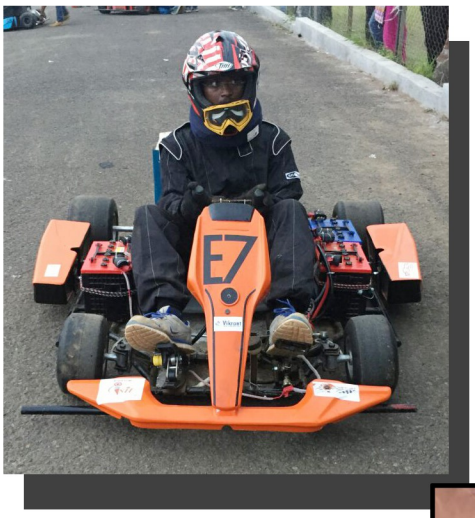
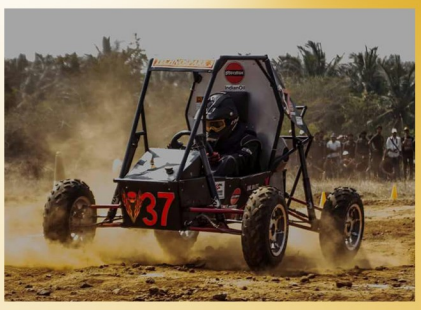
DBATU-AUTOMOBILE & INNOVATION



SAEINDIA
The Engineering Society For Advancing Mobility Land Sea Air and Space
Society of Automotive Engineers INDIA

SAEINDIA
COLLEGIATE CLUB
DR. BABASAHEB AMBEDKAR TECHNOLOGICAL UNIVERSITY, LONERE



CREATIVITY...
FUTURISTIC APPROACH
NEW ERA IN AUTOMOBILE

Message from HOD's Desk

Dr. Mudigonda Sadaiah
Associate Professor and Head
Department of Mechanical Engineering

At the outmost, I congratulate the **SAEINDIA** for bringing out a nice magazine on the latest trends in automobile. It gives me immense pleasure to see that **Mechanical Department** students working on the trends in the area of automobile design and manufacturing. I feel this gives ample opportunities for all the students of mechanical engineering towards the area of automobile. I encourage, all the students to work in the areas of electrical cars, battery operated cars, hybrid cars and driverless cars. In fact, in the next 10-15 years, most of the cars/automobile will be running using non-conventional sources of energy and resources. In fact, this is the need of the hour.

Wishing you all the best for your future endeavour.

Message from Faculty Advisor

Dr. Raju S. Pawade
Associate Professor
Department of Mechanical Engineering

It gives me immense pleasure to write few words as prologue to our SAE e-magazine exclusively meant for churning out the technical ideas, technocrat's talents and communication skills. It's a matter of pride that the **SAE Collegiate Club** students from **Mechanical Engineering** are bringing out e-version of the magazine, a platform in which the creativity and innovation of the students in automotive technology can be explored. The main focus of the magazine is to spread awareness about latest development in automotive technology.

I hope such kind of beginning will provide educative benchmark to all the students of **Mechanical Engineering**. The magazine continues to expand its reach to achieve its vision of being a true representation of students thought about automotive technologies. Wishing a best of luck for the endeavour.

Message from the President's Desk

Shivam P. Yadav
President
SAEINDIA Collegiate Club

I am extremely privileged to lead the **SAEINDIA Collegiate Club** of **Dr. Babasaheb Ambedkar Technological University** which is a undisputed pioneer in the field of training, education and student activities; not only in the country but also in the global arena. We at DBATU continuously upgrade the benchmark of the club through latest activities tool, classical training modules, exploration of new ideas with the help of expert talks and Industrial avenues visit to cope with ever changing corporate and education scenario. All the students are groomed in a real life corporate environment to immediately adapt themselves to high-pressure working environment after passing out from the institute.

I am overwhelmed by my team of hard working office bearers and well experienced and always assisting faculty advisors Dr. Raju Pawade and Dr. Hemant Warhatkar who have made me grow by making the club a classical training and management hub.

Editor's Column

PALASH G BHURE
Editor

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ANNUAL REPORT

The **SAEINDIA Collegiate Club** of the academic year **2017-18** witnessed many eventful programs. The club started off with a whooping membership of **97 members** which included the active participation from the **Department of Electrical Engineering** Student for the first time beside the students of **Mechanical Engineering**. The club initiated the process of building its first website and successfully launched it during the month of July, 2016. Various events were successfully arranged which included logo making competition on 28th February, 2017. The club showcased its participation in many national and international events such as **Go- Cart Competition** held at Kolhapur in which the team led by **Mr. Omkar Jadhav** finished amongst finalist and the **SAEINDIA student BAJA Competition** in which the team possessed an impressive performance compared to previous years. Various expert talks were organized which included speakers who are eminent personalities like Mr. Madhav Kadam, Manager at Mahindra and Mahindra, Kandivali on 16th July, 2016 and Mr. Sanjay Chopane, Manager at R&D Innovation Centre at Eaton Technologies Ltd., Pune on 25 September, 2016 and 1 April, 2017. The club also organized an **Industrial Visit** to **Accurate Industries** and **Aditya Engineering** on 27 August, 2016 which included participation of 82 Club Members. Competition of **Photohunt** was organized on 21st January, 2017 in which task was to find out and to click selfie with the components mentioned in their assignment. The competition of PPT fever was organized on 24th August, 2016 in which students were asked to deliver presentation on the spot. Three rounds of quiz league were conducted in which students from filtered in every league and the finalists faced the Interview round. The overall performance and participation of the club was very impressive as every club member was engaged and also excelled in one or the other activity. The administrative work of the club was at the same time fabulously maintained and recorded with a collaborative connection with the club members and the **SAEINDIA Chennai Administrative Office** with arranging regular meetings and delivering the best that the club could have. All the activities were carried out under the guidance and active promotion of the Clubs faculty advisors **Dr. Raju Pawade** and **Dr. Hemant Warhatkar**. Thus the club witnessed an overall development of all its members in team activities as well as personality development and knowledge incubation in the academic year of 2017-18.

VEHICLE DESIGN REPORT
BAJA SAE INDIA-2018
TEAM TECHNOSPARK

Roll Cage Design:

Roll cage is a functional part of any All-Terrain Vehicle. Primary goal of roll cage is to acquire driver in it with sufficient clearances and provide mountings to all subsystems.

We started design with main objectives:

- Ergonomics
- Weight reduction
- Easy manufacturing and serviceability of sub assembly

Rulebook is a primary design consideration. Along with it stiffness, structural rigidity and aesthetics were considered as design factors.

Roll cage material is selected on basis of specified bending strength and stiffness values. We selected material AISI 4130 (chromyl alloy) with yield strength of 746 MPa, density 7.85g/cm3. Outer diameter of tube is 1.25 inch and thickness is 1.65 mm. Secondary material is of 1 inch and 1 mm thick. This size is selected to satisfy all specified design values.

Material selection calculations:

- Bending stiffness = EI = 3367.44 Nm2.
- Bending Strength = Sy*I/c =Nm. 832.85

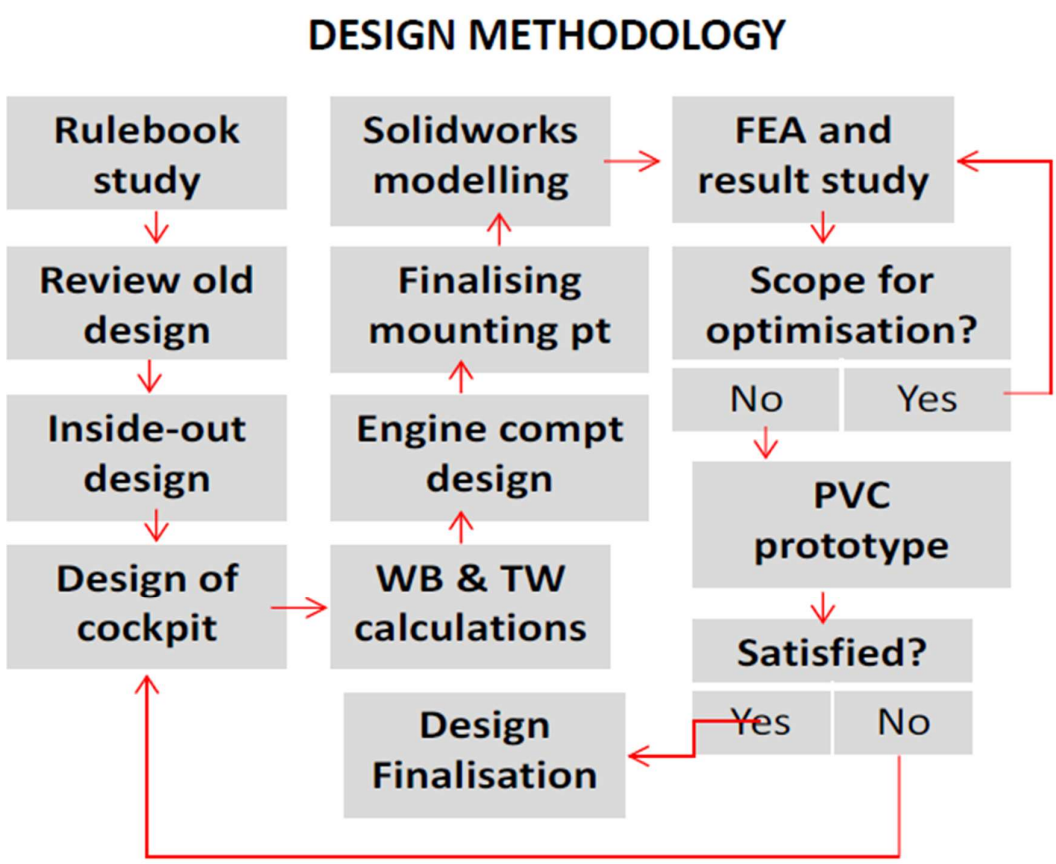
Roll cage is validated using ANSYS as a solver with FOS more than 1.5 for each load case.

Roll cage details:

- Total length = 1750 mm
- Maximum width = 762mm
- Total height = 1120mm
- Total no. Of bends = 8
- Total no. Of weld joints = 65

Conclusion:

- Designing is done by considering driver safety in cases of accident.
- Simple designing for easy and quick manufacturing.
- As selected material has high yield strength so that it is easy to select cross section with less thickness. This reduces weight by 30kg.
- Static analysis by using FEA (ANSYS) confirms our design as we get FOS more than 1.5.



Transmission Design:

Our team used the Briggs and Stratton engine which has the maximum torque of 19.69 Nm at 2800 rpm. Idle rpm of the engine is 1750 rpm, which is the minimum recommended engine rpm. The maximum useful engine rpm was 3600 on basis of data by Briggs and Stratton. The Governor sets limits to the engine speed to 3800 rpm. The calculated power is around 7.095 kW (9.51 HP) at 3600. rpm.

Continuously Variable Transmission (CVT):

CVT uses two diametrically adjustable pulleys and a V-belt. But this CVT design has several advantages and disadvantages being a part of transmission system.

Advantages:

1. Low Cost
2. High ratio change can be achieved by keeping engine power steady
3. Relatively simple
4. Less weight (Less than 14 kg)
5. Mounting flexibility (Due to Integrated centrifugal clutch and varying belt lengths)

Disadvantages:

1. Less efficiency
2. Limitations in torque capacity due to belt slippage

Assumptions:

- 22 in diameter tire
- CVT ratio of 0.5:1 at 3600 rpm
- 98% efficiency of the gears
- 99% efficiency of the bearings
- 97% efficiency of the constant velocity joints
- 76% minimum to 84% maximum efficiency of CV
- Air Density = 1 kg/m3
- Cd firewall= 1.28
- Cd wheel= 0.58
- Cd suspension= 0.9
- Area firewall= .92 m2
- Area wheel= 0.22 m2

Gear Ratio	Tractive Force	Acceleration (m/s2)	Speed (KMPH)
36	2624.38	6.3	10.89
6	874.79	1.53	56.80

- Area suspension = 0.08

Chassis

The primary function of chassis is to protect the driver, give a rigid support for the assembly of the sub-systems, motor, batteries and drive train, and also provide overall aesthetics. Besides these primary functions chassis should be easy manufactured, cost efficient, light-weight and strong.

Safety

Proper numbers of members are used in the chassis to ensure complete driver safety. These include the side bumper structures and bracings for these members, fire extinguisher, battery cover and firewall as per the specifications in the rule book.

Stiffness

Normally, a chassis should be torsionally rigid as possible. But as there are no suspensions, it needs to be little flexible as for turning purposes. So, the chassis is accurately kept stiff by reducing the cross members after analysis.

Weight and Moment of Inertia

To reduce the unnecessary weight of the chassis, minimum possible size of tubes of variable thicknesses have been used according to the rules. A car with a lower mass moment of inertia will be able to turn more quickly. In order to reduce mass moment of inertia, greater weight on the chassis is concentrated as far as possible near the centre of the vehicle.

Placement and Packaging

The chassis must comfortably accommodate the driver, motor, battery, controller, brake components, and templates while remaining as light and small as possible. While a problem with structural integrity or stiffness can usually be solved by simply varying the wall thickness or diameter of the tube, the challenge of fitting all components into the smallest space possible rarely has a clear or straightforward solution.

Chassis Construction Methods

This frame is a structure composed of many small, usually round tubes bent to shape and welded together. Tubular space frames do not require specialized machinery or equipment for manufacture and they are inexpensive and can be constructed from a wide variety of readily available materials. The chassis is of

variable thicknesses and variable diameter to reduce weight and deformations without compromising strength and desirable stiffness.

Material

The material selected for the chassis is AISI 4130 seamless pipes. The OD of the pipes is 25.4 mm and variable thicknesses.

Material Selection: The material selected for chassis is AISI 4130, instead of popular AISI 1018, because it of its high strength and less density which helps in weight reduction. The material available is also genuine.

Table I.1 Material comparison

	Yield Strength(MPa)	Cost(per meter)	Availability
AISI1048	370	320	Yes
AISI4130	587	720	Yes

The specification of the material is 1 inch and 1.25-inch diameter. The reason behind selecting different OD is for avoiding deformations due to impacts and load also different thicknesses for weight reduction. After selecting the material, design is done in accordance with the rule book. Safety considerations while designing the chassis were: -

- A firewall is placed between driver and the electric compartment.
- Bumpers at front, side and rear in case of impacts.

Design Considerations:

Wheel base of 1070mm, front track width of 863mm and rear track width of 1120 mm is fixed as it comfortably accommodates driver and other components. These dimensions were found optimum on the basis of cabin space and overall cabin dimensions. If front track width is less than the rear track with, then it limits under steer and turning is possible even at higher speeds.

CAE CALCULATIONS

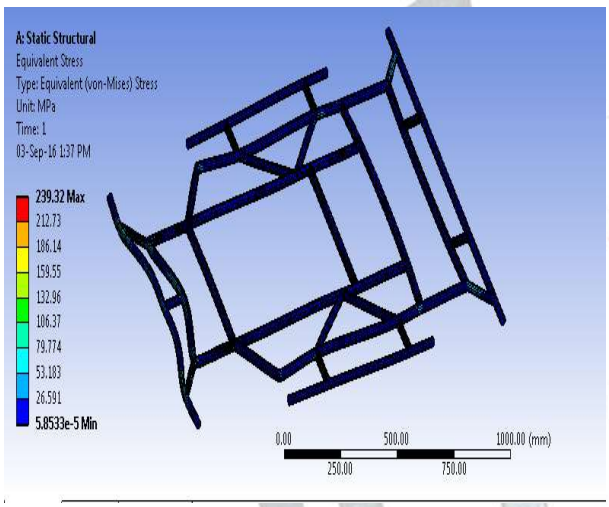
The analysis of the frame was done for various impact forces. Calculated forces done by impulse-momentum equation were applied.

TABLE I.2 CAE Results

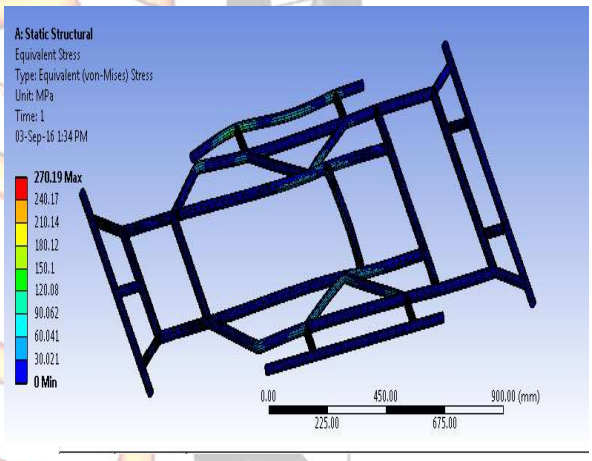
Static Analysis	Front	Side	Rear

Velocity(km/h)	45	45	45
Deformationin (mm)	.0652	1.86	1.26
G-force	3g	2g	3g
Max. Stress(MPa)	239.32	270.19	361.62
Factor of Safety	1.92	1.70	1.27

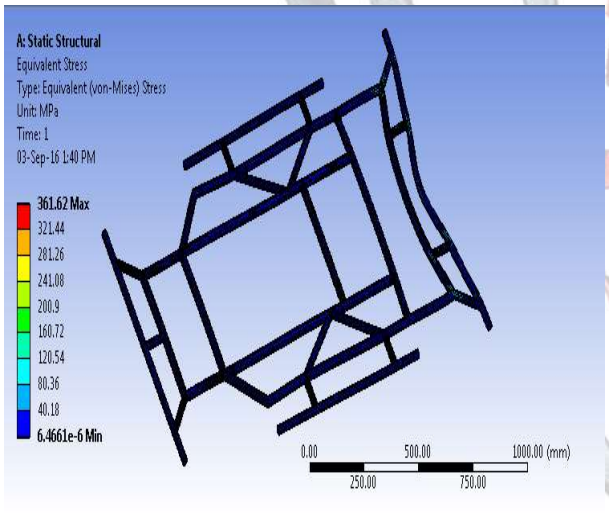
The results obtained were as follows-



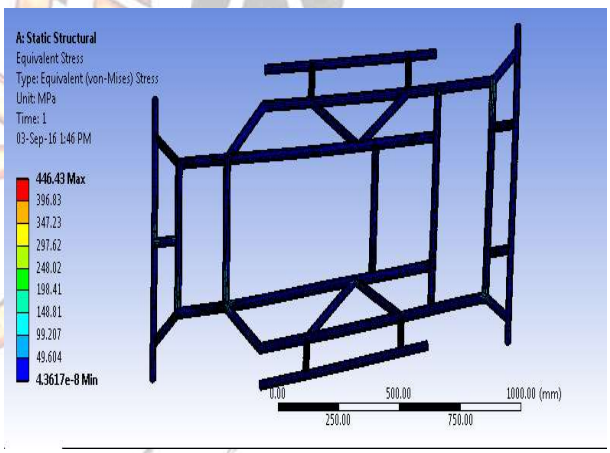
Front impact



Side impact



Rear impact



Torsional stress variation

ERGONOMICS

Ergonomics is the discipline concerned with the understanding of interactions among humans and other elements of a system with a view to improve

performance. The kart is designed keeping in mind the driver's comfort.

PVC prototype of chassis

A. Design methodology:

The calculated driver cabin space available is

- length:886mm
- width: 480mm
- height: 800 mm

From human factor tables the 95 percentile anthropometric measurements like: eye height, arm length, torso height, knee angle, etc. were decided according to the best fit of dimensions into the space available to us considering the variable components like, pedal angle, pedal position, seat position, steering column angle, steering position.

B. Steering comfort:

- Lowest possible steering effort
- Lowest possible turning radius.
- Light weight steering wheel to ensure effortless steering.

C. Driver seating:

Bucket seat - The seat has been selected considering best riding position .The position of seat is decided using anthropometric measurements giving a comfortable access to steering wheel, controller, kill switch, accelerator and brake pedal.

SAFETY

A. Fire safety:

- Fire extinguisher in easy reach of driver.
- Fire proof clothing for driver.

B. Accidental safety:

Enough room for driver has been provided to escape due to rear mounted engine. Further Kill switch disengages the motor instantly. The vehicle has been designed keeping in mind the below mentioned vision sphere of the driver.

Tires

TABLE IV.1 TYRE SPECIFICATIONS

Make	**BKT tires**
Type	Sleek tires-unthreaded, tubeless

Dimensions	Front – 10x4.5-5 SM 68 TL Rear – 11x7.1-5 SM 68 TL
Material	Soft compound
Weight	Rear – 1.4 kg Front - 2.2 kg

- Slick tires were selected due to dry road applications of the kart.
- Due to no grooves on surface, more contact patch is achieved which provides higher traction to the wheel.
- Lower diameter of tire reduces the rotational inertia of wheel which reduces the power loss and thus improves acceleration of the vehicle.
  (Rotational inertia $I = MR^2/2$, Torque=$I\alpha$)
- These tyres are highly convenient for alignment.
- These tyres heat up and get a good grip on dry roads giving superior cornering ability.

Electrical Transmission

The PMDC motor that we are implementing in our kart is a 2.5 kW powered 48 V motor. An equivalent of 48V, 50A-hr lead acid battery is used to quench its thirst. The electrical circuit consists of a microcontroller, and series of resistors, capacitors and diodes and the controller have been programmed based on Pulse width modulation (PWM). The battery is connected to the motor through the PWM circuit and the main reason to use PWM method is that controlling analogue circuits digitally reduce system costs and power consumption.

A. Specifications: -

TABLE V.1 Motor specifications

Motor Type	PMDC
Max net torque	235N-m @ 100 rpm
Max net power	3.33 HP @ 3500 rpm 48 volts

B. Transmission:

TABLE V.3 Known data for performance Calculations

Maximum Torque(T_{max})	235 Nm at 100 rpm
Maximum Power(P_{max})	2.5Kw at 3500 rpm
Drive Line Efficiency(E)	0.87
Chain Sprocket Ratio(F_r)	1:2.40

Tyre Radius (r)	0.1397 m
Mass Of Vehicle(M)	120 kg
Coefficient of Rolling Resistance(C_{rr})	0.04

TABLE V.4:- Formulae

Overall Gear Ratio (O_r)	Primary reduction * Gear ratio
Speed of Vehicle(V)	2*π*r*rpm*3.6/ (O_r*60)
Rolling Resistance (R)	$C_{rr} * M * g$
Tractive Force(F)	$T * E * \frac{Or}{R}$
Mass Factor(m)	$1 + 0.04 + 0.0025 * O_r^2$
Acceleration (a)	$\frac{F - R}{m * M}$
Gradability (θ)	$\sin^{-1}((\frac{F - R}{M * g}) * \frac{180}{\pi})$

C. Performance:

The performance characteristics of the vehicle after calculations have been enlisted below. Table shows the performance parameters:

Overall Gear Ratio(O_r)`	2.40
Speed of Vehicle(V)	16.31 kmph
Rolling Resistance(R)	62.78 N
Tractive Force(F)	508N
Mass Factor(m)	1.31
Acceleration(a)	2.27 m/s^2
Gradability (θ)	17.7 deg
Max speed (final gear)	76.8 Kmph

D. Calculations for Chain Sprocket:

Type of chain to be used is determined by referring to power rating charts and catalogue provided by chain manufacturers. Hence the selected chain is R428.

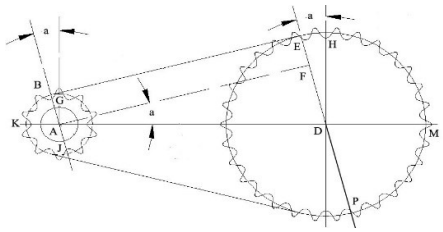


Fig V.1 Chain sprocket geometry

TABLE V.8: Known Data

Pitch (P)	12.7 mm	
No of teeth on driving sprocket	Primary	Secondary
	21	17
No of teeth on driven sprocket	51	17
Centre to centre distance	165mm	330.95mm

TABLE V.9 : Formulae

Pitch Radius of front and rear sprocket	Pitch/ Sin(180/N)
Chain Length	BE + ME + KB
No of Links	Chain Length/ Pitch

TABLE V.10:- Calculated Values

	Primary	secondary
Pitch Radius of driving sprocket	63.905mm	34.55mm
Pitch Radius of driven sprocket	154.72mm	34.55mm
No of links	56	73

E. Shaft Calculations based on ASME code:

TABLE V.11: Known Data

Yield Stress (S_{yt})	460 N.mm
Ultimate Stress (S_{ut})	760 N.mm

TABLE V.13:- Calculated Values

Max bending moment (M_b)	200946 N.mm
Max torsional moment	78375

(M_t)	N.mm		Diameter of Shaft (d)	24.9 mm

TABLE V.14:- Forces applied on shaft for analysis

Vertical weight on shaft	900 N
Tractive force	508 N
Braking force at disc due to calliper	1456 N
Max Torsional moment	78375 N-mm
Force at Sprocket	2165 N

F. Analysis of Rear shaft:

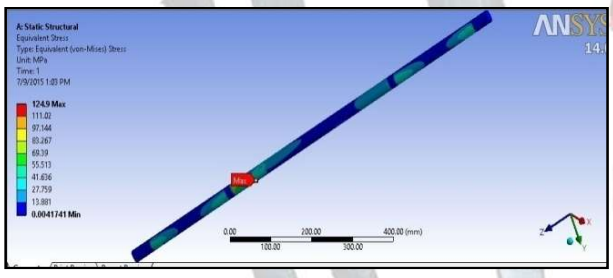


Fig V.2 Shaft stress variation

TABLE V.15

Material	Max stress	FOS
AISI 4340	124.9 MPa	2.6

G. Analysis of hub:

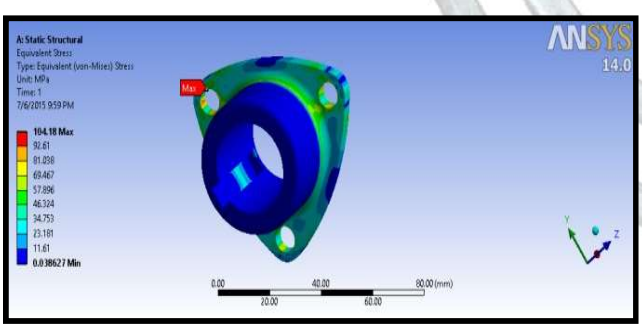


Fig V.3 Hub stress variation

TABLE IV.16

Material	Max stress	FOS
AISI 4340	104.18	3.11

Table IV.17: Forces applied on hub for analysis

Fixed Cylindrical support	At inner hub cylindrical surface
Moment about Bolts	78375 N-mm
Tractive force	508 N
Vertical load	900 N
Lateral force	612 N

H. Analysis of coupling shaft:

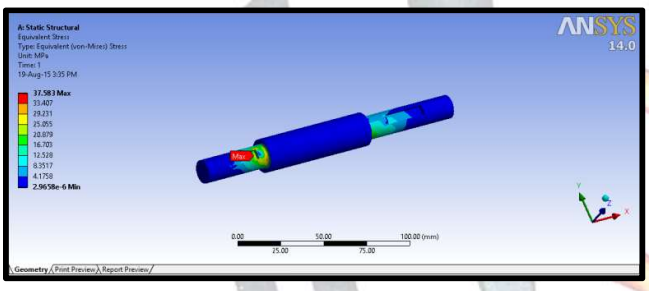


Fig V.4 Coupling shaft stress variation

Material	Max stress	FOS
AISI 4340	47.69	6.53

TABLE V.18: Forces applied on shaft for analysis

Force at sprocket end	223N
Forces at clutch coupling key	512N
Cylindrical fixed support at bearing position	

I. Analysis of Sprockets used:

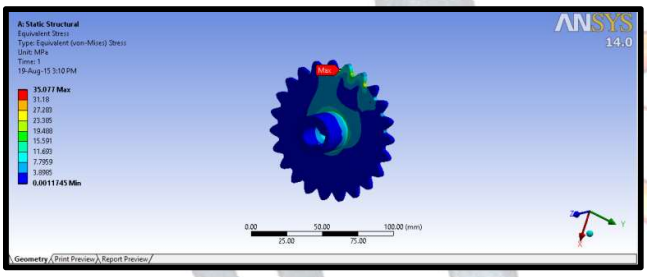


Fig V.5 Primary Driving Sprocket Stress Variation

TABLE V.19:- Forces applied on sprocket for analysis

Driving moment	7500N-mm
Tangential force on 2 Teeth face	210 N
Cylindrical fixed support on inner surface of hub	

Material	Max stress	FOS
AISI 1430	35 MPa	6.4

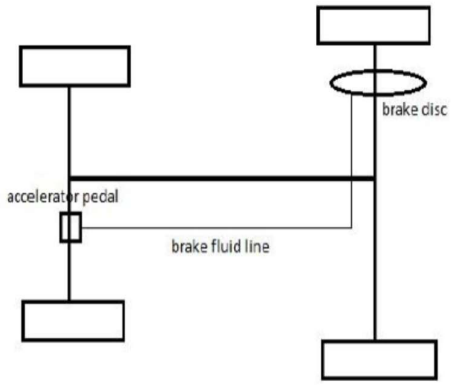
BRAKES

Objective:

The purpose of the brakes is to stop the car safely and effectively. In order to achieve maximum performance from the braking system, the brakes have been designed to stop the vehicle, while minimizing the cost and weight.

Design:

The E Kart is primed with Single Disc Brake System on rear axle operated by a single control. Single brake is composed of 200mm diameter disc and double piston calliper of effective piston diameter of 31mm.



Brake system layout

Braking Design Considerations:

Following are the assumptions for brakes calculations:

Parameter	**Value**
Disc diameter	200 mm
Wheel diameter	279.4 mm
Mass of car with driver (m)	160 Kg
Bore diameter of master cylinder (d1,r1)	10 mm
Effective bore diameter of double piston caliper (d2,r2)	31 mm
Pedal Ratio (p.r)	4:1
Coefficient of friction between tire and road (μ1)	0.6
Coefficient of friction between calliper pad and disc (μ2)	0.4
Height of centre of gravity	254mm
Braking system	Rear wheel
Effective radius of disc	85 mm
Ratio of effective bore areas of MC and calliper	1 : 9.61

Keeping pedal ratio as **4:1** and ratio between bore areas of calliper and MC as **9.61:1,** the effort applied at the pedal gets multiplied **4×9.61 = 38.44** times which gives effective force at calliper pads.

Following are the specifications of final components selected:

Component	Used in	Specification
Disc	Bajaj Discover 125M Front Disc	Outer diameter 200 mm
MC	Pulsar 200	Bore diameter 10 mm
Calliper	Baja Discover 125M	Effective Piston Diameter 31mm
Hoses	Baja Discover	M5 opening

Disc Mounting: -

Fixed support at contact surface between disc mounting and rear axle Torque of 79968 N-mm at mounting points

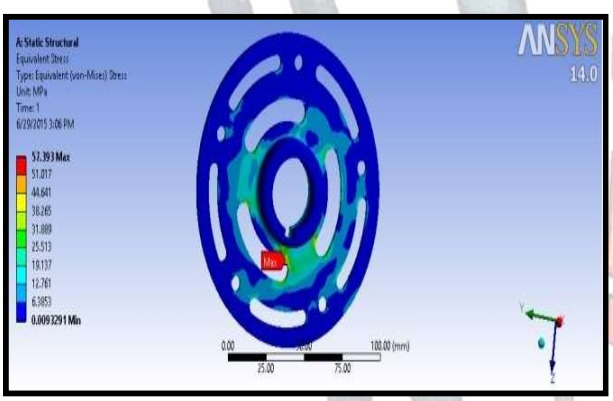


Fig: Disc hub stress variation

Fixed support at pivot

Force of 800N on pedal pad

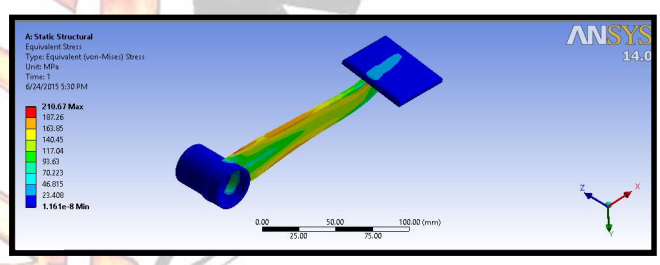


Fig: Stress variation of brake pedal

Steering:

The steering mechanism provides the driver with lateral motion control of the vehicle. It is a group of parts so arranged that transmit the movement of steering wheel to the front wheels. It fulfils the purpose of allowing the driver to guide he vehicle.

Tyre sizes,

1. Wheelbase, track width fixtures,
2. Chassis frame geometry,
3. Ergonomics of the driver.

The above mentioned features are mentioned in the rulebook to be fixed for the further building of the kart. Coming to the main parts of the steering system (considering Pitman arm mechanism) they are as follows:

1. Steering column,
2. Triangular plate,
3. Tie rod kit,
4. Spindle kit.

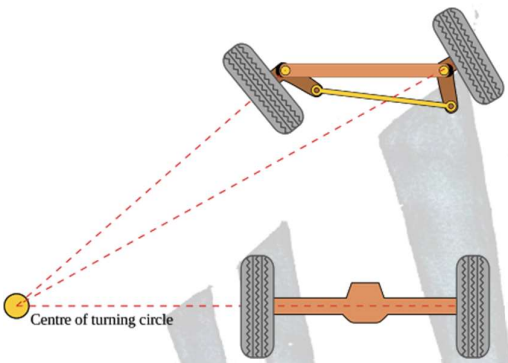


Fig. Ackermann steering mechanism

The initial calculations are tabulated as follows:

Specification	Value
Wheel base	42 inches
Front track width	34 inches
Rear track width	44 inches
Steering ratio	1:1
Ackerman angle	15^0
Steering arm length	8 inches
Inner wheel lock angle	30^0
Corresponding outer wheel angle	23^0
Steering wheel diameter	12 inches
Turning radius	2.28 m
Steering effort	80 N

The steering ratio was considered to be 1:1, for quick response in the mechanism in the cart. The planned line view of the mechanism is shown. Hence the maximum steering angles were further decided. The length of steering arm, dimensions of triangular plate, and tie-rod lengths were decided.

Analysis:

The vehicle stub, C bracket are the important load transmitters. They need to be safe in design considerations itself. The designs of these components were made

on software SOLIDWORKS and were further analysed on ANSYS by platform transfer. The analysed results are shown as follows:

Part	Material	Max. stress calculate (N/mm^2)	Factor of Safety	Max. deformation (mm)
Steering column	Mild steel	2.026e+001	11	3.612e-002

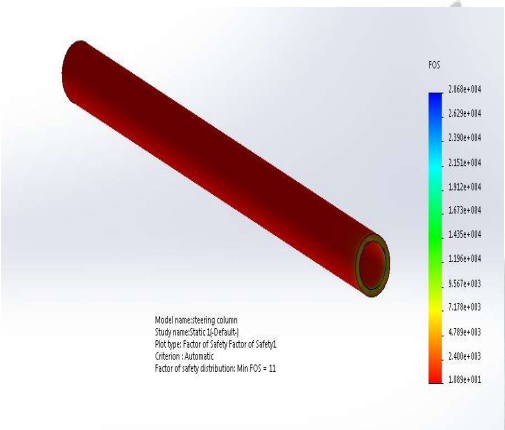


Fig. Factor of Safety

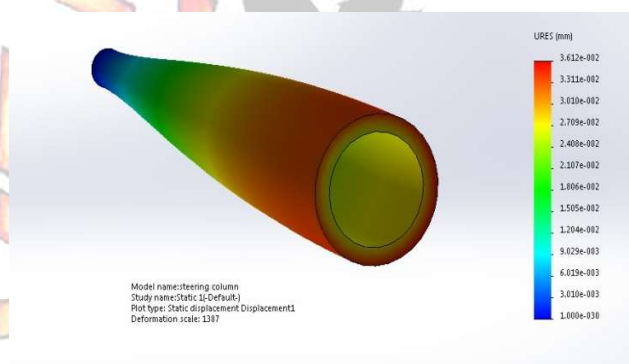


Fig. Maximum Deformation

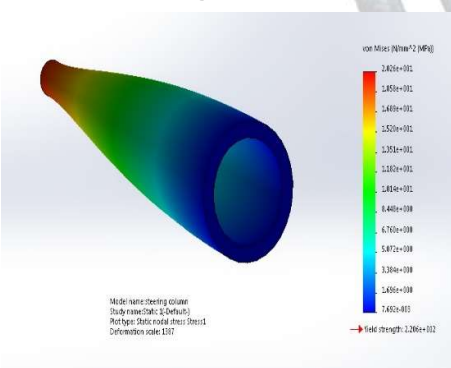


Fig. Maximum stress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LAND ROVER RANGE ROVER EVOQUE

Land Rover Range Rover is a car manufacturing company known for their comfort, safety, performance, features and much more. These cars provide excellent performance to give better satisfaction to their buyers. Range Rover specifically manufacture **compact crossover SUV**s. This company now run by **India's Tata Motors** since 2008 but before that owned by British Manufacturer Jaguar Land Rover. Land Rover is symbolised as **British Icon** which was granted a Royal Warrant by King George VI in 1951. British Manufacturer founded this company on 1978 and since then giving cars that satisfactorily stands in people's heart. [1]

Land Rover Evoque

Land Rover Range Rover Evoque is one of their best product. It has been produced from 2011 in three and five-doors variant with two-wheel and four-wheel drive. The Evoque is designed to meet requirements for lower CO_2 emission and fuel economy and best in class for features. This vehicle is similar to the Land Rover LRX concept, which was unveiled at North American International Auto Show in January 2008. Basically the Evoque was designed to add a more affordable model to the high-end classic Range Rover range, was received positively by the automotive press for having the features, amenities and off-road capabilities of a traditional Range Rover in a small package. Land Rover sold around 88,000 units of Evoque in the first year of production. [2]

As we all know Land Rover known for their feature and performance. This model too gives better feature and performance. Evoque basically available in 2.0 litre engine gives better power output and torque but it various as per variant. This variant is available in both two-wheel and four-wheel drive to fulfil buyer's conditions most likely for off-road drive. Most of the people chose this model for complete their off-road passion. And this two-wheel and four-wheel drive gives much more performance and features during off-road driving. The Evoque is basically known for feature inbuilt inside the cabin to give joyful ride to the people who sit inside car. This model is fully loaded with features that gives best ride over long distance. [2]

Specification: -

The car was launched in two models: the **five-door Evoque** and **three-door Evoque Coupé**. Both models are available in four trim variants- **Pure**, **Prestige**, **Pure Tech** and **Dynamic**. Land Rover lower the market of Pure version while Prestige adds luxury options and Dynamic focuses more on performance. Evoque available in both **left** and **right** hand drive as per buyer's requirement in various countries.

Interior: -The cabin is intended to be best in class and luxurious in line with rest of Range Rover brand. Cabin provides full length **panoramic sunroof** and **8-inch touch screen infotainment system**. Interior provides colours like red, blue instead of base coating that enlighten the mood. It also provides the **Start/Stop** push button that automatically start the vehicle, once key fob is sensed. The cabin seats four, with optional heated seating, steering wheel, windscreen wipers. There is also a **5-inch driver's information display**, which display current information about the vehicle and more. There are 12 interior colour choices available in a variety of wood and metal as well as three optional contrasting roof treatments. Dashboard fully covered with high quality leather. [3]

Body: -

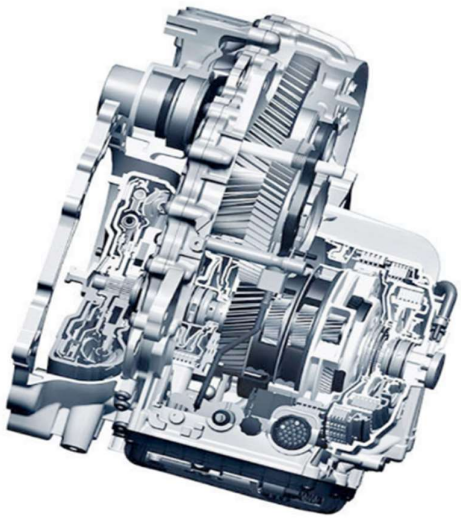
The Evoque departs from the classic body on frame design used in 20th century for vehicle designed for off-road use. **Modern Unibody Construction Technique** is

used for improving handling and ride quality on road. Evoque still gives class leading off-road performance with **215 mm** of ground clearance, **25-degree approach** and **33-degree departure angle** and ability sink up to **500 mm in water**. The Evoque platform, named **LR-MS** is loosely based on **Ford EUCD** platform but 90% of its parts were redesigned which is highly strong and durable.

Engineers used advanced weight saving technique to bring the total kerb weight down to **under 1670 kg**. The used of **Aluminium** for bonnet and the roof and **composite plastic**s for one-piece tailgate helped produce a vehicle weighing 100 kg less than the Freelander (Other model of Land Rover Range Rover). The Evoque equipped with 5 exterior cameras so that electronic system of car allows driver easy driving during off-road. The Evoque is **4360 mm** in length, **2120 mm** in width and **1635 mm** in height. [3]

Engine: -

Three engine options were originally available for the Evoque: two **2.0 litre (1999 cc) turbodiesel** producing either **150bhp** (112 kW; 152 PS), or **190bhp** (142 kW; 193 PS) and a **2.0 litre 240 bhp** (179 kW; 243 PS) **turbocharged petrol** engine.



Land Rover came in market with **9-speed automatic transmission**. This new automatic transmission is developed by **ZF Friedrichshafen** and offers better acceleration, efficiency and improved comfort. [3]

Land Rover since have developed their own branded **Ingenium** engine to adhere to EU6 emissions regulations. There are three 2.0 litre variants available:

Engine	Power	Drive type	Transmission
eD4 Turbodiesel	150bhp (112 kW; 152 PS)	2-wheel drive	Manual
TD4	180bhp (134 kW; 182 PS)	4-wheel drive	9-speed automatic
2.0 litre Turbodiesel petrol	240bhp (179 kW; 243 PS)	4-wheel drive	9-speed automatic

All-terrain System: -

The Evoque came with either 2-wheel drive and a new generation **IV Haldex** permanent 4-wheel drive until 2004 model update when this system replaced by two-optional **All-Wheel Drive Systems** (Standard Drive line or Active Drive line) by GKN driveline. The Evoque comes with the Land Rover's latest version of Terrain Response, which maximises **traction** in a variety of conditions by altering throttle response, power distribution and suspension settings. This system also includes **Electronic Stability Control** (ESC), **Roll Stability Control**, **Traction Control**, and an optional **Hill Descent Control** which automatically applies braking to control speed when moving down an incline.

A third generation **MagneRide** suspension system is also available which works by magnetising iron particles inside the suspension fluid to quickly adapt Shock Absorber firmness to road changes. New suspension developed by **MacPherson** is also used i.e. **MacPherson Strut**.

Evoque provides power steering having turning radius of **5.65 metres**. In this system Rack and Pinion gear system is use. The Evoque provides with 6 drive modes that can be use during driving on several tracks like follow:

- **Auto**
- **Rock Crawl**
- **General Driving**
- **Glass Gravel Snow**
- **Mud & Ruts**
- **Sand**

These different modes electronically adjust the acceleration, braking, suspension, and other important systems of vehicle. We can easily drive Evoque from any road just by selecting one of required drive mode and vehicle itself help driver to drive through any tracks that he want. [4]

Safety: -

- Driver Air Bag
- Passenger Air Bag On/Off Switch
- Passenger Air Bag
- Rear Air Bag
- Side Head Air bag
- Rear Head Air Bag
- Side Air Bag
- Rear Body Air Bag
- 4-Wheel ABS
- ABS
- 4-Wheel disc Brakes
- 4-Wheel Drum Brakes
- Front Disc/Rear Drum Brakes
- Brake Assist
- Electronic Stability Control
- Auto-On Headlights
- Daytime Running Lights
- Child Lock Safety
- Integrated Turn Signal Mirrors
- Night Vision
- Adjustable Pedals
- Rollover Protection System
- Front & Rear Tow Hooks
- Traction Control
- Emergency Trunk Release
- Blind Spot Monitor
- Auto-Levelling Headlights
- Lane Departure Warning
- EBD
- Parking Sensors
- Crash Sensors
- Engine Check Warning
- Front Impact Beams
- Side Impact Beams
- Door Ajar Warning
- Crawl Control

Features: -

- Keyless Entry
- Power Window Front & Rear
- Automatic Climate Control
- Air Quality Control
- Heater
- Engine Start/Stop Button
- Height Adjustable Driver Seat
- Adjustable Seat
- Cruise Control
- Electric Folding Rear View Mirror

- Automatic Headlamps
- Steering Wheel Gearshift Paddle
- Accessory Power Outlet
- Power Steering
- Foldable Rear Seats
- Remote Trunk Opener
- Power Gesture Tailgate
- Low Fuel Warning Light
- Rear Seat Headrest
- Cup Holders Front
- Trunk Light
- Vanity Mirror
- Bluetooth Connectivity
- Fog Lights Rear
- Power Adjustable Exterior Rear View Mirror
- Rain Sensing Wiper
- Rear Window Defogger
- Alloy Wheels
- Tinted Glass
- Rear Spoiler
- Smoke Head Lamps
- Remote Fuel Lid Opener
- Full length panoramic sunroof
- Automatic Parking System

Security Features: -

- Smart Access Card Entry
- Central Locking
- Power Door Locks
- Anti-Theft Device
- Engine Immobilizer
- Anti-Theft Alarm

Description: -

RANGE ROVER EVOQUE 5-DOOR – PURE 2.0 LITRE		
Engine	TD4 Diesel	TD4 Diesel
Driveline	4WD	4WD
Transmission	9-Speed Automatic	9-Speed Automatic
Power	110 kW	132 kW
Torque	380 Nm @1750rpm	430 Nm @1750rpm
Max Speed (km/h)	180	195
Acceleration (0-100 km/h)	10.0 s	9.0 s
Mileage	15.7	15.68

RANGE ROVER EVOQUE 5-DOOR – SE 2.0 LITRE		
Engine	TD4 Diesel	Si4 Petrol
Driveline	4WD	4WD
Transmission	9-Speed Automatic	9-Speed Automatic
Power	132 kW	177 kW
Torque	430 Nm @1750rpm	340 Nm @1750rpm
Max Speed (km/h)	195	217
Acceleration (0-100 km/h)	9.0 s	7.6 s
Mileage	15.68	TBC

Range Rover Evoque 5-door **SE Dynamic 2.0 litre**, **HSE 2.0 litre** and **HSE Dynamic 2.0 litre** have same specification as that of **SE 2.0 litre TD4** as shown in above table. [5]

RANGE ROVER EVOQUE COUPE – HSE DYNAMIC 2.0 LITRE	
Engine	Si4 Petrol
Driveline	4WD
Transmission	9-Speed Automatic
Power	177 kW
Torque	340 Nm @1750rpm
Max Speed (km/h)	217
Acceleration (0-100 km/h)	7.6 s
Mileage	TBC

RANGE ROVER EVOQUE – HSE DYNAMIC CONVERTIBLE 2.0 LITRE	
Engine	Si4 Petrol
Driveline	4WD
Transmission	9-Speed Automatic
Power	177 kW
Torque	340 Nm @1750rpm
Max Speed (km/h)	209
Acceleration (0-100 km/h)	8.6 s
Mileage	TBC

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- Palash Bhure

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Pre-Collision System

In recent years, we have seen many changes in global automotive safety market. With increasing awareness among consumers & government about car safety. That's why they are continuously improving their vehicle safety level. However, the focus is on accident and injuries preventing technologies. These technologies continuously improving drivers' position and modifying vehicle design to ensure safety, to prevent damage that may cause by an accident.

So, you might be thinking what is safety in automobiles? In simple words, automobile safety is study to minimise the occurrence of traffic collision. Generally, there are two types of safety system in automobiles.

1) Active System **2) Passive System**

Passive safety system protects driver and passengers from further injury once an accident has already occurred. Passive works to maintain the LIFE SPACE is as safe as possible. LIFE space is just like safety zone around vehicle occupants within which there are more chances to minimise crash. Passive safety system includes safety features like Seat Belt, Air Bags. These safety features reduce the risk of serious injuries and allow driver to ride out of crash. [1]

Active system is very different as compared to passive safety system. Active system helps to prevent road accident such as crashes. Its operation is based on information and signal taken from current vehicle position. Active system includes Pre-Collision System, Lane Departure Alert, and Antilock Braking System.

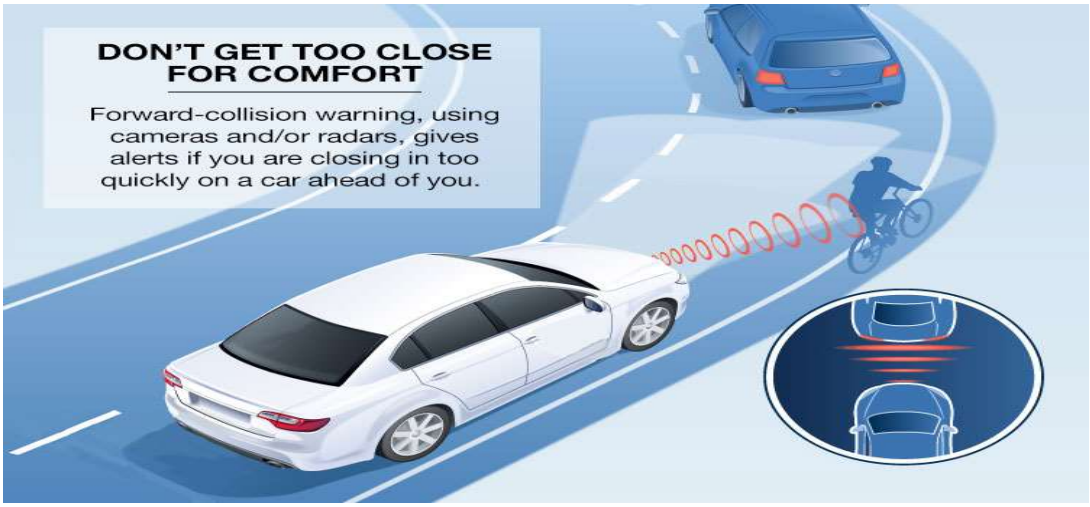

Fig. 1: Pre-Collision System

In this article, I'm going to focus on Pre-Collision System used in vehicles. **Pre-Collision System** is one of the sophisticated technologies used in today's vehicles. It

is also called as **Collision Avoider** or **Pre-Crash System**. It's a complex and automatic automobile system that helps driver to prevent damages, injuries and accident. Early collision system used **Infra-Red** waves for detecting units, but now many of the Pre-Collision System work with the help of **RADAR**, which is like the sound waves which that can bounce. But instead of sound waves radar uses radio waves having greater wavelength than sound waves.

Pre-Collision System Requirements:

1.PCS must have to detect an incoming collision threat and act accordingly to avoid it.
2. PCS should warn the driver near about 12-13 seconds before predicted impact
.3. PCS shall adjust vehicle settings to decrease passengers' injury 10 seconds before predicted collision.

How Pre-Collision System works?

PCS consist of small RADAR placed in the front of the car within body, which continuously emits high frequency RADAR waves. These waves bounce from the object and returns to the sensor where a separate unit connected to it. Sensor calculates how long it took for a signal to leave and bounce back. With this information PCS unit determines another car's position, speed and distance between them. [1]

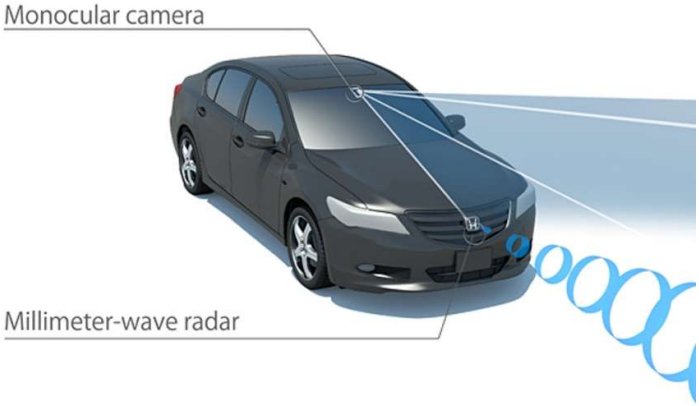

Fig.2: Positions of Camera And Sensor

System can provide or helps driver in avoiding an accident. The question is how this system controls vehicle? Some PCS sounds an alarm about collision or accident. Sound of alarm alerts a driver and get him ready to take control of car. There are some pre-crash systems which apply extra pressure to cars brake in slowing the car to minimise damage caused by an accident. Some Seat Belt

Pretensioner connects PCS with seat belts development of such system must be accurate because any technical problem could distract a driver's attention and cause an accident. That's why before applying PCS to the vehicle it goes through many testing to avoid such issues.

Developers of pre-collision system:

One of the earliest users of accident detection system was the **Mercedes Benz**. Mercedes developed its own system named **Pre-Safe System** in **2003 S-Class sedan**. System used sensors to measure car steering angle and acceleration without surrounding environment like pretending of seat automatic sunroof closing.

In recent years any accident detection technologies were discovered which works on radar system one of them is **Toyota PES** in **2003**, one vehicle sold in Japan in 2010. System uses its millimetre RADAR for the detection of vehicles and to determine when braking helper is required. Toyota also added facilities like Pre-Crash Seat Belt Preparation which automatically brought inclined seats to its original position when crash situation is possible.

Besides Toyota, **Ford** also announced its own RADAR system Collision which gives Warning with Brake Support. While Honda and Nissan provides other active system like lane departure alert and front collision avoidance on their domestic model. [1]

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-Mandar Patil

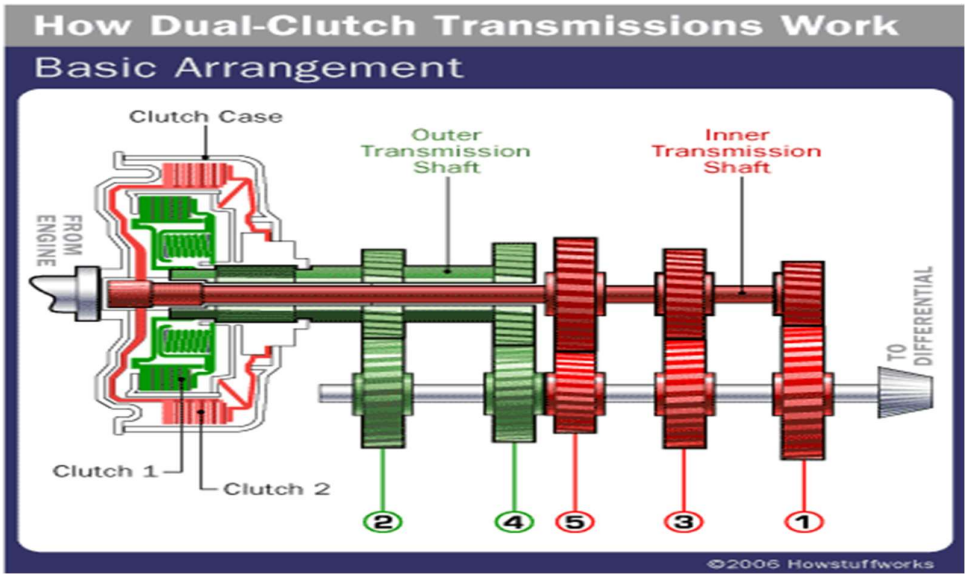
3rd YR Mechanical Engineeering

Most people know that cars come with two basic types of transmission: manual transmission, in which the driver change gears by pressing a clutch pedal and using a stick shift, and automatic transmission, which shifts all the gears automatically using clutches, a torque converter and planetary gears. But there is also something in between that offers the best of both -- the dual-clutch transmission, also called the semi-automatic transmission, the "clutchless" manual transmission and the automated manual transmission.

A dual-clutch transmission offers the function of two manual gearboxes in one. To understand what this means, it is helpful to understand how a conventional manual gearbox works. When a driver wants to change from one gear to another in a standard manual transmission car, he first presses down the clutch pedal. This operates a clutch, which disconnects the engine shaft from the transmission shaft the engine shaft. This cuts the power flow to the transmission. Then the driver changes the gear using a stick shift, a process that involves moving a toothed collar from one gear wheel to another gear wheel of a different size. Devices called synchronizers are used to match the gears before they are engaged to prevent grinding. Once the new gear is engaged, the driver releases the clutch pedal, which re-connects the engine to the gearbox and transmits power to the wheels.

So, in a conventional manual transmission, there is not a continuous power flow from the engine to the wheels. Instead, power flow is discrete when the clutch pedal is pressed during gear shift, causing a phenomenon known as "shift shock" or "torque interrupt." For an unskilled driver, this can result in passengers being thrown forward and back again as gears are changed. [1]

A dual-clutch transmission gearbox, on the other hand, uses two clutches, but it has no clutch pedal. Sophisticated electronics and hydraulics control the clutches. In a DCT, the clutches are operated independently. One clutch controls the odd gears (first, third, fifth and reverse), while the other clutch controls the even gears (second,



fourth and sixth). Using this type of arrangement, gears can be changed without interrupting the power flow from the engine to the transmission.

A two-part transmission shaft is the main component of a DCT. Unlike a conventional manual gearbox, which has all of its gears attached on a single input shaft, the DCT splits up odd and even gears on two input shafts. Outer shaft is hollow, inside which the inner shaft is placed. The outer hollow shaft controls second and fourth gears, while the inner shaft controls first, third and fifth. That's the reason that allows the gear changes to be fast and keeps power delivery constant. A standard manual transmission can't do this because it uses one clutch for all odd and even gears. In principle, the DCT behaves just like a standard manual transmission, except for a clutch pedal, because the action of clutch is made automatic using computers.

Good driver experience is one of the many advantages of a DCT. The up shifts take only 8 milliseconds. Many feel that the DCT offers the most dynamic acceleration of any vehicle on the market. It certainly offers smooth acceleration by preventing the shift shock which accompanies gearshifts in manual

transmissions and even some automatics. Best thing is, it allows the drivers the luxury of choosing whether they prefer to control the shifting or let the computer do all of the work.

Perhaps the most compelling advantage of a DCT is improved fuel economy. Because power flow from the engine to the transmission is not interrupted, fuel efficiency increases drastically. Some experts say that a six-speed DCT can deliver up to a 10 percent increase in relative fuel efficiency when compared to a conventional five-speed automatic. [1]

[1] http://auto.howstuffworks.com//dual-clutch-transmission

- Shantanu Patil

3rd YR Mechanical Engineering

VARIABLE GEOMETRY TURBOCHARGER

The role of the modern automotive technician has changed drastically in the past decade. The job of today's vehicle specialist involves a deep knowledge of a wide variety of technical disciplines. Few professions encompass such a diverse understanding of technology. The automotive technician is now expected to know about chemistry, electronics, mechanics, optics, as well as possess a deep analytical mind. The last only comes with time and experience. [1]

Turbocharger

Now-a-days more and more technologies are being developed in order to increase the net efficiency of an automobile. A **turbocharger** was traditionally used to increase a diesel engine's efficiency and also to increase power output by forcing extra air into the combustion chamber. It is an induction device which is based on turbine driven. This turbine is powered on exhaust gases coming out of engine which is coupled with a fan which forces more air in the engine. The main disadvantage of turbocharger was that it could not work efficiently, if exhaust gases coming out of engine are less, or in non-accelerated condition. Its turbine does not work efficiently if exhaust gases are low, like engine does not meet its air supply condition when the engine is started and incomplete combustion takes place, which in return reduces its efficiency. In order to tackle this problem a concept of turbocharger was introduced known as **supercharger** was introduced. The key difference between a turbocharger and a conventional supercharger is that a supercharger is mechanically driven by the engine, often through a belt connected to the crankshaft, whereas a turbocharger is powered by a turbine driven by the engine's exhaust gas. Compared to mechanically driven superchargers, turbochargers were less responsive, but more efficient. Due to the responsive nature of supercharger they are widely used in high end sports cars. Main disadvantage of supercharger is that it is heavy weighted and it consumes a part of shaft work of engine. Due to development in technologies and extensive application of aerodynamics in the automobiles, a new generation of turbochargers was introduced, known as **Variable Geometry Turbocharger (VGT)** where the turbo uses variable vanes to control

exhaust flow over the turbine blades. Variable Geometry Turbocharger is also known as **Variable Turbine Geometry Turbocharger** or **Variable Nozzle Turbine** (VNT). It is a turbocharger which is equipped with variable turbine geometry, and has little movable blades which can direct exhaust gas flow into the turbine blades. The vane angles are adjusted by an electronic actuator. The angle of the vanes varies throughout the engine RPM range to optimize turbine behaviour. VGT electronic actuation vanes increases accuracy to control over a wide range of operating conditions. The Electro-servo actuation has several sensors and motorised components that work in tandem to control the turbo boost. It consists of gears and an electric motor to regulate the vain position. [2]

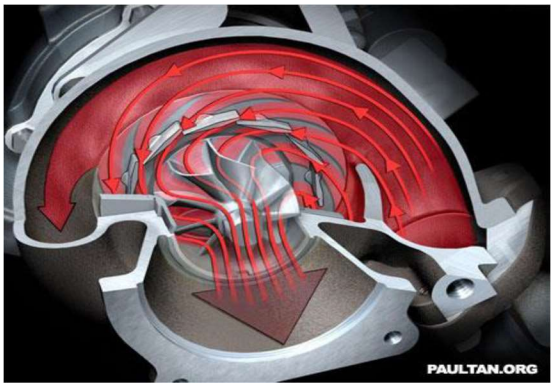


Fig. a Fig. b

Fig. 2: Vanes with nearly closed angles

When the engine is at low RPM, less amount of exhaust is present. The sensors detect the low RPM and moves the electronic actuator which makes the vanes to make almost closed angle. The narrow passage through which the exhaust gas has to flow, that accelerates the exhaust gas towards the turbine blades, making them spin faster. The angle of the vanes also directs the gas to hit the blades at the proper angle.

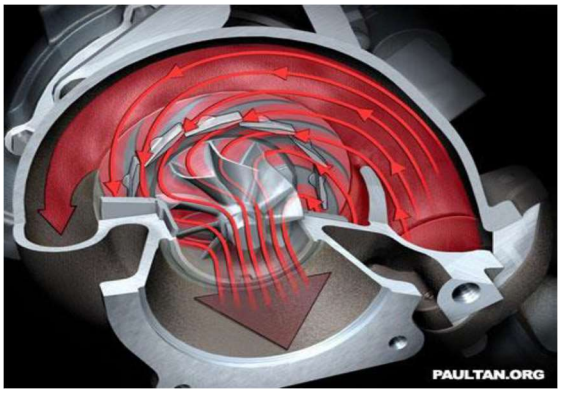


Fig. a Fig. b

Fig. 2: Vanes with fully open angle

As the RPM increases, amount of exhaust also indirectly increases, and the sensors make the electronic actuator move which makes the vanes fully open. High exhaust gases flow at a high engine speeds as fully directed onto the turbine blades by the variable vanes. The aerodynamic design of the vanes makes the exhaust gases to flow directly on blades of the turbine. [3]

Variable Turbine Geometry has been more often used in turbodiesel engines since the 1990s, but it has never been on a production petrol turbocharged car until the new Type **997 Porsche 911 Turbo**. This is because petrol engine exhaust gases are a lot hotter than diesel engine exhaust gas. So generally, the material used to make VTG turbos could not stand the heat from petrol engine. The 997 911 Turbo uses a **BorgWarner VTG turbocharger** which used special materials derived directly from aerospace technology, thereby solving the temperature problem.

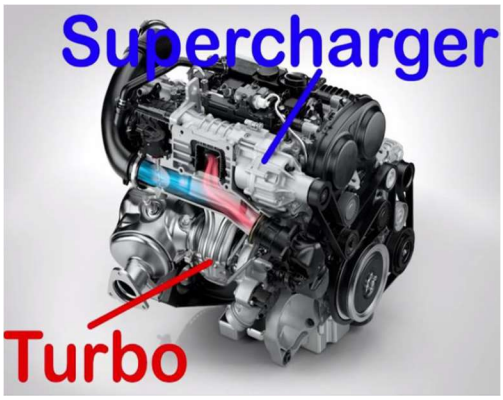


Fig. 3: Combined Supercharger & Turbocharger

Latest technology has made it possible to take a next step in development in method of forced induction by combining turbocharger with supercharger. These kinds of new designs are seen in Volvo and Volkswagen engines. The goal there is to improve efficiency as well as improve low end performances. So, they have a supercharger to give an instant off the line acceleration and then after a pre-determined set point it transitions from that supercharger over to the turbocharger for improved efficiency. [4]

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3rd YR Mechanical Engineering

AUTOMATIC CARS:

THE ERA OF TECHNOLOGY

An autonomous car is the latest technology built by the humans which is capable of sensing it's environment and navigating without their input. Cars are generally not fully autonomous and they all require a special attention to take care of the steering at critical situations.

Bentley Bantayga Tablet

This car uses a variety of techniques to detect their surroundings such as radar, laser, lights, GPS, oximetry and computer vision to control the car. [1]

CLASSIFICATION:

LEVEL 0: - In the type the system issues warning but has no vehicle control. So the driver is must to drive the car.

LEVEL 1("hands on"): - In this type the driver and automated system share control over the vehicle. An e.g. would be Adaptive Cruise Control (ACC). In this the driver controls steering and the automated system controls speed. The driver must be ready to take full control at any time.

LEVEL 2("hands off"): - In this type the automated system takes full control of the vehicle like acceleration, braking and steering. The driver must be confined to driving and be prepared to immediately intervene at any time if the automated system fails to respond properly in some situations.

LEVEL 3("eyes off"): - The driver can safely turn their attention away from the driving tasks e.g. The driver can text or watch a movie or do any kind of stuff he wants. The vehicle will hand situations that call for an immediate response, like emergency braking and many more. The driver must still be prepared to intervene within some limited time.

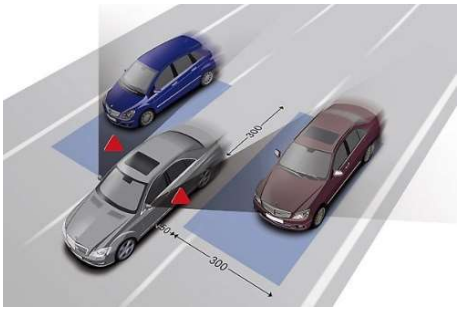
LEVEL 4: - Its same as level3, but no driver attention is required for safety i.e. the driver may safely go to sleep or leave the driver's seat if he wants.

LEVEL 5: - in this type no human intervention is required and is the safest.

SYSTEM USED IN THE LATEST UPCOMING AUTONOMOUS CARS:

1. ACTIVE BLIND SPOT ASSIST:

A radar system monitors the area around the vehicle and will warn you if it detects a vehicle in your blind spot. If you begin to turn, the system can actively apply the break to help bring us safely back into our lane so that we may avoid any kind of disorder created do to the dislocation of our lane.



Blind Spot Assist

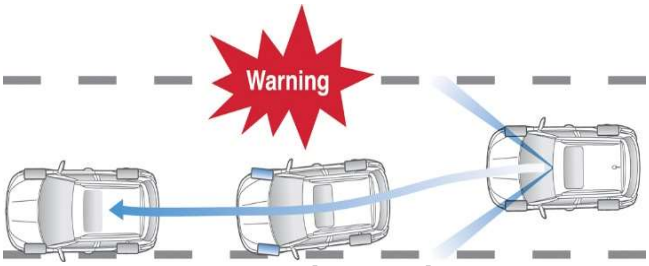
Blind spot is the one area that even a glance in the mirror is not always able to cover. This system shows us a red triangle in the exterior rear view mirror to indicate that there is vehicle in our blind spot. If the system identifies a risk of collision with the vehicle detected in our blind spot, then it efficiently applies one sided braking at last moment to return the vehicle to its lane and prevent a side collision. [2]

2. SIDE GUARD ASSIST:

If there is a moving object like any cyclist or pedestrian walking there, then it gives the driver a visual and acoustic warning. If the sensor detects a stationary obstacle in the tracking pattern of the truck when turning off e.g. a traffic light or road signs, a warning is also given. This technology is mainly used to avoid accidents and control the traffic. [3]

Side Blind Zone Alert

3.LANE DEPARTURE WARNING SIGNALS:



Lane Keeping Assist

A lane departure warning system is a mechanism designed in order to assist or warn the driver when the vehicle begins to move out of its lane on freeways and arterial roads.

This system is based on:

A. Video sensor in the visual domain (mounted behind the wind shield, typically integrated beside the rear mirror).
B. Laser sensor (mounted on the front of the vehicle).

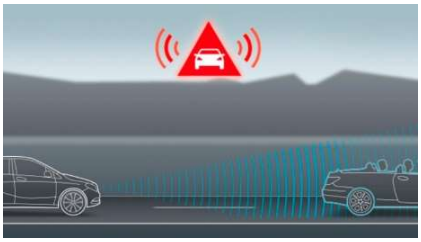
C. Infrared sensor (mounted either behind the windshield or under the vehicle). [4]

4.EMERGENCY BRAKE ASSIST(EBA):

EBA is a generic term for an automobile technological that increases pressure in an emergency situation. By interpreting the speed and force with which the brake pedal is pushed, the system detects and in case driver is trying to execute an emergency stop, and if the brake pedal is not fully applied, the system overrides and fully applies breaks until the **Anti-Lock Braking** system takes over to stop the wheel locking up. In this way, the break system works. [5]

Active Brake Assist System

5. COLLISION PREVENT ASSIST:

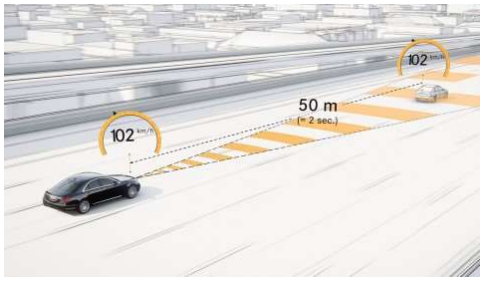


Collision Prevent Assist

It helps the driver to keep a sufficient distance from man and optimise the breaking performance if the driver himself breaks too low. [6]

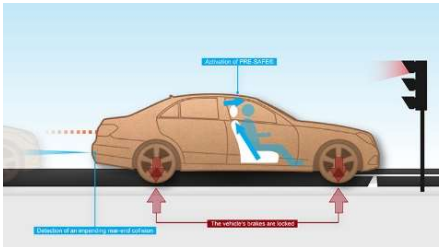
6.DISTRONIC PLUS:

It is Adaptive Cruise Control. That is, cruise control where the driver sets a certain speed, and if the car in front of him slows down, his car will automatically break. If it speeds up again, so will your car. Also, while taking a turn, the car will slow down. This also works in stop and go traffic because if the car in front of you comes to a complete stop, autonomous car will too. [7]



Distronic Plus System in Mercedes-Benz

7. PRESAFE BRAKES:



Using the **Distronic Plus Radars**, they can detect possible collision. If within 2.5sec of impact, the driver will have an audible warning. At about **1.6 sec**, breaks are applied at **40%** and primed to be put into full strength if and only if the driver steps on the

breaks. The seat belts are also tightening along with closing of windows. [8]

8. NAVIGATION SYSTEM:

We can enter our final destination and the map will be created according to our current and final location. Then accordingly car will follow the path towards our required destination. [9]

Sony Navigation System

"The use of automatic cars has made our human life more comfortable. The driver has to take no care of the steering and can enjoy traveling towards his destination. This has reduced the traffic problems in accordance to the precise driving. It has increased the safety of the people and car accident rates have been reduced due to this grand upcoming Technology used in the cars."

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- Bhagyashree Chinchankar

2nd YR Mechanical Engineering

BIO METHANE AS A TRANSPORT FUEL

The world is now facing huge challenges because of shortage of conventional fuels and environmental degradation. To overcome these problems, the interest in sources of renewable energy sources is raised and the need to produce energy from these resources is enhanced. Biogas or Bio-methane, that can be upgraded from biogas, is one of many possibilities. Biogas produced from an anaerobic process is good enough to generate heat and electricity, but after upgrading to Bio-methane, it also has a great potential to act as a vehicle fuel.

Bio-Methane

Biogas is upgraded to Bio-methane by elimination of carbon dioxide (CO_2) and other trace components, which can be used for many applications in order to reach both a maximum energy value and an environmental friendly performance. Especially, when biogas is to be used as a transport fuel, it has to be upgraded to the strict gas quality demands. The cleaned gas is as pure as natural gas and is suitable for all engine configurations.

The "Bio" part of the term "**Bioenergy**" refers to life and biomass that is biological material derived from living organisms, which are abundant in nature [1]. The most common type of bioenergy is biofuels such as biodiesel and bioethanol. They are important because they have potential to replace petroleum fuels and natural gas in the future. Unlike petroleum fuels, biofuels have the capacity to reduce greenhouse gas emission and a country's dependence on conventional fossil fuels.

As people might know, fossil fuels were formed millions of years ago. When burning them, carbon dioxide as well as other greenhouse gases (GHGs) are released, which were absorbed in ancient time. Making use of biofuels itself generates about the same amount of carbon dioxide as fossil fuels do. But the main advantage is that the carbon dioxide is absorbed by plants, which can be converted into biofuels again thereby creating a carbon cycle [2]

The application of Biogas as a transport fuel is generally still a young industry in **Europe**, despite the fact that it has already been proved that the crude oil deficiency can be broken. About **82%** of motorized road vehicles in **Pakistan** were using methane as a fuel in 2010 [3]. For transport purpose, it is usually in the form of **Compressed Biogas**, (CBG), or **Liquefied Biogas** (LBG). CBG is typically used for

light transport vehicles such as cars, vans, urban buses, boats, etc., while LBG is the fuel for heavy transport, such as trucks, intercity coaches and ships, due to the fact it has three times higher energy density than CBG [4].

In 2017 home-grown automaker Tata motors recently showcased the country's first **bio-CNG** (compressed natural gas) Bio-Methane bus in India. The company has designed and developed Bio-Methane engines for **LCV**, **ICV** and **MCV** buses and the powertrain options include – **5.7 SGI** and **3.8 SGI**.

A positive side of using Bio-methane as a transport fuel other than environmental and energy security is that it is suitable for all engine types and all transport modes. The bio-methane fuel upgraded from biogas has around 40 more **octane numbers** than gasoline fuel, which can reduce the likelihood of the problem of engine knocking [5].

Tata Bio-Methane Bus

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2. Nan Cui, (2015) Biomethane as Transport Fuel. A Study on Upgrading Technologies and Biomethane Potential in Finland, p.6-7
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-Milind Ukey

3rd year Mechanical

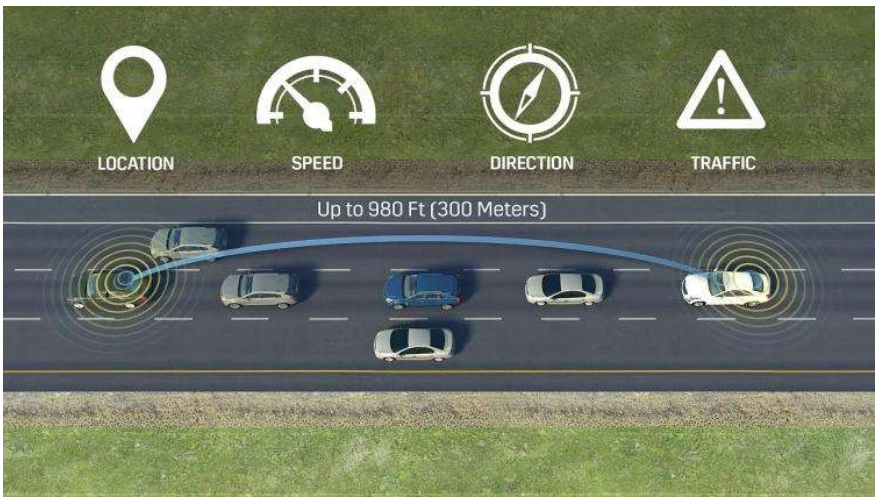
V2V Communication By Ad-hoc Network

Imagine a day when vehicles are able to communicate with one another. Imagine a future where drivers would be warned of a potential crash by the vehicles they are d riving. The technology to make this happen exists today.
Ad-hoc inter-vehicle networks will soon be a reality as cars become equipped with wireless communication system. One use of an inter-vehicle network is to propagate alters such as accidents and road conditions within a region.

This network initiated a vehicle-to-vehicle (V2V) for short collaborative project where one of the objectives is to determine if a diverse group of drivers accept V2V safety technology and to see how they respond to the system. [1]

V2V communication system provides a 360-degree view of similarly-equipped vehicles within communication range.

Transmitted messages common to all vehicles include each vehicle's current GPS position, vehicle speed, acceleration and heading vehicle control information such as the transmission state, brake status and steering wheel angle as well as the vehicle's Path History and Path Prediction. [2]



Technology that will prove beneficial to all of the drivers of our roads the world over for today, tomorrow and generations to come.

V2V is currently active in some models developed by **General Motors**, which demonstrated this system in **Cadillac** vehicles in 2006. Others companies like Toyota, BMW, Daimler, Honda, Audi, Volvo are still working on this system in automobiles. [3]

Cadillac

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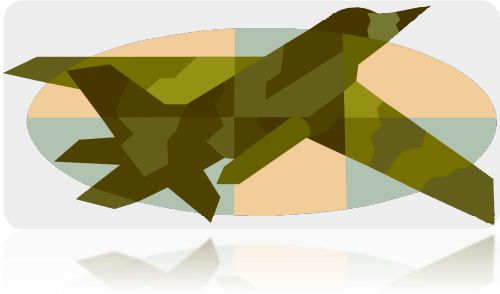
- Komal Mali

2nd YR Mechanical Engineering

INVENTION OF AIR PLANE



Isn't it fascinating that we can now fly to any part of earth without hassles? Few decades back, who would have thought that we could fly in the air even without a pair of wings? The idea of soaring high like birds and kites has been the inspiration of the inventors of aero plane. Man's romance with skies started back in **18th century** when **Hot Air Balloon** was launched in France. But there was one problem with these hot air balloons that they could not be directed to the location one wanted to visit. Rather wind was one that decided destination and direction of balloon. Year 1880 witnessed earliest steam power airplanes. And during this time, **Hiram Maxim** came up with steam powered flying machine too. As the machine was bulky, it could not ever become airborne. And finally in 19th century, the heroes- Wilbur Wright and Orville Wright, that are known to endow successful Airplane, became interested in the concept of flying.

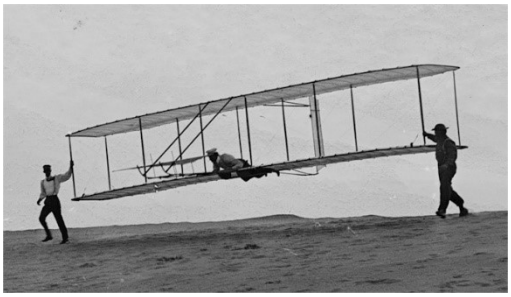
The first airplane inventors were the **Wright brothers**, **Orville** and **Wilbur**, who sustained flight in on the **17th of Dec in 1903**. A young age both brothers were said to have excelled in intellectual understandings and be interested in learning new things. Their father, Milton Wright, was a bishop and on his travels he would back souvenirs and toys for the boys. One time Milton bought home a toy helicopter-like top which sparked the boy's interest in flying. On the 30th May 1899, he wrote to the Smithsonian Institution of Aeronautical Research who sent back papers regarding aerodynamics and within a few months he had read all he could find written on flying.

The first step towards the successful invention of aero plane, was research through reading various books on it. In year 1900, the Wright brothers tested the new biplane glider with 17 feet wing warping technique and wingspan, weighing 50 pound at the Kitty Hawk, in piloted as well unmanned flights. Based on the glider's results, the brothers planned on refining landing gear and controls and designed a larger glider. [1]

In the year **1901**, at the **Kill Devil Hill** in **North Carolina**, the brothers flew largest glider ever. With **100 pounds**' weight and 22 feet wingspan, the boys geared up for their glider's flight. The glider faced problems too. The wings did not have enough power to lift, forward elevator was not that effective and its wing warping technology caused it to spin out of control occasionally. They keep reviewing the test results till they found out that the calculations used for the mechanism were not up to the mark. Then they thought of building wind tunnel for testing the wing shapes and their effect on the lift.

The Wright brothers took the idea of needing power as it was essential to keep the airplane up. After studying all they could on aviation the brothers' then defined the elements needed of a flying machine; wings to provide lift, a source of power of propulsion, and a system of control. They saw that control was needed not just to go in a straight line but also for the 'three axes of motion'; pitch, roll and yaw.

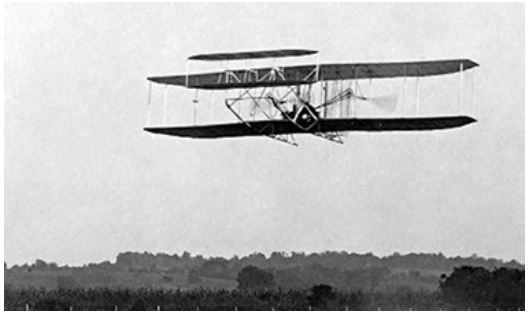
Both of the brothers' spent a long time observing birds in flight and they realized over a period of time that what they were seeing was the birds shaping their wings to turn and manoeuvre. They noticed birds soared into the wind and that they then decided that the air flowing over the curved shape of their wings created lift. After this they then decided that control of the flying aircraft would be the most crucial and hardest problem to solve and they had an idea for solving that problem. The brothers believed they could use the birds' technique in their design of an aircraft to obtain roll control. The solution to the need for control in the aircraft was then called 'wing warping'. Wing warping is a method of arching the wingtips slightly to control the aircrafts rolling motion and balance when moving/in flight. Wilbur came up with the system by twisting an empty bicycle tube box with the ends removed, twisting the surface of each 'wing' changed its position in relation to oncoming wind. These changes resulted in direction of flight; this kind of folding is similar to how paper airplanes are made. Wilbur tested this theory on a small 'kite' and it worked. [3]



When unmanned, the 'kites' had ropes dragging from behind them used to twist the trailing edges of the wings in opposite directions, this however proved to be a hard way of controlling the wings (the warping). When manned the wing warping could be controlled by the pilot who would have several ropes-cables which he would use to pull the wing up or down depending on the direction he

was trying to achieve. After successful flights of these kites-gliders the brothers' designed and built a full-size glider that they chose to test in Kitty Hawk, North Carolina.

However, there was several problems with the glider; the ribs on the wings flexed under the weight of the pilot, distorting the aero foil shapes of the wings, the brothers' fixed the trouble however the wings did not have enough lifting power. It was at this point in disappointment that Wilbur and Orville predicted that man will never fly in their lifetime. Added a single steerable rudder in replacement of a fixed double vertical rudder. With successful glider flights the Brother's set their sights for greater success in aviation history and planned to build a powered aircraft with a propeller and engine.The Brother's studies showed them that a movable tail would help balance the craft and so connected a tail to the wing-warping wires to coordinate turns. The Brothers then began to test their new glider on the 19th September 1902. Over a span of five weeks the brothers' made between 700 and 1000 glide flights, though they did not keep detailed records. However, it is known that the longest of these flights lasted for 26 seconds and the glider flew 622.5 feet (189.7 meters). After tests the Brothers' [2]



Their first powered Aero plane was named Flyer. It was plane with two wings and 12 horse powered engine. It also had wooden wings which were 40 feet wide, and in year 1908, another plan was introduced by the brothers that stayed in the air for about 1½ hours. In year 1909, the brothers got a contract from US military for building first plane for them. Since then, Airplane travel has improved a lot. Airplanes now cover thousands of miles at great altitudes of 7 miles and more, carrying around 300 passengers. Jet engines have now replaced the propellers and they travel with speed of more than 600 miles every hour. The best part is that in innovations never stop, they are ongoing.

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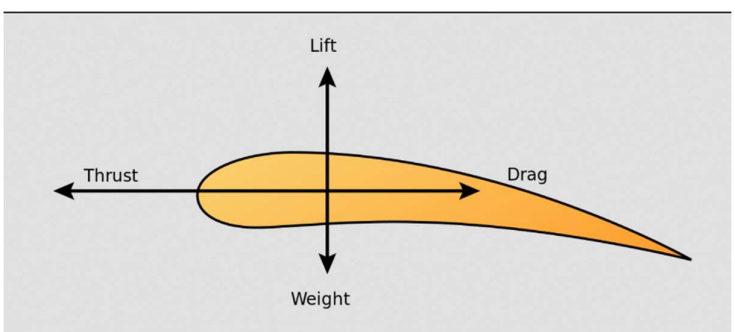
- Prajwal Bhingare

3rd Year Mechanical

INTRODUCTION

When objects move through air, forces are generated by the relative motion between air and surfaces of the body, study of these forces generated by air is called **aerodynamics**. Based on the flow environment it can be classified in to external aerodynamics and internal aerodynamics; external aerodynamics is the flow around solid objects of various shapes, whereas internal aerodynamics is the flow through passages in solid objects, for e.g. the flow through jet engine air conditioning pipe etc. The behaviour of air flow changes depends on the ratio of the flow to the speed of sound. This ratio is called Mach number, based on this much number the aerodynamic problems can be classified as subsonic if the speed of flow is less than that of sound, transonic if speeds both below and above speed of sound are present, supersonic if characteristics of flow is greater than that of sound and hypersonic if flow is very much greater than that of sound. Aerodynamics have wide range of applications mainly in aerospace engineering, then in the design of automobiles, prediction of forces and moments in ships and sails, in the field of civil engineering as in the design of bridges and other buildings, where they help to calculate wind loads in design of large buildings.

AERODYNAMIC FORCES ON A BODY



LIFT

It is the sum of all fluid dynamic forces on a body normal to the direction of external flow around the body. Lift is caused by **Bernoulli's effect** which states that

air must flow over a long path in order to cover the same displacement in the same amount of time. This creates a low pressure area over the long edge of object as a result a low pressure region is formed over the aerofoil and a high pressure region is formed below the aerofoil, it is this difference in pressure that creates the object to rise.

DRAG

It is the sum of all external forces in the direction of fluid flow, so it acts opposite to the direction of the object. In other words, drag can be explained as the force caused by turbulent airflow around an object that opposes the forward motion of the object through a gas or fluid.

WEIGHT

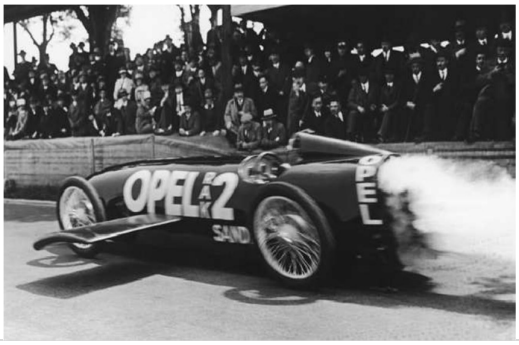
It is actually just the weight of the object that is in motion i.e. the mass of the object multiplied by the magnitude of gravitational field. This weight has a significant effect on the acceleration of the object.

THRUST

When a body is in motion a drag force is created which opposes the motion of the object so thrust can be the force produce in opposite direction to drag that is higher than that of drag so that the body can move through the fluid. Thrust is a reaction force explained by Newton's second and third laws, the total force experienced by a system accelerating in mass "m" is equal and opposite to mass "m" times the acceleration experienced by that mass. [1]

HISTORY & EVOLUTION OF AERODYNAMICS

Ever since the first car was manufactured in early 20th century the attempt has been to travel at faster speeds, in the earlier times aerodynamics was not a factor as the cars where, traveling at very slow speeds there were not any aerodynamic problems but with increase of speeds the necessity for cars to become more streamlined resulted in structural invention such as the introduction of the windscreen, incorporation of wheels into the body and the insetting of the headlamps into the front of the car. This was probably the fastest developing time in automobiles history as the majority of the work was to try and reduce the aerodynamic drag. This happened up to the early **1950**'s, where by this time the aerodynamic dray had been cut by about 45% from the early cars such as the Silver Ghost. However, after this the levels of drag found on cars began to slowly increase. This was due to the way that the designing was thought about.



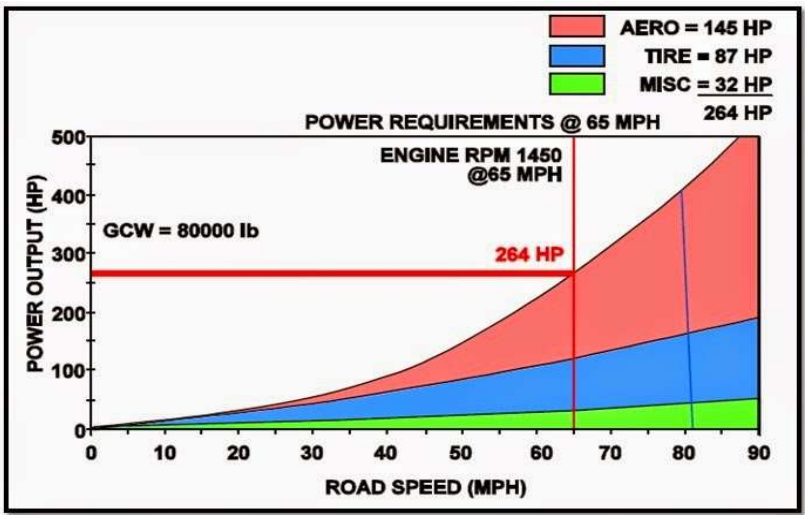
Before **1950**, designers were trying to make cars as streamlined as possible to make it easier for the engine, yet they were restricting the layout of the interior for the car.

After **1950**, the levels of aerodynamic drag went up because cars were becoming more family friendly and so as a consequence the shapes available to choose were more limited and so it was not possible to keep the low level of aerodynamic drag. The rectangular shape made cars more purposeful for the family and so it is fair to say that after 1950 the designing of cars was to aid the lifestyle of larger families. Although this was a good thing for families, it didn't take long before the issue of aerodynamics came back into the picture in the form of fuel economy. During the 1970‟s there was a fuel crisis and so the demand for more economical cars became greater, which led to changes in car aerodynamics. During the 1970's there was a fuel crisis and so the demand for more economical cars became greater, which led to changes in car aerodynamics. If a car has poor aerodynamics then the engine has to do more work to go the same distance as a car with better aerodynamics, so if the engine is working harder it is going to need more fuel to allow the engine to do the work, and therefore the car with the better aerodynamics uses less fuel than the other car. This quickly led to a public demand for cars with a lower aerodynamic drag in order to be more economical for the family. [2]

Vehicles with an aerodynamic shape use less fuel. Air flows easily over them and less energy is needed to move them forward. At 95 Km/h 60-70% of a vehicle's energy is used to move it through the air, compared with only 40% at 50 Km/h. Installing a sloping front roof on a lorry could save you as much as 7% of your fuel costs. Even small changes to design and shape will make a difference. Take a look at the Aerodynamic Checklist, walk around your vehicle and look at each feature to see what improvements you can make. Vehicles that travel at higher speeds and for longer distances will benefit most from aerodynamic styling, giving you greater savings. Drag is the energy lost pushing through air, and it accounts for most of the fuel used on long-distance journeys, regardless of
Vehicle type.

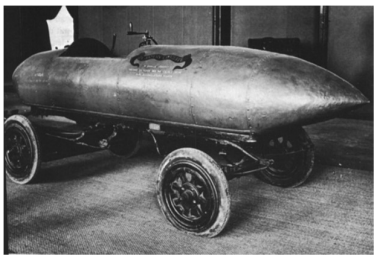
- Overcoming drag uses approx. 60% of fuel used at cruising speeds when loaded, 70% when empty.
- Sharp corners, racks and parts that stick out will add "parasitic drag", further reducing fuel efficiency. [3]

As shown in the graph below, the resistance of tires makes the biggest impact when the speed of a vehicle is lower than 50 MPG while the Aerodynamic Drag force have a greater impact on the fuel consumption and power requirement when the vehicle is driven over 50 MPG.

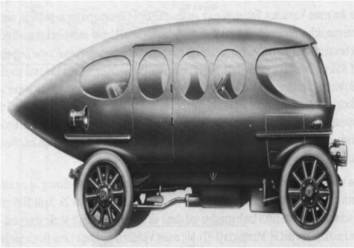


Approaches in vehicle aerodynamic

- **1900-1920** Adaptation of shapes from other fields



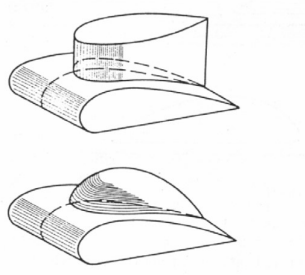
Torpedo

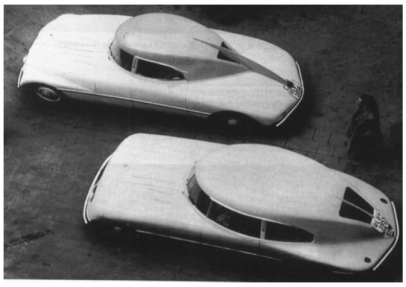


Airship

Boot

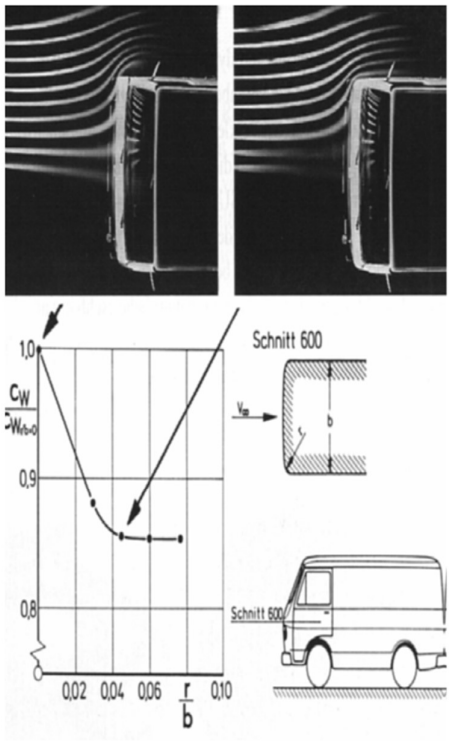
- **1920-1970** Adaptation of results of airplane and airship development streamlining

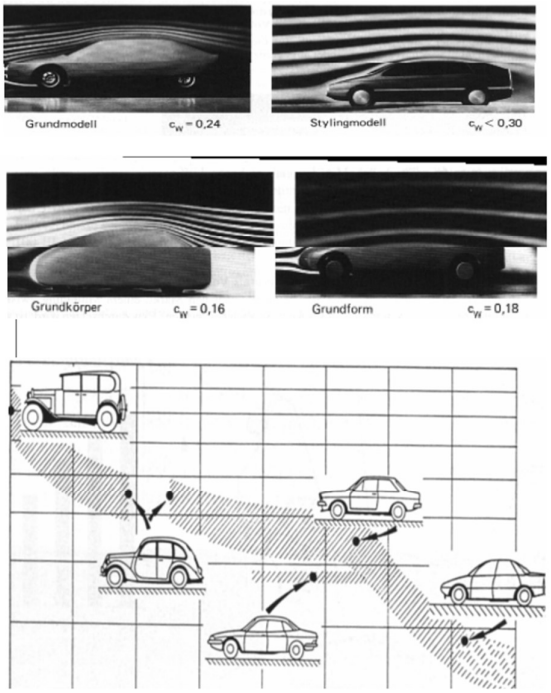




Jjáray Experimental Cars

- **1970-1990** Detail optimisation **1990** - Basic form optimisation





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- Shree Nakade

3rd YR Mechanical Engineering

SIX SENSE TECHNOLOGY

It's the beginning of a new era of technology where engineering will reach new milestones. Just like in the science fiction movies where display of computer screen appears on walls, commands are given by gestures, the smart digital environment which talks to us to do our work and so on, these all will be possible very soon. You imagine it and **Sixth Sense Technology** will make it possible. Isn't it futuristic? Now it's time for sci-fi movie directors to think ahead because the technology shown in their fiction movies soon will become household stuff. Before few years back it was considered to be supernatural. But now it has been made possible. Thanks to Pranav Mistry, a genius who introduced mankind to this futuristic technology.

What is sixth sense technology?

Sixth Sense is a wearable gestural interface that enhances the physical world around us with digital information and lets us use natural hand gestures to interact with that information [1]. It is based on the concepts of augmented reality and has well implemented the perceptions of it. Sixth sense technology has integrated the real world objects with digital world. It associates technologies like hand gesture recognition, image capturing, processing, and manipulation, etc. It superimposes the digital world on the real world.

Sixth sense technology is a perception of augmented reality concept. Like senses enable us to perceive information about the environment in different ways it also aims at perceiving information. Today there is not just this physical world from where we get information but also the digital world which has become a part of our life. This digital world is now as important to us as this physical world. And with the internet the digital world can be expanded many times the physical world. God hasn't given us sense to interact with the digital world so we have created them like smart phones, tablets, computers, laptops, net books, PDAs, music players, and others gadgets. These gadgets enable us to communicate with the digital world around us.

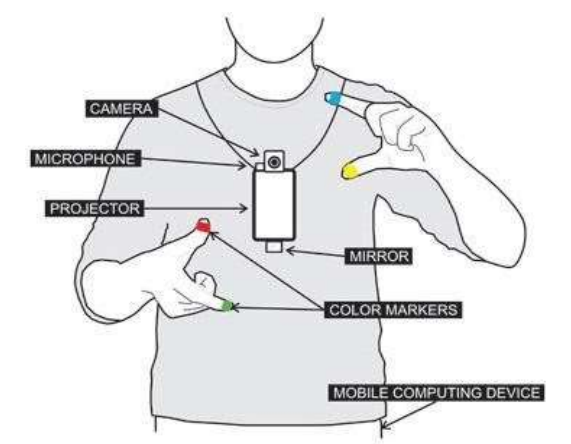
But we're humans and our physical body isn't meant for digital world so we can't interact directly to the digital world. For instance, we press keys to dial a number; we type text to search it and so on. This means for an individual to communicate with the digital world he/she must learn it. We don't communicate directly and efficiently to the digital world as we do with the real world. The sixth sense technology is all about

interacting to the digital world in most efficient and direct way. Hence, it wouldn't be wrong to conclude sixth sense technology as gateway between digital and real world.

This sixth sense device invented by Pranav Mistry is a prototype of next level of digital to real world interfacing. It contents a camera, a projector, a mobile computing device and colored sensors which are put on the fingers of a human being. The device efficiently senses the motion of the colored markers. Using them it provides us the freedom of directly interacting with the digital world.

Evolution of Sixth Sense Technology

Steve Mann is considered as the **Father of Sixth Sense Technology** who made a wearable computer in **1990**. He implemented the Sixth Sense technology as the neck worn projector with a camera system. Then his work was carried forward by **Pranav Mistry**, an Indian research assistant in **MIT Media Lab**. He came up with exciting new applications from this technology.



Six Sense Prototype

How does sixth sense works?

The sixth sense technology uses different technologies like gesture recognition, image processing, etc. The sixth sense prototype is made using very common and easily available equipment's like pocket projector, a mirror, mobile components, color markers and a camera.

The projector projects visual images on a surface. This surface can be wall, table, book or even your hand. Thus, the entire world is available on your screen now. When user moves their hands to form different movements with colored markers on the finger tips, the camera captures these movements. Both the projector and the camera are connected to the mobile computing device in the user's pocket. Recognition is made using computer vision technique. The software program processes this video stream data and interprets the movements into gestures. The gestures are different from one another and are assigned some commands. These gestures can act as input to application which is projected by the projector. The mirror reflects the image formed by the projector to front. The entire hardware is fabricated in the form of a pendent.

The entire product cost around **$ 350**. It works very similar like a touch screen phone with entire world as the screen. [2]

Applications

Fingers as Brush: The user can draw anything on paint with the help of his fingers. This drawing can be 3D also. Hence, no need to use mouse.

Drawing

Capture Photos with Fingers: Using the fingers the user can capture photos hence, no need to carry an additional gizmo. The box created by the fingers act as frame for capturing photo.

Camera

Palm Is the New Dialer: This technology enables the user to call without using the dialer. The dialer will be projected on palm and the user can dial the number using other hand.

Dialer

Read Books Easily: Check out the ratings of the Book you are going to buy; it checks the ratings from the internet. And another amazing thing is that it reads the book for you.

Video Newspapers: Like the video newspapers of Harry Potter this technology identifies the news headline and then projects the relevant video.

Check your Flight Status: Just place the ticket in front of the projector and it checks its status from the internet.

Clock: The user just needs to make gesture of clock and the watch will be projected on the user's hand.

Access Anywhere Internet: The users can browse internet on any surface even on their palm. [3]

Conclusion

This technology has seamless applications. This can provide easy control over machineries in industry. This will have different application for different developers just depending upon how he imagines and what he wants. So, considering its widespread applications the inventor Pranav Mistry has decided to make its software open source. This will enable individuals to make their own application depending upon needs and imagination. As this technology will emerge may be new devices and hence forth new markets will evolve. Some existing devices and technologies will be discontinued but one thing is guaranteed it will write a new chapter in history of science and technology.

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- Sameer Ghanvat

3rd YR Mechanical Engineering

ELECTRIC CARS-THE FUTURE

Introduction: -

We, engineers always aim towards efficiency n environment friendly technology. Our mission is to create an efficiency 1 machine which would cause less harm to the environment.

In the beginning of 21st century, most country's government learned about the serious consequences of global warming. It was the time when the urge started to develop a pollution free car (significantly less carbon emitting car). Innovators came with many new ideas and electric car was one of them. At present **48% of America's** population uses electric cars. India too has bigger plans for EC'S.

History: -

Electric cars have a long history; of which many are unaware. Electric vehicles first appeared in the mid-19th century. The high cost, low speed and efficiency compared to the internal combustion gasoline engine gave a great decline to the electric car worldwide.

Although there are many names behind the EC's (electric car) evolution, the honour is given to the **Scottish** inventor **Robert Anderson**. He developed the first electric crude carriage working on non-rechargeable primary cells. Another man who must be given credit is the **American** inventor **Thomas Davendort** for bringing EC's into action. He is recognized as the first man to build a practical electric car.

Invention of the lead- acid battery by a **French** physicist **Gaston Plantè** played a vital role in evolving the EC. The batteries were rechargeable, capacity was greatly increased and were bought into industries for manufacture purpose.

Despite their low speed electric cars had many advantages over the gasoline cars in the early 1900's. They did not had noise, smell and vibrations like gasoline cars and also they were pollution free. [1]

Below are some electric cars of early nineteenth century: -

German Electric Car, 1904, with chauffeur on the top

Columbia Electric Car (1896-99)
Victoria Electric cab on Pennsylvania Ave, Washington DC, 1905

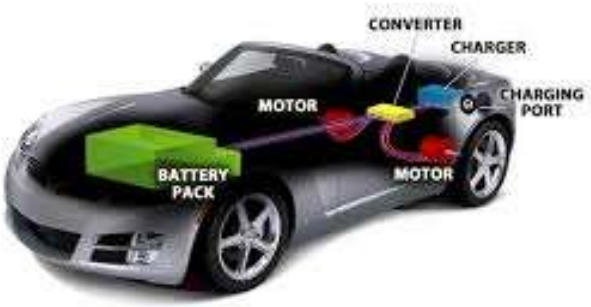
Electric Car built by Thomas Parker, 1895

[1]

How Electric Cars work?

Well electric cars don't consist of an IC engine, transmission system like gasoline cars. So what makes it works? How the wheels are made to run on the road? A gasoline engine with its fuel lines, exhaust pipes and coolant houses look like a plumbing project. While an electric car is definitely a wiring project.

Electric cars are basically made up of three components: -



1) ELECTRIC MOTOR: -

Well we can say that this is the heart of the electric cars. Gasoline cars do have IC engine which is responsible for driving the car. But here's where electric car excels over gasoline car. IC engine have over 100 of typical moving parts unlike the electric motor which comprise of only one moving part. This helps a lot for weight reducing factor. Electric motors are different for different car voltages.

2) THE CONTROLLER: -

The controller acts as a transmission system here like in gasoline cars. It delivers power to the electric motor which are then delivered to the wheels. The controller is controlled by the **Accelerator Pedal**. It's like the more you press down the more power is delivered to the motor. Quality of the modern controllers is increasing exponentially. They are supposed to last for a longer time. For example, the popular **Curtis Controller** has a failure rate of about 3%. The controller is a vital component; without it we would have either full power or no power. [2]

3) THE BATTERIES: -

We can say that batteries are the fuel of the electric cars. They are the power storage units. They supply power to the electric motor through the controllers. Generally, the batteries are arranged in an array of pack. Nowadays rechargeable battery pack is available which can be plugged into three power sources like, a **household electricity system**, a **portable charging system** or a **charge station** provided by city or public utility. Recharging the battery pack is not a difficult task. It can take about one hour to recharge a car using high voltage quick public charge station or 12 hours using a household outlet.

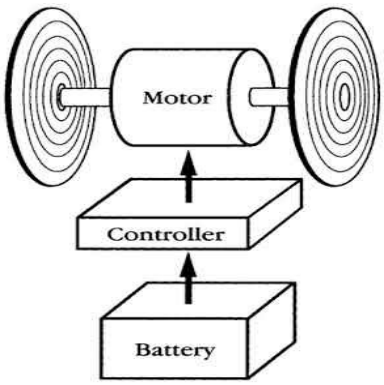
The motors used in electric cars can be AC or DC. Mostly DC motors are preferred than AC motors because they are simple to configure and are not at all expensive. For AC motors 3-phase motors have to be used, running at 240V AC. DC motors, on

the other hand requires only (96-192) Volts. DC motors can also be overdriven for a short period of time. [2]

Recharging Station for Electric Cars

(Nissan Leaf charging on a London Street)

Basic Transmission in an Electric Car: -



Some Modern Popular Commercial Electric Cars: -

1. Nissan LEAF: -

Price: - $31,545

Battery: -30kwh

Range: -107 miles (EPA)

Motor: -80kW

Nissan LEAF is an electric car manufactured by Nissan. It was introduced in Japan and USA in December 2010. LEAF here stands for 'Leading Environment- friendly and Affordable Family car'

2. BMW i3: -

Price: -$43,395

Battery: -22-33 kWh

Range: -81-114 miles

Electric motor: - 125 kW

The **2017 BMW i3** represents the first significant update of the electric city car since its May 2014 U.S. launch. The 2017 i3 gets a new 33-kilowatt-hour battery pack, which boosts range to 114 miles. The original 22-kWh pack is still available in base models, with the same 81-mile range as before.

3. Chevrolet Bolt EV: -

Price: -$37,495

Battery: -60 kWh

Range: -120 miles

Motor: -150 kW

The **Chevrolet Bolt EV** offers a currently-unmatched combination of an EPA-rated 238-mile range and a base price of under $40,000, before incentives. It's the only non-Tesla electric car currently on sale with a range of more than 200 miles.

4. Fiat 500e: -

Price: -$32,780

Battery: -24 kWh battery

Range: - 84 miles (EPA)

Motor: -83 kW

Fiat's 500e electric car may be a mere "compliance car", but the engineers have done a great job—it's nippy, fun to drive and probably a better vehicle than the gasoline version. Limited availability is a hindrance, though, and the price is pretty steep for such a small car.

5. Mahindra e2o: -

Electric motor: - 3 Phase Induction Motor

Battery: - 11 to 16Kwhr Lithium-ion battery

Range: - 120 km (75 mi)

The **Mahindra e2o**, previously REVA NXR, is an urban electric car hatchback manufactured by Mahindra REVA or Reva Electric Vehicles. The e2o (pronounced ee-two-oh) is the successor of the REVAi (or G-Wiz as it was known in the UK) and was developed using REVA's technology, and has a range of 120 km (75 mi). Probably it is the first Indian commercial electric car [2].

If we get over some liabilities of electric cars, then at the end of the 21st century we will see electric cars running on highways and roads. It will be an end for the gasoline cars.

Engineers are trying different methods of recharging the battery, which is the greatest liability of EC. Electric cars are going to be finest green technology with almost zero carbon emission.

Consumers choose according to the car's and its comfort. Market matters, but there is also need of government policy and inputs. Indians are always value conscious. Hence, despite the pollution problem they tend to choose diesel and petrol cars. The cost of electric cars depends on the value of electricity which varies significantly. These matters should be looked upon ideas have to come forward by our young engineers.

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- Siddharth Bopatrao

4th YR Mechanical Engineering

JET ENGINE ROAD VEHICLE

Jet vehicle works on **Newton's Third Law of Motion** which states that **"Every action has equal and opposite reaction"**. Jet engine take the atmospheric air and compress it. This compressed air is mixed with kerosene molecules and air is heated. So, compressed air becomes more hot.

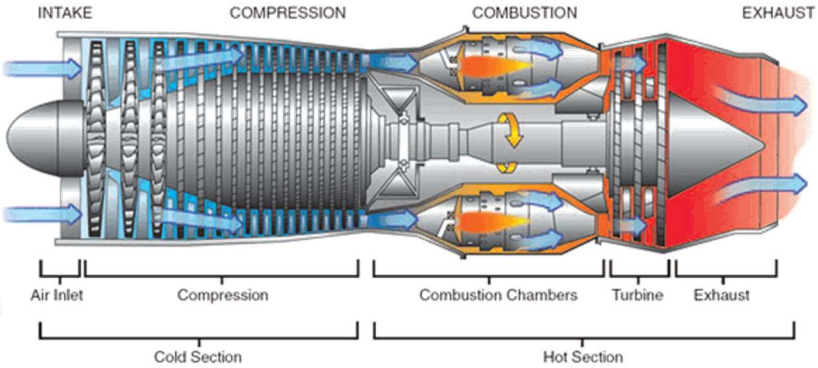
Truck with Jet Engine

As we know hot air has more tendency to do work than cold air. This compressed air is forcefully ejected from other side of jet engine so; at the end of engine a large amount of thrust is created. This is responsible to in forward direction with high speed. [1]

JET ENGINE

Mostly, these types of engine are used in Aero planes to move fast in air. But, there are some vehicle. Which are constructed by using jet engine. Such types of vehicles constructed only for land speed records. The highest land speed obtained by jet vehicle is 500kmph or more. Now some engineers are trying to exceed land speed more than 1000kmph.

If we start the use of jet vehicle in actual, there will be very fast travelling. But it is very difficult to use this jet vehicle for our daily travelling. Because there are many limitations to use this vehicle in our daily life. [2]



Jet Engine SVG

When this vehicle is running hot pressurized air ejected from jet engine, which will create problem for backside coming vehicles on the same road. So, the road for jet

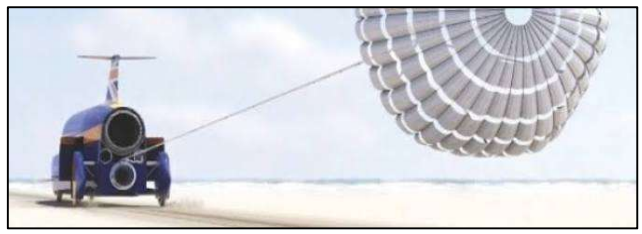
vehicle should be independently for each vehicle or vehicle should run with proper distances.

As we know, thrust created by jet engine is very large in amount. So, in high speed there will be problem to turn vehicle. So whatever will be thrust created, which should be controllable by driver.

Driver of such vehicle should be well trained and skilled like aero plane piolet. Because it is very hard to drive and control the vehicle at such high speed.

Mostly air brakes are used to stop the vehicle. But air brake minimizes the speed of vehicle slowly. So to stop vehicle urgently we should use other wheel brakes after air brake.

AIR BRAKE:



Running jet engine create more heat, this heat can burst the vehicle which will be dangerous for driver and passengers. So the design should be perfect and material of the vehicle should be suitable for high speed and heat.

Still jet vehicles created are very big in size and weight, and there is no extra seat for passenger except driver. So for daily use of jet vehicle compact structure of vehicle is required and there should be some seating arrangement for passengers. [3]

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- Vitthal Gadekar

2nd YR Mechanical Engineering

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