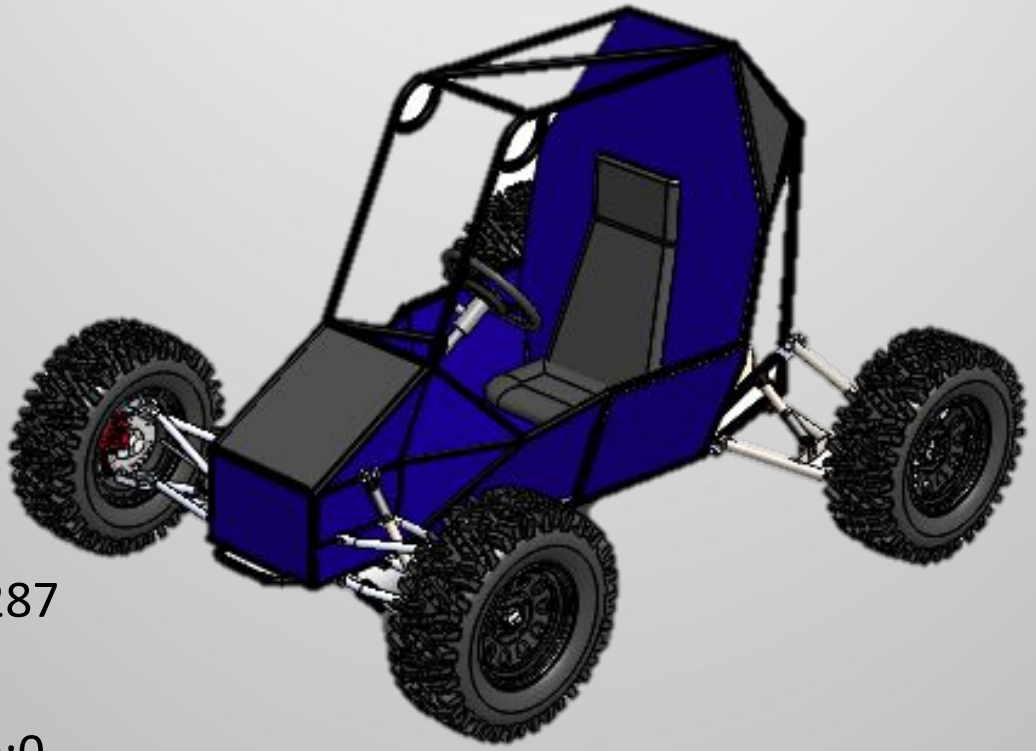
Marwadi education foundation

Presents

Team MMR

Registration ID: **18208**



Dream

Design

Demonstrate

Old Team id: 16287

Car No:81

Endurance Score:0

Total Score:138.4

SAE INDIA MEFGI * Collegiate Club *

Lessons Learnt

Weight

- Unsatisfactory result in final events
- 3rd heaviest ATV in the competition with Kerb Weight : 332 kg

Steering

- Uncomfortable driving due to more lock to lock turn
- Wheel base needed to be decreased to improve turning radius

Transmission

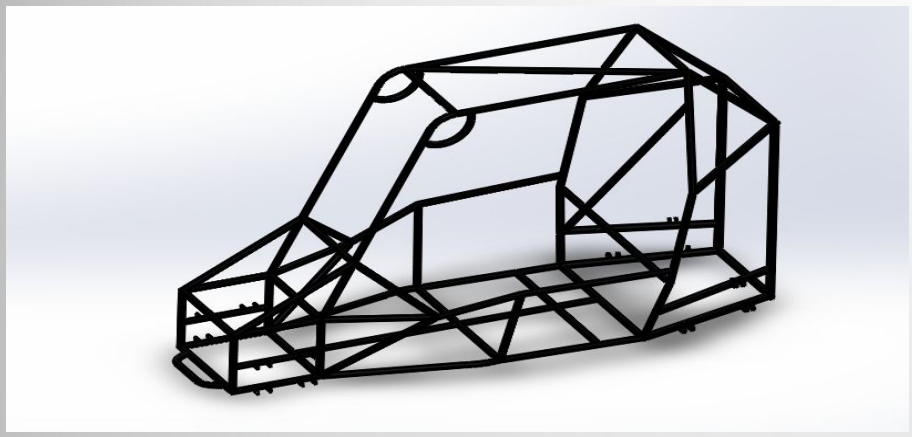
- Failure of CVT due to human error
- Importance of acceleration in gradeability test
- Need of accuracy in manufactured components

Suspension

- Entire Lever Mechanism could have been replaced by a simple arrangement
- Error in design calculation

Brake & Tyre

- Could not use the designed brake system due to measurement error
- Effectiveness of mud cutter profile on off road condition



Roll cage

Improvement

- Excessive unutilized space
- Material can be improved
- Unnecessary Members can be removed

Dynamic Events	Score	Reason	Lessons learnt	Implementation
Acceleration	0/75	Overweight	Effect of weight on performance	Less factor of safety and proper Material selection
Hill Climb	50.1/75	Better Gradeability	Importance of height to base ratio	Lower “height to base ratio”
Maneuverability	0/75	Could not attempt For not being technically sound	Accuracy regarding the rules should be of concern	Rulebook followed thoroughly
Suspension & Traction	0/75			
Endurance	0/400	CVT failure	Should void simultaneous accelerating and braking	Non-metallic bush can be replaced by Metallic bush (as precaution)
Total	50.1/700			

Compariso n

Weight	
Old	332
Proposed	211
% reduction	33.4%

ROLL CAGE

- AISI 1018
- Bulky design (unnecessary members)
- Roll cage weight: 66kg

→

- AISI 4130
- Compact design
- Roll cage weight: 33kg (Weight Reduction by 50%)

Cost	
Old	3,33,380
Proposed	3,63,500
% Increment	8.2%

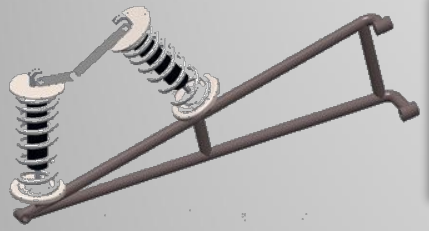
SUSPENSION

- Trailing arm Mechanism (Rear)
- Six - coil over hydraulic shocks (Large c/s area, Heavy)
- 10 point adjustment only

→

- Three link Mechanism (Rear)
- Four - pneumatic shocks (Lightweight ,Small c/s area)
- Infinitely adjustable air spring

BRAKE & TYRE



Trailing arm suspension

- Maruti 800 disk brakes (solid disk, heavy)
- Single piston caliper
- 23”/24” Mud Cutter

→

- Honda active 125 disk brakes (Drilled disk, Lightweight)
- Dual piston caliper
- 22”/22” Mud Cutter

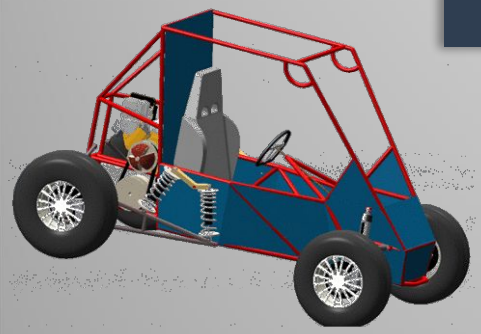
Three link suspension

POWER TRAIN

- FNR reduction box
- Gear ratio: 14
- Non- metallic Bushes (In CVT)

→

- reduction gear box
- Gear ratio: 17
- Metallic Bushes (In CVT)
- Catalytic converter installed

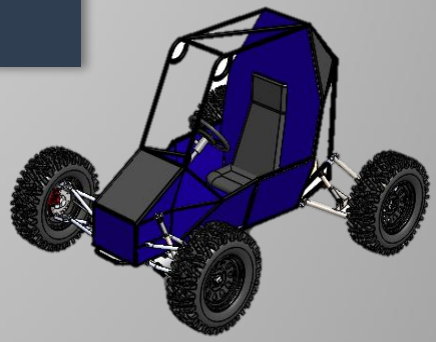


STEERING

- Turning radius : 3.33m
- Lock to lock Turn: 4.2

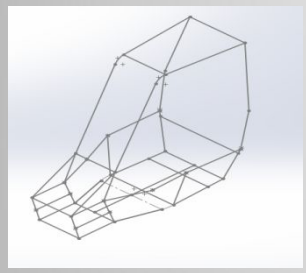
→

- Turning radius : 3.00m
- Lock to lock Turn : 2

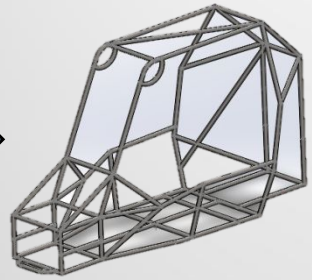


Design Process & Ergonomics

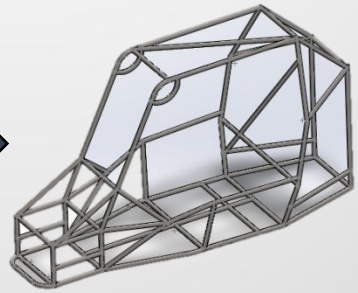
Setting Objective → Rulebook & Reference → Material Selection → Sketches → CAD Model → FEA → Optimization



Primary Design

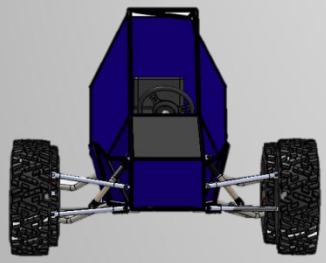


Secondary Design

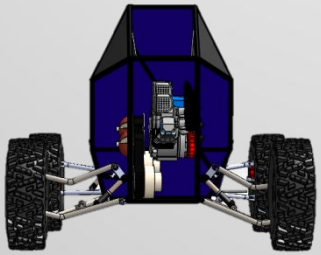


Final Design

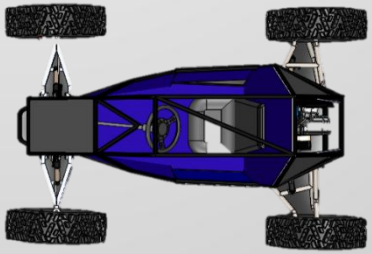
Ergonomics
- Less steering effort
- Pneumatic suspension thus, comfortable ride
- No gear shifting needed
- NVH Considerations



Front View

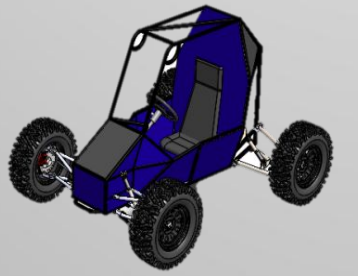


Rear View



Top View

Side View



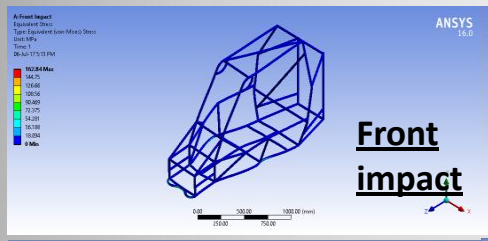
Isometric View

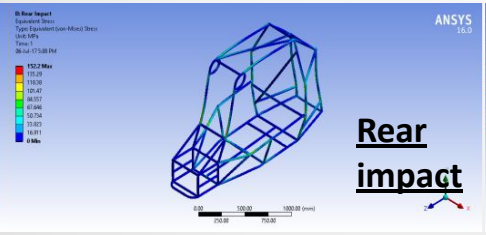
Binocular View

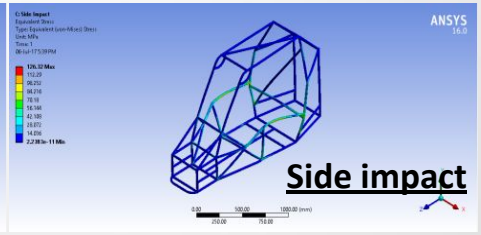
All Over Dimensions	
Wheel base	66”
Wheel track	46”
Ground Clearance	13”

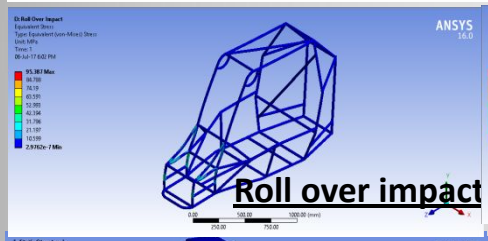
Roll Cage	
Estimated Cost	23,500
Material	AISI 4130
Pipe Diameter	25.4mm
Weight	34 Kg
Pipe Required	30m
Natural Frequency	3.68 Hz

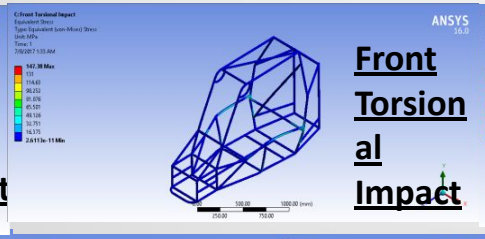
CAE Processes

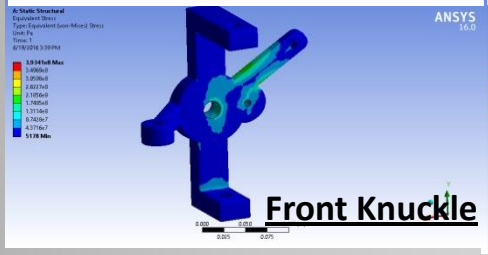


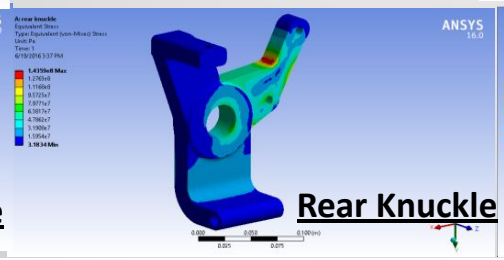


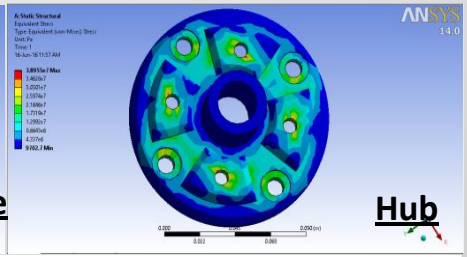












No. of Nodes	5366306	**Mesh Size (Edge Length)**	0.053086 mm
No. of Element	18721564	**No. of members and weld**	67 and 76

Sr. No.	Material	TS Ultimate (MPa)	TS Yield (MPa)	Young Modulus (GPa)	%Elongation (50 mm)	Density (kg/m^3)	Cost (/m)
1	AISI 1018	440	370	200	15	7850	140
2	AISI 4130	560	460	190-210	21.5	7850	520
3	AISI 1040	660	415	190-210	25	7845	360

Chemical composition of AISI 4130

Element	Content (%)
Fe	97.03 – 98.22
Cr	0.80 – 1.10
Mn	0.40 – 0.60
C	0.280 – 0.330
Si	0.15 – 0.30
Mo	0.15 – 0.25

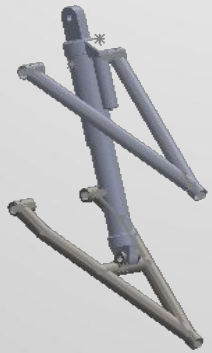
Force applied	Stress (MPa)	Deformation (mm)
Front Impact		
5G	162.84	0.36
Rear Impact		
5G	152.2	2.55
Side Impact		
3G	126.32	2.09
Roll over Impact		
3G	195.38	1.20
Front Torsional Impact		
3G	147	1.24
Front Wheel Bump Impact		
2G	249	1.80
Analysis On Front Knuckle		
12000 N	393.41	0.365
Analysis On Rear Knuckle		
12000 N	143.59	0.159
Analysis On Hub		
3625N	42.9	0.000161

Suspension

Technical Specifications	Front	Rear
Upper Arm Length	13.12 ”	12.8”
Lower Arm Length	13.50 ”	17.8”
Motion Ratio	0.485	0.496
Travel (Tyre)	8”	8”
Caster	4˚	0˚
Camber	-3˚	-0.5˚
Toe Angle	0˚	0˚
King Pin Inclination	7.1˚	0˚
Scrub Radius	0.875 ”	1.12”
Natural frequency (Hz)	1.42	1.66
Required stiffness (N/mm)	15	20
Damping Ratio	0.25	0.22

Features

- Nitro – Pneumatic shock absorber
- Infinitely adjustable spring stiffness
- 8” wheel travel
- Better stability
- Minimum distance between roll centre and CG

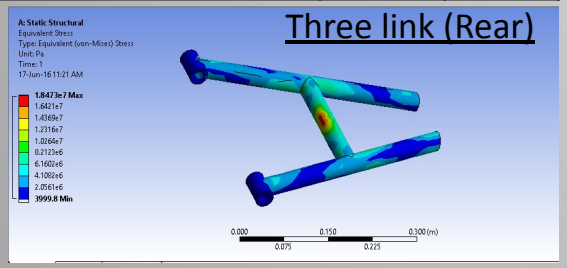


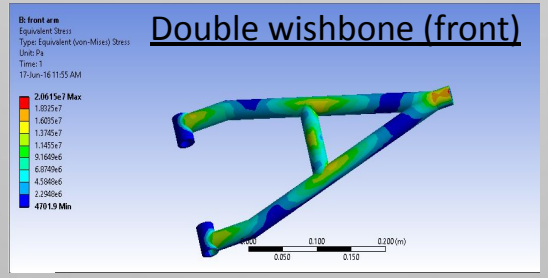
Double wishbone (Front)

Three link (Rear)

Pneumatic shock absorber (Fox float Evol R3)

Technical Specifications	Old		Proposed	
	Front	Rear	Front	Rear
Roll Centre Height	5.76 ”	15”	21.00 ”	21.73 ”
Ride Rate	-	-	133.3	410.48
Roll Axis Inclination	8˚		1.74˚	
C.G. Height	22”		23”	
Ground Clearance	12”		13”	
Sprung Mass	243 kg		135 kg	
Unsprung Mass	89.9 kg		76 kg	

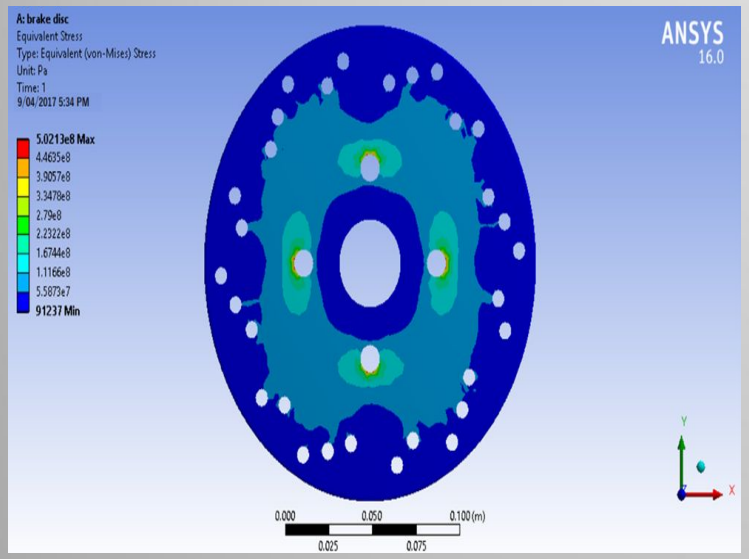




Brakes

Specifications

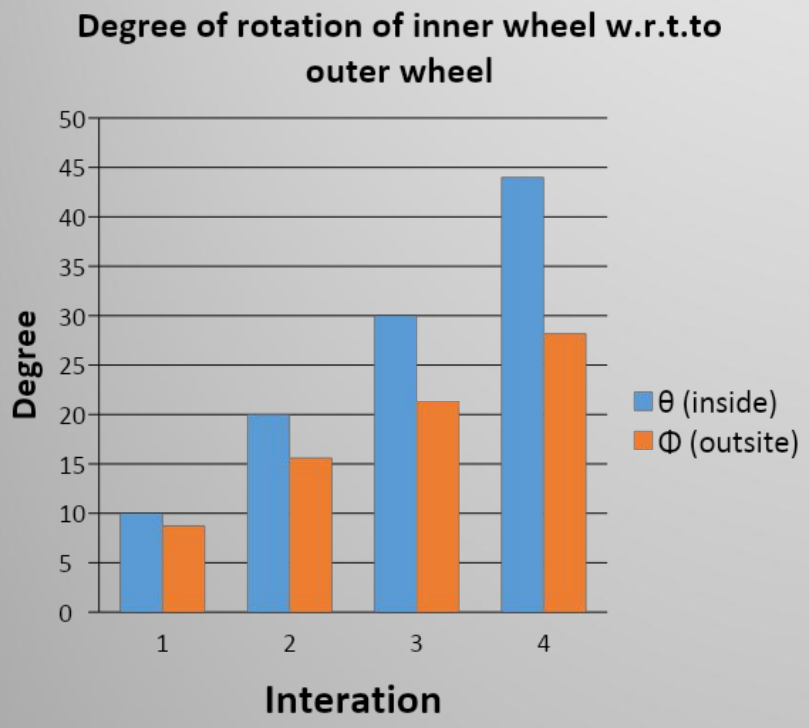
- Honda Activa 125 rotor & calliper
- Tandem master cylinder
- Double piston calliper
- Pedal Ratio – 6:1
- X-split type brake circuit
- DOT – 4 Brake fluid
- Disc diameter 190mm thickness 3mm
- Mean braking Radius 0.08m



Braking circuit	
F/R split or X-split	X-split
master cylinder bore size	0.75''
master cylinder stroke Length	0.038m
Brake disc or drum	Disc
Caliper cylinders bore size	1.25''

Data	Previous year	This year
Weight transfer @ 40-0 Kmph	--	42.95 kg
Static Rolling Radius for tire	11.5/12	11/11
Coefficient of friction for road	0.7	dry0.7 Wet : 0.4
Brake torque required per wheel	190.77/162.35	**10713.82/12028.9**
Force required by caliper cylinders (N)	4540.32/4741.1	5124.5
Balance between two braking circuit	-	85.5%
Which wheels lock first	-	All the Four
Stopping distance @ 45kmph	6.41	3.79
deceleration	8.96	20.59
Applied Forces	721.66/787.57	1544.97/1544.97

Steering

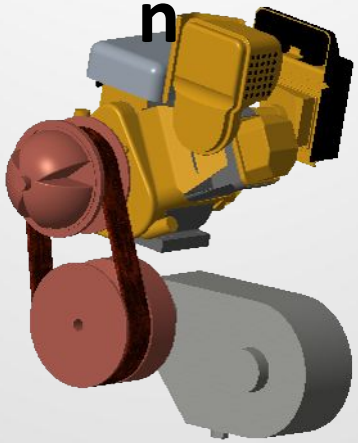


Specifications	Values (past)	Values (present)
Steering geometry	-	Understeer
Ackermann percentage	-	64.46 %
Inside steer angle	44°	45°
Outside steer angle	33.16°	33.69°
Turning circle radius	3.33 m	3.00 m
Drive type	Centrally aligned steering system	Centrally aligned steering system
Rack travel	4.9”	4.0”
Turns lock to lock	4.2	2
Steering ratio	17.18:1	17:1
IBJ center distance	9.7”	9”
OBJ center distance	20.7”	18”
Steering column type	Tilting	Tilting
Steering column	Without power assist	Without power assist
Steering wheel diameter	330 mm	330.2 mm
Steering wheel torque	-	7725.37 N-mm
Steering effort	-	47 N

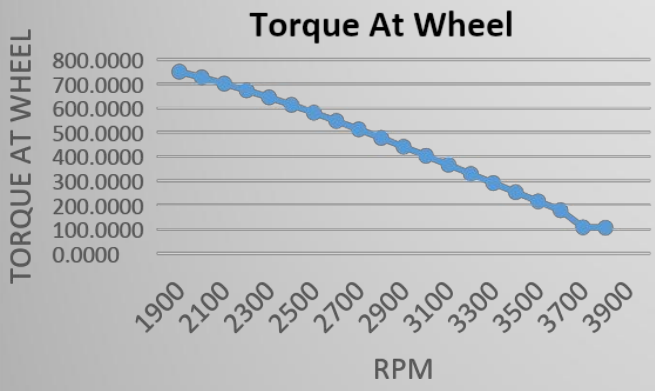
Transmission

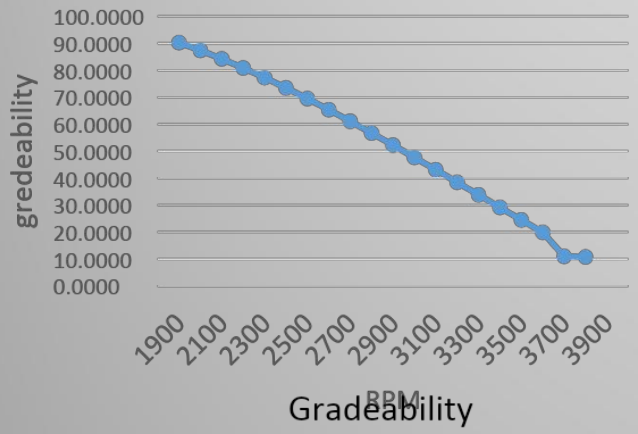
Why CVT use ?

- No need to shift gear.
- Give smooth drive in comparison to conventional gear box.
- Can achieve more speed, torque, and acceleration.



Transmission Element		
	Previous	Present
CVT ratio (max)	0.43	0.43
CVT ratio (min)	3	3
Gear Box ratio	14(F)-16(R)	17(F)
Overall ratio (max)	6.02	7.31
Overall ratio (min)	42	51





Engine Specification	
B&S OHV Intake 10HP OHV Vanguard	
Max.Torque	19.659Nm@2800RPM
Max.Power	9.68HP@3800RPM
Max.RPM	3800

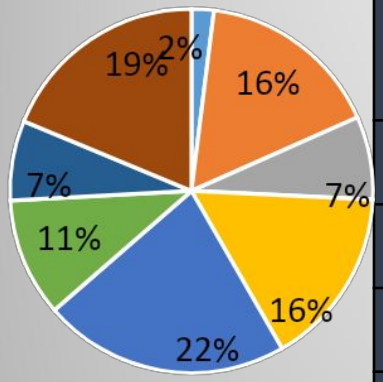
- We are using Muffler-Silencer and catalytic converter.
- For engine mounting we will use shock absorber material.
- We will use flange coupling to connect CVT and Gear Box.

Performance of Vehicle		
	Previous	Present
Acceleration(m/s²)	6.02	6.6
Gradeability	36°	38.24°
Velocity(km/h)	57.02	45.79

Tyre Specification		
	Previous	Present
TYPE	Mud cutter	Mud cutter
Designation	23x8R12(F) 24x8R12(R)	22x8R12(F) 22x8R12(R)
Aspect ratio	68.75/75	75

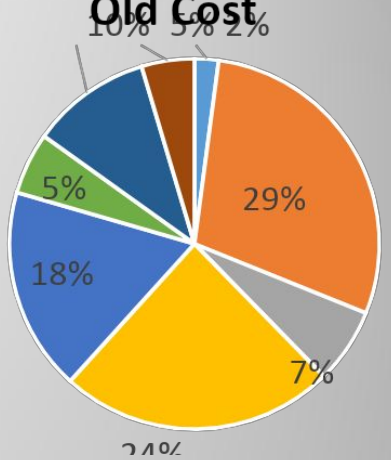
Cost & Weight Analysis

Old Weight

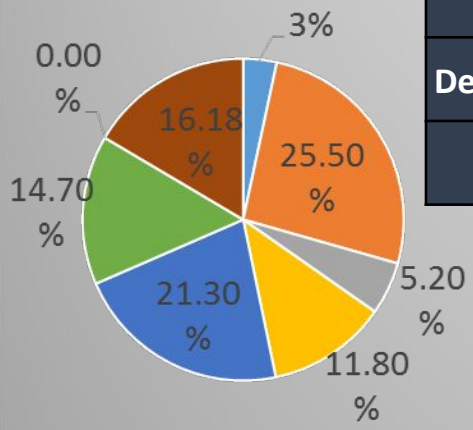


	Weight			Cost	
Department	Old	New	% reduction	Old	New
Steering	7	7	**0**	7000	6500
Transmission	57	54	**5.2**	96700	98000
Brake	26	11	**57.6**	21900	17000
Suspension	56	25	**55.3**	80180	110000
Tyre	77	45	**41.5**	59200	43500
Miscellaneous	18	10	**44.4**	18000	30000
Safety	25	25	**0.00**	35000	35000
Design(Roll cage)	66	34	**48.4**	15400	23500
Total	**332**	**211**	**33.4**	**333380**	**363500**

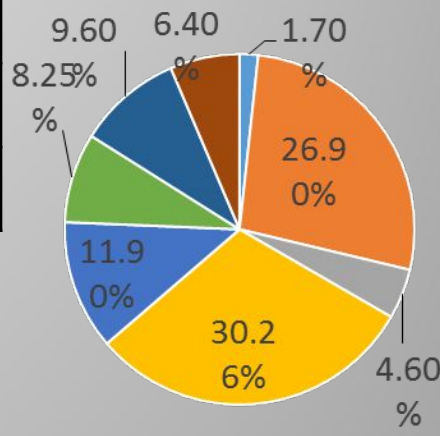
Old Cost



New Weight



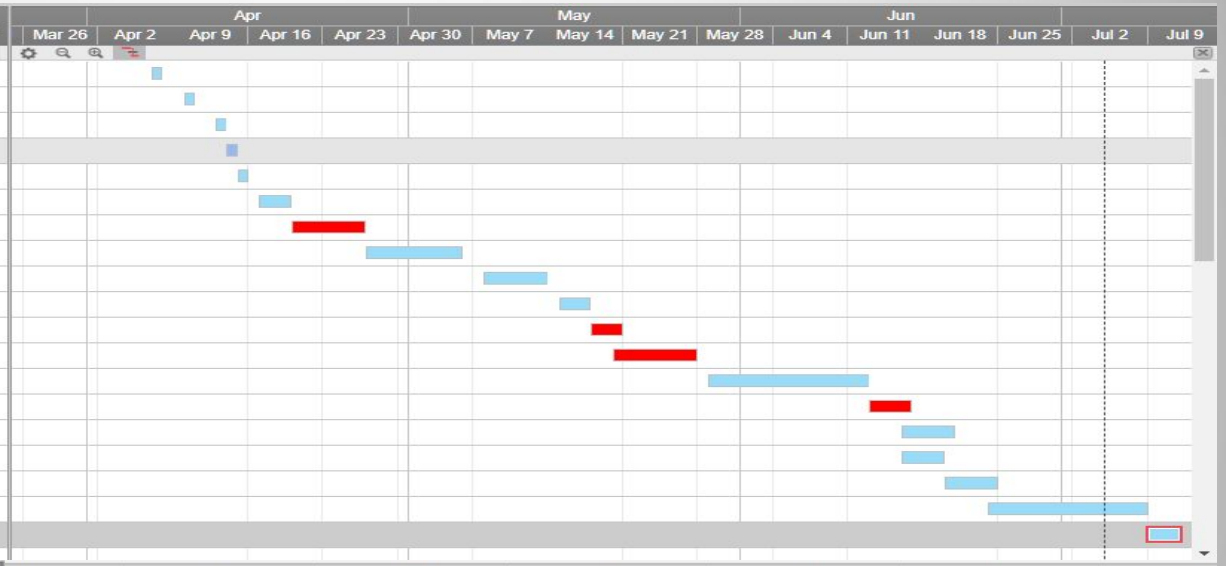
New Cost



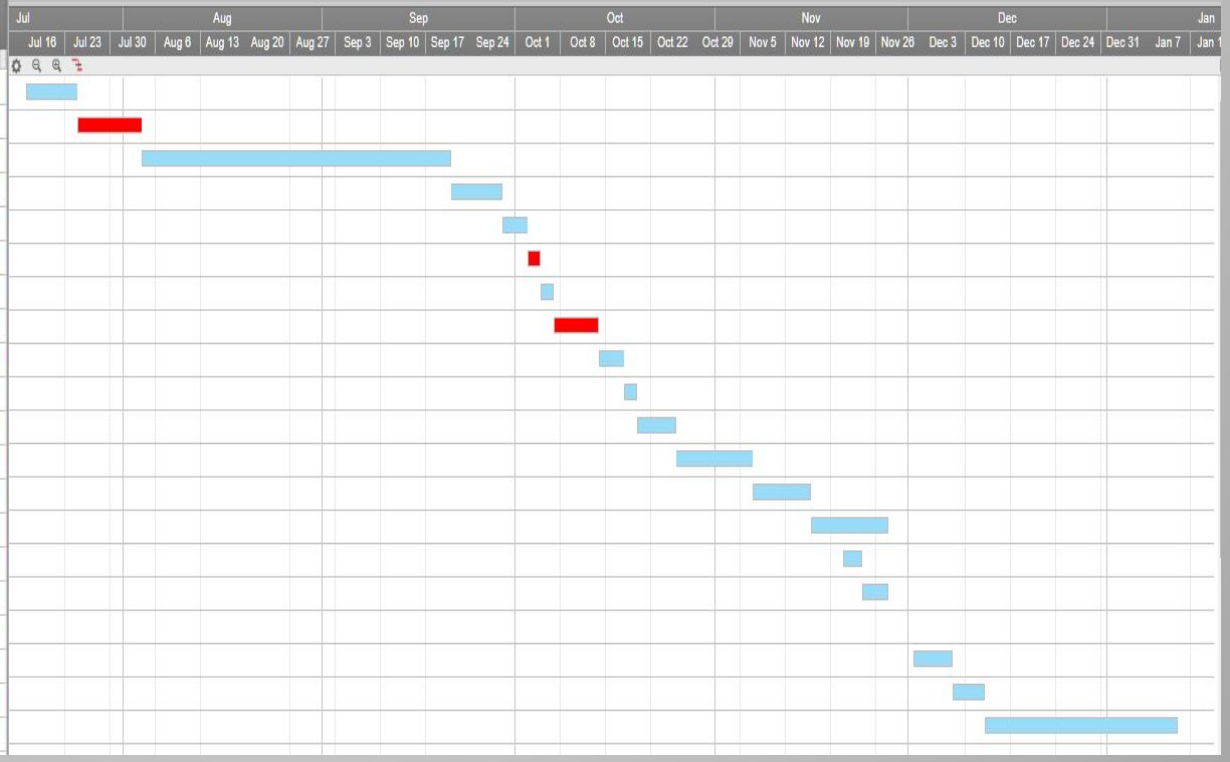
Steering Transmission Brake Suspension
Tyre Miscellaneous Safety Design

Project Planning

	Task Name	Start	Finish	Duration
1	Introductory Seminar about	07/04/2017	07/04/2017	1d
2	Written Test	10/04/2017	10/04/2017	1d
3	Interview Process	13/04/2017	13/04/2017	1d
4	Selection of Final team	14/04/2017	14/04/2017	1d
5	Departmentization	15/04/2017	15/04/2017	1d
6	Rulebook knowledge	17/04/2017	19/04/2017	3d
7	Market Survey	20/04/2017	26/04/2017	7d
8	Calculations of Components	27/04/2017	05/05/2017	9d
9	Selection of Components	08/05/2017	13/05/2017	6d
10	Primary Design	15/05/2017	17/05/2017	3d
11	Analysis of Design	18/05/2017	20/05/2017	3d
12	Corrections in Design	20/05/2017	27/05/2017	8d
13	Final Exams	29/05/2017	12/06/2017	15d
14	Final Phase Design	13/06/2017	16/06/2017	4d
15	Final Components	16/06/2017	20/06/2017	5d
16	Primary Powerpoint Presen	16/06/2017	19/06/2017	4d
17	Final Powerpoint Presentati	20/06/2017	24/06/2017	5d
18	Preparations for Virtual	24/06/2017	08/07/2017	15d
19	Virtual Round	09/07/2017	11/07/2017	3d



	Task Name	Start	Finish	Duration
1	Contacting Dealers	17/07/2017	24/07/2017	6d
2	Preordering Parts	25/07/2017	03/08/2017	8d
3	Fabrication Work	04/08/2017	20/09/2017	34d
4	Fabrication of roll cage	21/09/2017	28/09/2017	6d
5	Inspection of weld joint	29/09/2017	02/10/2017	2d
6	Modification if needed	03/10/2017	04/10/2017	2d
7	Tyre mounting	05/10/2017	06/10/2017	2d
8	Suspension mounting	07/10/2017	13/10/2017	6d
9	steering mounting	14/10/2017	17/10/2017	3d
10	Diver seat mounting	18/10/2017	19/10/2017	2d
11	Engine & CVT mounting	20/10/2017	25/10/2017	4d
12	Validation and procedure	26/10/2017	06/11/2017	8d
13	Modification in case of any	07/11/2017	15/11/2017	7d
14	Final exam	16/11/2017	27/11/2017	8d
15	Final modification	21/11/2017	23/11/2017	3d
16	Painting	24/11/2017	27/11/2017	2d
17	Final finishing	10/04/2018	13/04/2018	4d
18	Inspection and validation of	02/12/2017	07/12/2017	5d
19	Electric circuit mounting	08/12/2017	12/12/2017	3d
20	Racing practice	13/12/2017	11/01/2018	22d



Testing & Validation Plan

Category	Failure Mode	Cause(s) of Failure	Effects of Failure	Safeguards	S	O	D	RPN	Action to be taken	Process Testing	Performance Testing
Roll cage	Bending and Buckling	Impacts	Safety of Passenger Compromise	Law Of Triangulation followed with enough F.O.S	5	2	1	10	Welding	Weld joint destructive testing	Performance testing of each assembly at our collage off road type ground with different obstacles
A-arm	Mechanical failure	shock applied leads to excess axial stress	Crack or Failure of arm	Relative high FOS to ensure mechanical integrity	6	5	4	120	Welding or Replacement	Destructive testing for welds	
Three link arm	Bending	Sudden load on arm causing improper weight transfer	Bending or failure of arms	Proper selection and design of arms of higher strength	7	6	4	168	Welding or replacement	Testing for welding and weld test	
Transmission (Rear Axle & Cvt)	Bending &Bush melt	Excess torsional and bending moment & Improper heat blowing away	Inability to operate	Selection of proper transmission axle and proper material Selection	7	5	2	70	Axle replacement and proper material selection	Testing for torque transmission and	
Brakes	Leakage	Air trapped in hydraulic system	Insufficient braking force	Proper bleeding is to be done	6	3	2	36	Bleeding process	Inspection of brake piping	
Tyres	Puncture	Sharp Edges	Inability to run	High quality tyres	2	6	8	96	Replacement	Pressure testing	
Steering	Mechanical	Front sudden impact	Inability to handle ATV	Provide damper	4	4	3	48	Welding	Impact load	
Knuckle	Shear	Front Impact on Tire	ATV break down	Better design with adequate strength	9	1	1	9	Replacement	Shear & impact load	

Team & Workshop facilities

Suspension	Transmission	Design	Steering	Brake	Tyre
Viren Donga	Mathuresh Rupapara	Yash Mavadiya	Farhan Shekhani	Ritul Sharma	Rishikesh Mohite
Chintan Vaghela	Mayur Madariya	Prashant Pachani	Bhavik Butani	**Bhargavgiri Gosai (VC)**	Prince Govani
Harsh Raval	Parth Nandha	**Kishan Khant(D)**	Yogesh Chudasama	Jairaj Mehra	Sanket Virani
Rajveer Panesar(c)	Harit Mehta	Ravi Solanki			
Bhavyarajsinh Sarvaiya					

Faculty Advisors
Prof. Jatin Raiyani

Facilities	Operation
TIG Weld. m/c , MIG Weld m/c , MMAW m/c , Spot Weld. m/c ,SMAW m/c.	For welding operation.
Metal sheet cutter , Hand cutter m/c , Hacksaw m/c.	For cutting operation.
Hand drilling m/c , Radial drilling m/c.	For drilling operation.
Lathe m/c , Shaper m/c ,Milling m/c , Grinding m/c	For finishing operation.
Sheet metal bending.	For bending operation.
Hardness Tester, Universal Tester, Frequency Tester, Impact Tester	For Testing.