored in door trim panels, roof trim panels, or seatbacks.

3. Antilock brakes:

Antilock brakes are designed to help drivers avoid crashes. When a driver hits regular brakes hard, the wheels may lock and the vehicle may skid. Wheel lockup can result in longer stopping distances, loss of steering control and, when road friction is uneven, loss of stability if the vehicle begins to spin. The main advantage of antilocks is that they can

reduce these problems on wet and slippery roads. Antilocks work with your car's normal service brakes to decrease stopping distance and increase the control and stability of the vehicle during hard braking. Vehicles equipped with antilocks have speed sensors mounted at each wheel and a secondary electro-hydraulic braking circuit. The principle behind antilocks is that a skidding wheel provides less stopping force and control than a wheel that is rotating. Antilocks prevent wheels from skidding by monitoring the speed of each wheel and automatically pulsing the brake pressure on any wheels where skidding is detected. Antilocks shouldn't make much difference in stopping distances on dry roads, although they can enhance vehicle stability and allow drivers to maintain steering control during emergency stops when conventional brakes might allow wheel lockup and skidding.