



KHWARZIMIC SCIENCE SOCIETY

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Automobiles Beyond 2000



Summary:

Over a 100 years ago an invention (horseless carriage) transformed totally the way we live, we think and we travel. This horseless carriage which was named afterwards as 'automobile', gave birth to a whole new industrial setup. It is these 100 years which transformed crude oil into 'black gold', and it is the same 100 years which transformed the earth's atmosphere into a store house of carbon dioxide, lead, NOx etc., threatening our future existence on this planet. Since our existence is more important than our transportation and the depletion of fossil fuels is anticipated in the near future, so there is a wave of change in the automotive industry heading towards a zero emission vehicle (ZEV) and alternative fuel vehicles. A vehicle which guarantees safe and emission free transportation is in its inception. This presentation focuses on this change along with new safety standards which are now becoming STD on every new car (in advanced countries).

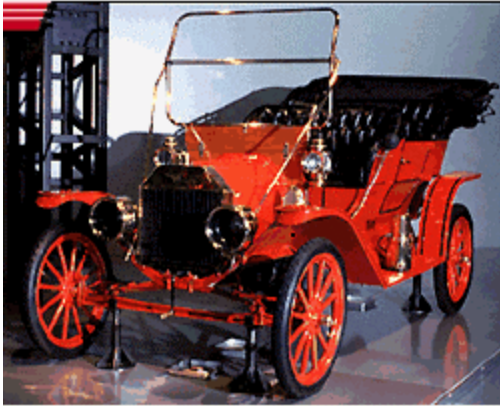
Animal Vehicles are Superseded:

In the early part of this century, automobiles were welcomed wherever they had replaced horse-driven carriages on the roads. They were taken as a blessing.

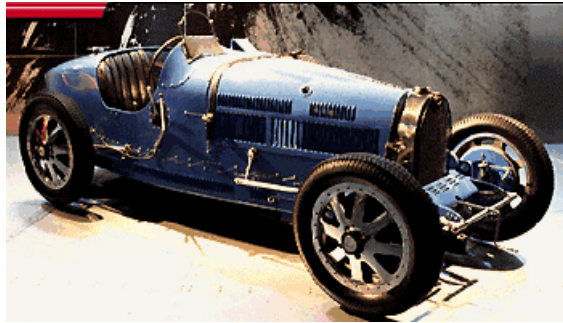
People were confused as how to name these new non-animal machines. Some called them the 'horseless carriage'. The French gave them the name 'automobiles'. Today, they are also called 'automotives' and more simply, 'cars'.

Cars have not changed a lot since they were invented: the same four wheels, an internal combustion engine, the four seats - even though there have been improvements, some of them tremendous, but the overall skeleton of the automobile has remained unchanged.

Have a look at the following vehicles selected from three different phases of the present century and note the similarities for yourself.



Ford Model-T, 1903



Pontiac, 1938: fancier in shape, longer and nothing more - in this as well as the 1903 car, the edges are sharp and no concern has been shown about the aerodynamic features of the vehicles



Nissan Cedric, 1968: the only addition is a roof



MRS by Toyota, 1997: at least it does not seem to be much different from the outset!

Problems with Today's Automobiles:

What Makes them Run?

Fuel: So what is the paranoia? Our automobiles are powered by fuel, mostly petroleum based petrol (US gasoline). There are two major associated problems:

- a) The exhaust of the fuels are major pollutants and contributors to the greenhouse effect
- b) Estimates show that the reserves of fossil fuels are only finite and can last for another 100 years, if used at the same rate.

One can be forgiven for making the claim, that in another century, you may either find a pint of petrol at auction in the Sotheby's or on display at the Cairo Museum.

The major change required is in devising, discovering or inventing a fuel that has higher economy, less emission and is cleaner, without compromising for speed, torque and other luxury factors of present automobiles. Other changes in the mechanism of the engine are also required, or the engine has to be replaced by some better implement that meets the above mentioned results. In some cases, the engine is to be done with altogether. The need is to produce greener cars: cars that have less emission, higher fuel efficiency, can be recycled and work on alternative fuels. Let us now observe the different changes that are underway to produce a greener car.

Alternative Chemical Fuels:

One approach is to replace petrol with other fuels that are not as threatening to the environment as octane. With these fuels, no radical changes are required with the IC Engine. Some promising hydrocarbon-based fuels are compressed natural gas, light petroleum gas and M85 (85% petrol and 15% methanol). The penalty of using these mixtures includes (a) limited range, (b) price difference, (c) chances of explosion due to volatility and (d) no curtailment in CO₂ emission which is a major greenhouse gas. The pay-offs, however include emissions with lower proportions of NO based compounds that are chief villains of the overhanging smog in many industrialised cities.

Hydrogen H₂

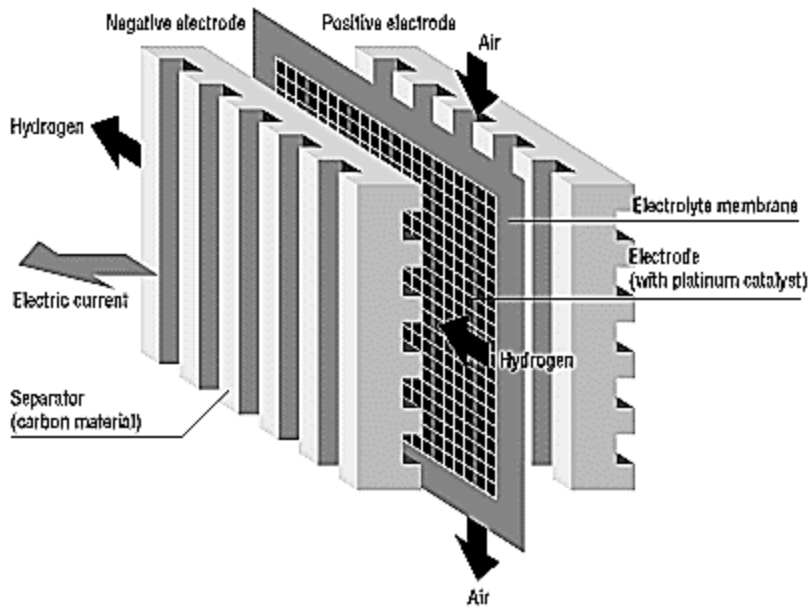
A very competitive candidate for an alternative fuel is hydrogen. Hydrogen is emission-free, the only pollutant being water. Moreover, hydrogen is abundantly available in the form of water. The hindrances for using this gas, however are (a) bulky casing is required to compress and contain the highly compressed gas, (b) is volatile and thus dangerous, (c) it has very dismal mileage and (d) the automobile industry will have to be revamped altogether which is like undoing and unlearning all the automotive technology.

Road Powered Electric Vehicles:

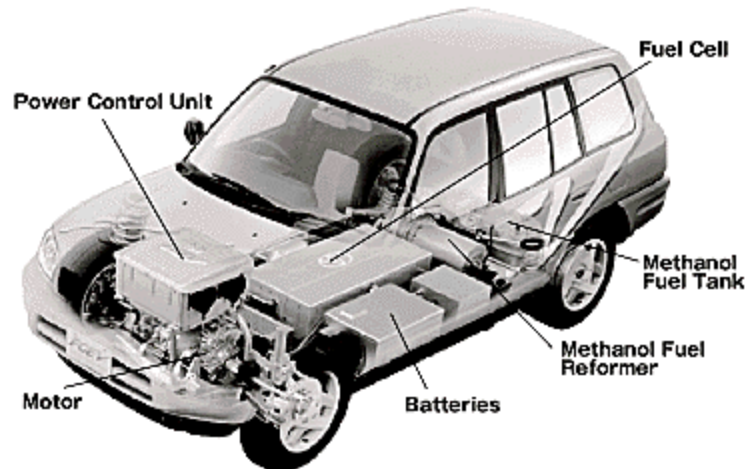
Another fascinating idea is that the automobile is driven by the power from not within, but without. The car travels on a road that is embedded with electric cables. These cables activate an electronic circuit inside the car which drive the motor and the axle of the wheels, through electromagnetic interaction. This technology requires close vicinity of the automobile and the surface of the road. Moreover, the cost for laying down such a road amounts to more than a million dollars per mile, so the idea seems more as a phantasm than a reality-to-be-turned-true.

Fuel Cell Electric Vehicle:

A fuel or a flow cell is a special type of chemical cell. The reactants of such a cell are constantly supplied from the exterior of the cell. A special type of such a cell (a bacon cell) is shown in the figure to the left. the electrodes are made of graphite and the anode is impregnated with platinum or palladium.



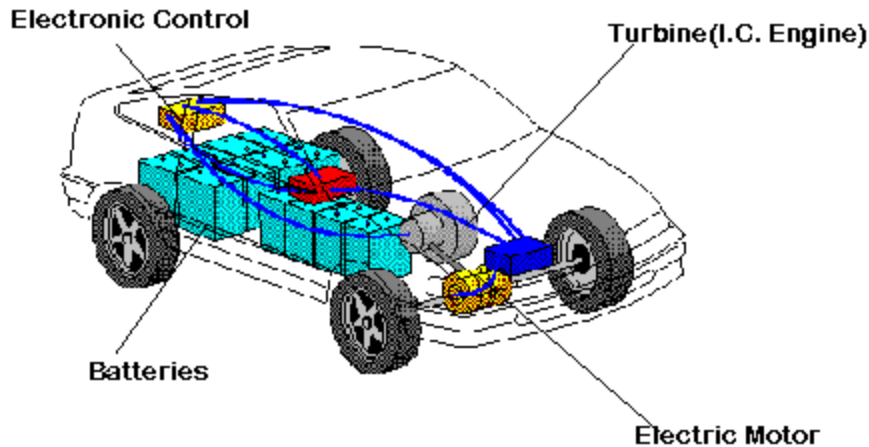
The reactants are hydrogen and oxygen, both being cheap. Hydrogen is supplied from methanol, CH_3OH , a product of the dry distillation of wood. Methanol is a cheap source. A converter is required to extract hydrogen from the methanol and this hydrogen is then fed into the fuel cell. The figure below shows the schematics of energy transfer in an FCEV:



The energy from the FC drives the motor as in an EV, the difference being a different source of energy - a battery in one case and a fuel cell in the other. Batteries however are there to store the energy that is produced in excess by the fuel cell. It also augments when the vehicles are in need of more power, as in driving uphill and also accounts for regenerative braking mechanisms.

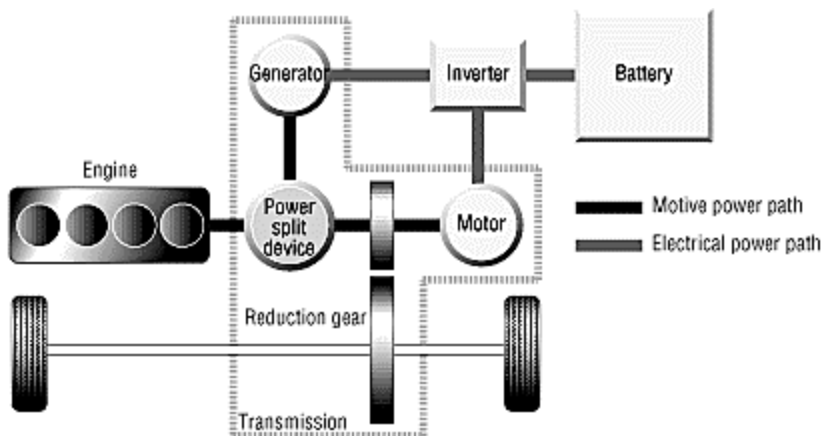
If the fuel cell technology is used, no massive overhauling of filling stations and fuel cells is required - methanol like its fossil counterparts is a liquid. Methanol has half the calorific value than petrol, but its conversion is twice as efficient. So an FCEV gives the same net mileage.

Hybrid Cars and their Twofold Approach:



Hybrid cars are the most promising and most efficient of the prospective future cars.

In a hybrid car, different techniques are employed to run the IC engine on optimum speed. This gives the best possible efficiency, lowest fuel consumption and the cleanest drive! A computerised power-splitting device delivers mechanical power to the trans-axle depending upon the driving conditions. During start-up and at ordinary speeds, the battery supplies electrical power to the motor that drives the wheels. While running downhill or during deceleration, the excess mechanical output from the motor, is supplied to a generator. The generator charges the battery, keeping the engine running at optimum rpm. The IC engine is always near its best performance. The diagram below shows the various features of a hybrid car schematically:



The Flywheel Approach:

A flywheel is a mechanical battery - simply a mass rotating about an axis - and is one of the oldest and most common mechanical devices in existence. The potter has been using the flywheel to mould his pottery. Today, flywheels are being developed for energy storage needs on tomorrow's vehicles.

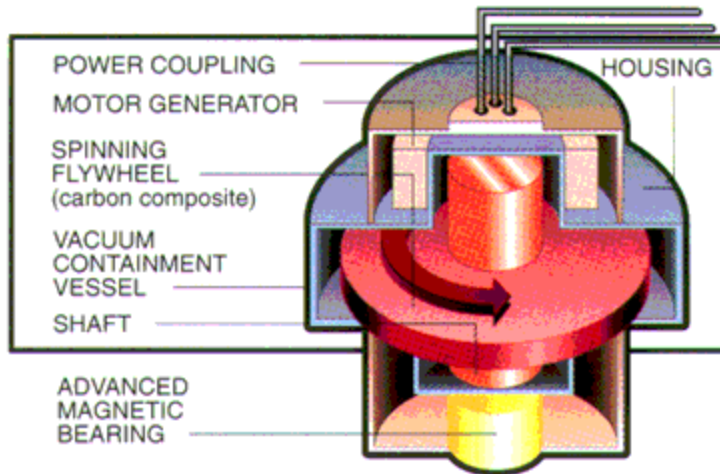
On hybrid vehicles, a flywheel's motor would accept energy from the vehicle's power source (i.e. an engine running a generator or fuel cell) to spin the flywheel up to speed. Electric energy would be drawn from the flywheel generator to power accessories and a motor that will power the vehicle's wheels.

Flywheels wheels can avoid some of the special problems associated with energy storage for hybrid vehicles, especially for those that need their energy storage systems to recharge and discharge often and quickly. Compared to other forms of energy storage, flywheels have the ability to:

- Deliver higher power per weight and size;
- Cycle (discharge and recharge) many thousands of times;
- Have a precisely known state of charge;
- Have long life, and;
- Operate without using potentially hazardous materials.

Since flywheel rotors spin at very high speed, the possible hazard due to rotor failure must be addressed. Flywheel safety involves designing the rotor to resist failure, to fail in a benign way if it does, and to make sure the containment structure can handle the loads. Testing a containment structure ties all these elements together.

Fundamental safety and containment design tools are being developed to enable flywheel developers to design effective, lightweight containment for a variety of flywheel designs. The design tools will be made available to the flywheel industry; A combination of experimental methods will be used to generate data. The testing will include gas gun tests, explosive charges to simulate burst, ring failure tests, rotor failure tests, and full system tests. United Technologies Automotive has completed a simulation of a bearing failure by intentionally dropping a flywheel rotor within the test tank while it was spinning at 34,000 RPM. Tests are now also being carried out to develop levitating superconducting materials for the flywheel. This is an area of extensive research.



Regenerative Braking: When brakes are applied, heat is produced and wasted due to friction. Regenerative brakes transfer this energy to the flywheel, which excites the flywheel generator. Hence power wastage is minimized.

Short Term Changes:

The requirement is to improve fuel economy. Let us see what short term changes can be made for the time being, with the same IC engine mechanism before having to wait till it gets too late.

Reduce the weight of the car: A lighter car means less inertia and hence smaller fuel consumption.

Aerodynamic improvements: These improvements aim at reducing the coefficient of drag (CD) of the vehicle with the air and the surface of the road.

Direct Fuel Injection (DFI): In direct fuel injection, there is no need of the carburetor. In an ordinary Otto engine, the air:fuel ratio is nearly 14.5/1. This does not ensure the complete combustion of the petrol. Instead it leads to the wastage of fuel. If, however, the fuel is directly sprayed over the spark plug in minuter amounts (the air-fuel ratio being only 50/1), complete combustion of the fuel occurs. The result is economy. Such a mixture is referred to as a lean mixture.

Variable Valve Timing: This is a mechanism that further improves upon fuel economy. The valves of the cylinder open and close at different rates depending upon the speed of the car. These valves allow variable amounts of air-fuel intake. The valves are controlled programmably.

Recycling the Whole Car: One approach is to recycle the whole car. Even today, the metal parts can be recycled. The real problem is posed by bio-non-degradable plastics used in cars. The stimulus is to develop and incorporate bio-degradable and recyclable plastics and polymers into the vehicles of tomorrow.

Safety and Comfort Features:

Accidents are a common future - in Pakistan and abroad alike. These accidents claim thousands of life each year. There are certain safety features that are now becoming STD (standard) in cars. We shall have a brief look at them:

Air Bags: Air bags inflate with compressed gas whenever sudden braking is executed. There are intelligent airbags too that inflate in the proper position and to the proper extent, sensing the posture and position of the driver.

These intelligent airbags diminish the chances of impact from the airbag itself. Sometimes both the rear and the front passengers are given airbags and in most cases, only the driver and/or the front passenger is saved by these bags. In more expensive cars, the side-doors are also fitted with lateral airbags to safeguard against lateral impact.

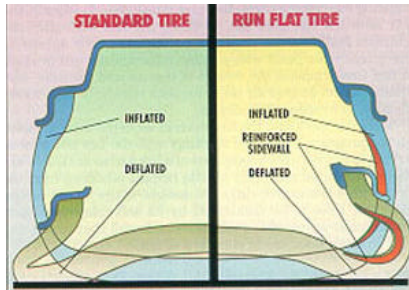
Seat-belt Tensioners: They are used in conjunction with air bags. They are controlled logically and fasten the seat-belt whenever sudden braking occurs.

Antibraking System (ABS): ABS prevents the car from slipping on wet, slippery roads. Electronic pulses are intermittently supplied to the barking wheel. These pulses momentarily stop the translatory motion of the wheel but allow the rotational motion. This rotary motion dissipates the energy of the fast-moving vehicle without allowing it to slip appreciably. This is similar to a car stuck in mud: the wheels are rotating at high speeds but the car does not move. The driver, therefore exercises greater control over the car and can easily manouver it to safety.



The above test shows how the ABS car to the right, was able to save the obstruction whereas the non-ABS car skidded out of control. The test surface was poured with a soapy solution.

Extra Mobility Tires: What if your tire punctures on your way to Islamabad on the Pakistan Motorway and you are midway between Lahore and Bhera - the first puncture spot on the road and no spare tire, either. If you have extra-mobility-tires (EMT), you are saved. They are lined with a tough polymeric material that does not collapse and keeps the tire stiff and you can drive another 350 km, unscathed.



Other comfort features include:
electronic ride control
trip computers
global positioning systems (GPSs)
differential vehicular climatic control

The Future:

*There is no such thing as a scheduled breakthrough.
(A Nissan Adage)*

Hope not we take a U-turn back into the past and once again start hearing the trod of horses.