Engineering Projects Portfolio - I

CAD Designs

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LinkedIn Profile

GradCAD Page

GradCAD Group

Contact Details

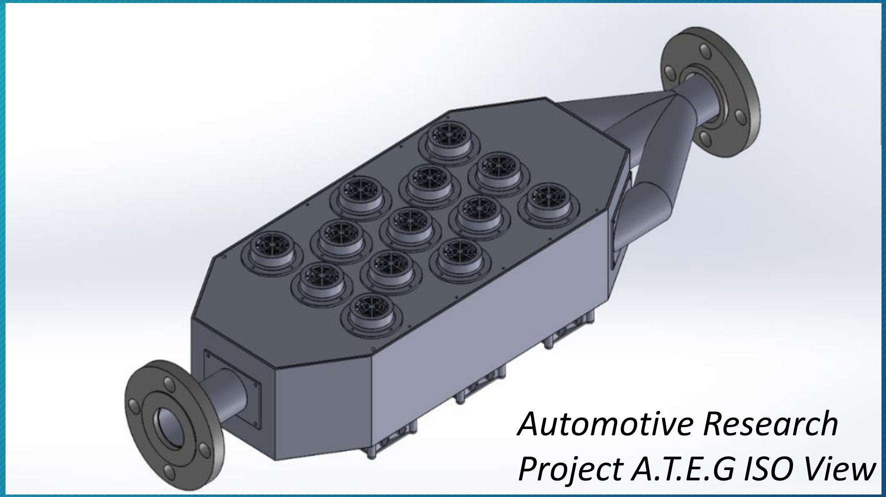
Introduction

AIM: The idea behind creating this Project Designs' Portfolio is to give the reader a deeper insight into my engineering design and software skills which I have self-learnt over the last 5+ years. Most of these Design projects were in fact created, well before I started my Automotive Engineering degree at Coventry University. I strongly believe that this differentiating presentation will allow the reader to objectively assess my engineering skills and abilities which would be relevant to your company. I would be delighted to be given the opportunity to discuss this portfolio in more detail, in person and I can be reached through the contact information on the front page.

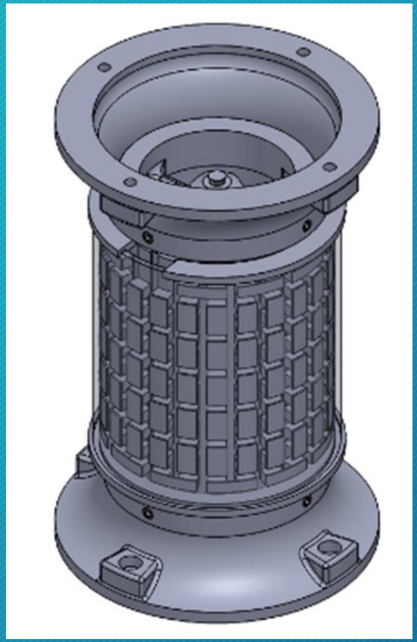
Contents

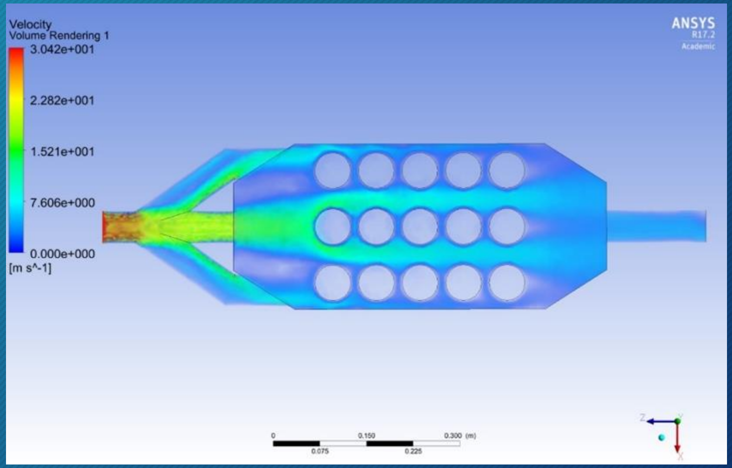
Automotive Research Project

In 2017, I first attempted to showcase my creative and project development skills at the age of 17, by independently authoring a 41 page automotive research report titled, "Is there a device that generates useful power from the waste energy of a car?" for an "Automotive Thermoelectric Generator" and then got it critiqued by the McLaren F1 design experts. This comprehensive project report includes detailed component designs, engineering calculations, results, a final prototype, links to all the preparatory research done for this project and a presentation outlining the challenges faced and my recommended solutions.



Automotive Research Project A.T.E.G ISO View



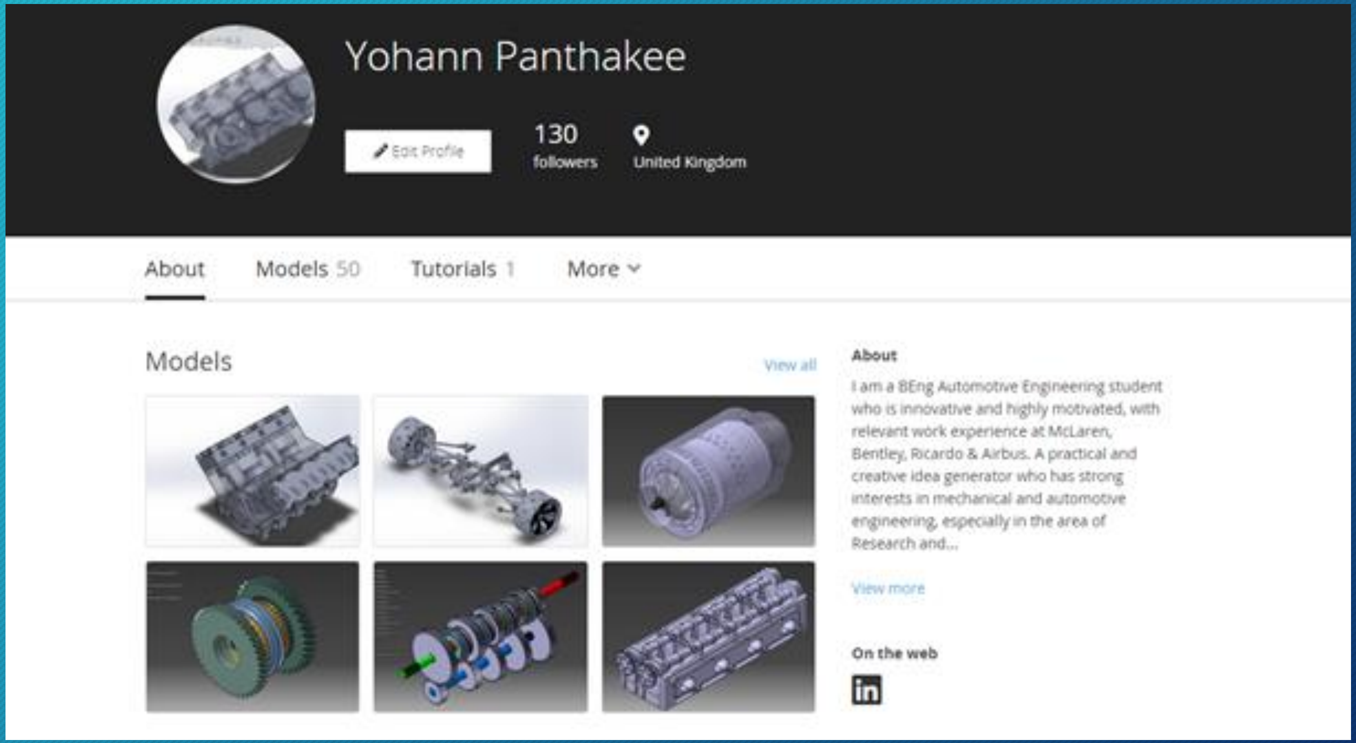


GrabCAD Portfolio

- **Online CAD Portfolio:-** This is a collection of most of my CAD models/assemblies. This also includes a specialist discussion group called “Cars and Automotive Design” which I have created.

- **Aim:-** To record the progress of my engineering skills using various CAD software though project-based learning. Through this group that I have set up, I am able to learn and gain more knowledge on specific /general engineering topics and the same is true for other like-minded engineering aspirants.

Main profile page Statistics	
GrabCAD score	4923
Total downloads	10435
Profile views:	3227
Followers:	187
Comments left:	106
Member since:	January 01, 2016
Group Statistics	
Members	8006
Discussions	169
Created	April 12, 2018



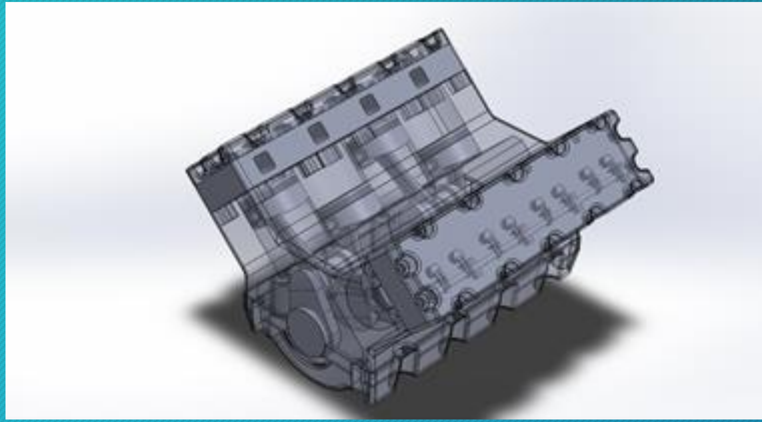
Project: V8 Engine

- **Software:** SolidWorks

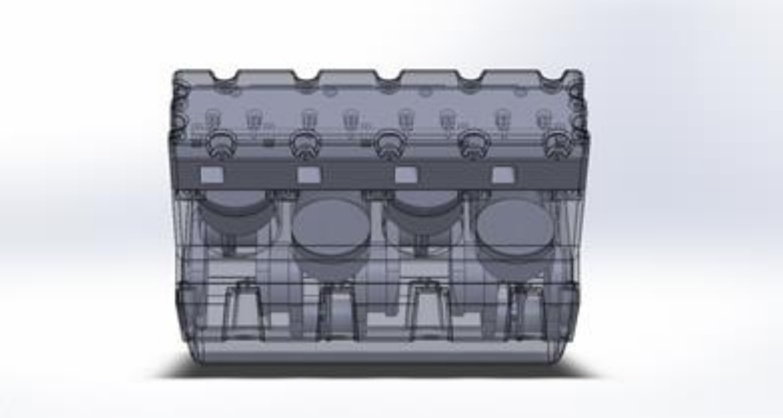
- **Aim:** To model a V8 Engine with all its components and an assembled final product. The V8 Engine was modelled based of my own research off the internet.

- **Challenges:** The issues I had faced included finding initial rough dimensions of the V8 engine as there were very few completed technical drawings accessible on the internet. This also posed an issue as finding out how each component is assembled was difficult.

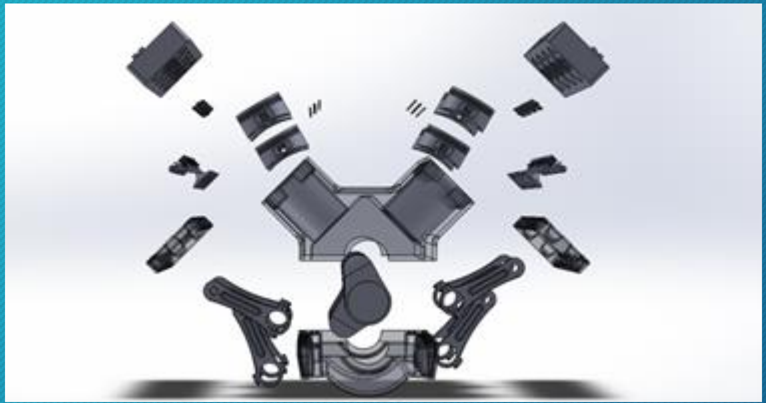
- **Solution:** To solve these issues, I took a 180-degree approach and studied how each component works in the engine. By using spatial visualization, I was able to piece together each of the components in my mind to see how they could fit together.



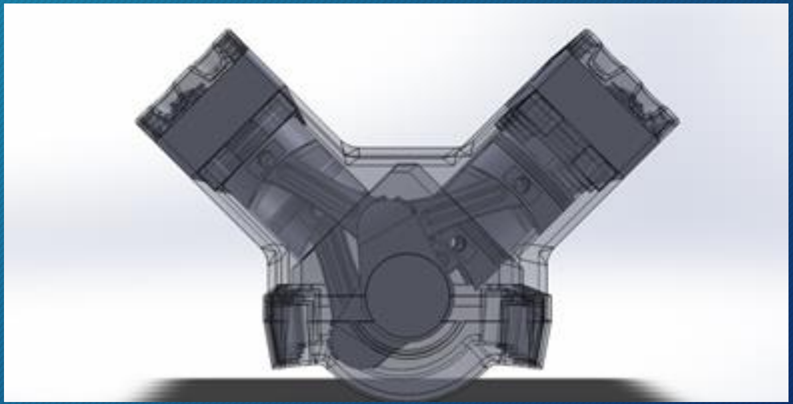
V8 Engine ISO View



V8 Engine Side View



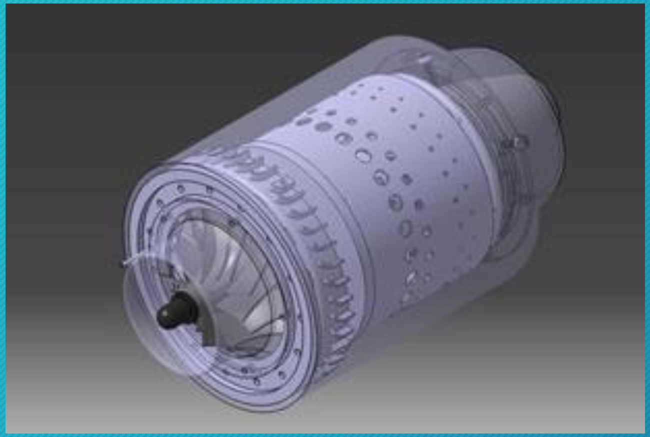
V8 Engine Exploded View



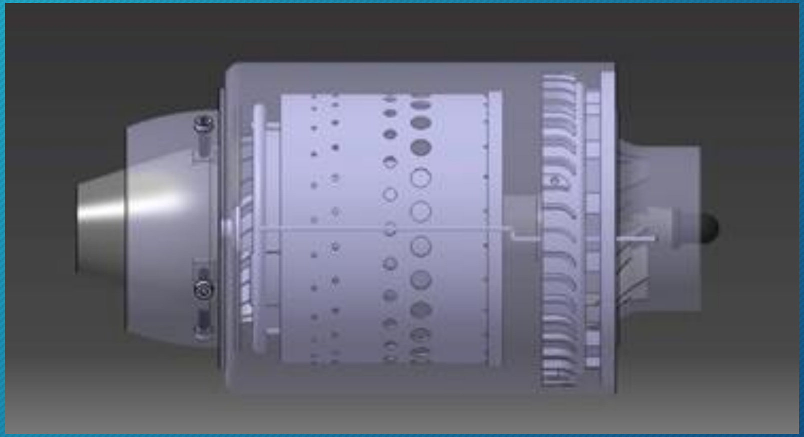
V8 Engine Front View

Project: KJ-66 Micro Turbine Jet Engine

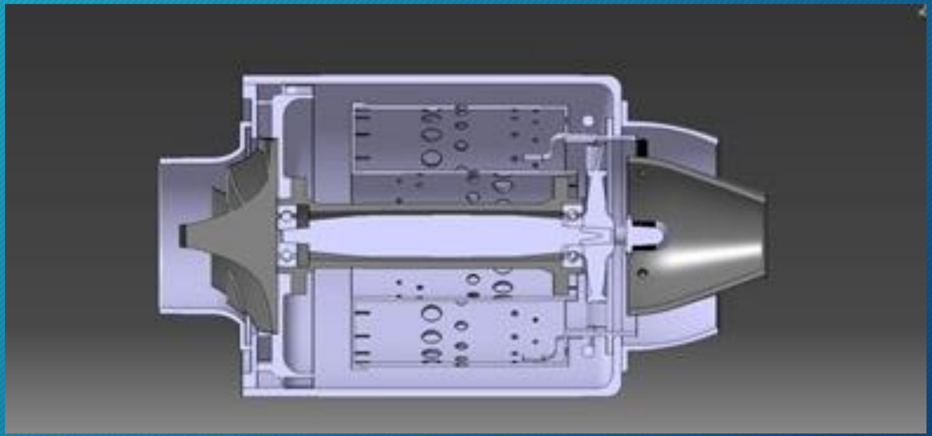
- **Software:** CATIA
- **Aim:** To model a micro Turbine Jet Engine with all its components and an assembled final product. The micro Turbine Jet Engine was modelled based of my own research off the internet.
- **Challenges:** The issues I had faced was modelling the diffuser, NGV and fuel lines. This was difficult because of the complex nature of the components.
- **Solution:** To solve these issues, I did some more research online into “Generative Shape Design (GSD)” and by using this, I could model the complicated tubular shape for the fuel lines. For the NGV and the diffuser plate, I pre-planned my steps before attempting the design and this helped me a lot.



KJ-66 Micro Turbine Jet Engine ISO View



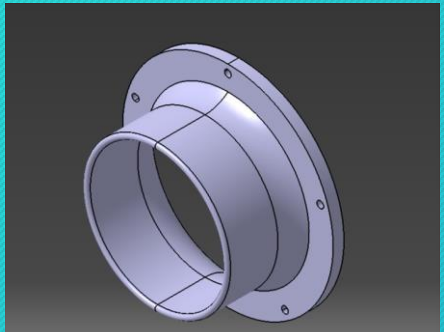
KJ-66 Micro Turbine Jet Engine Exploded View



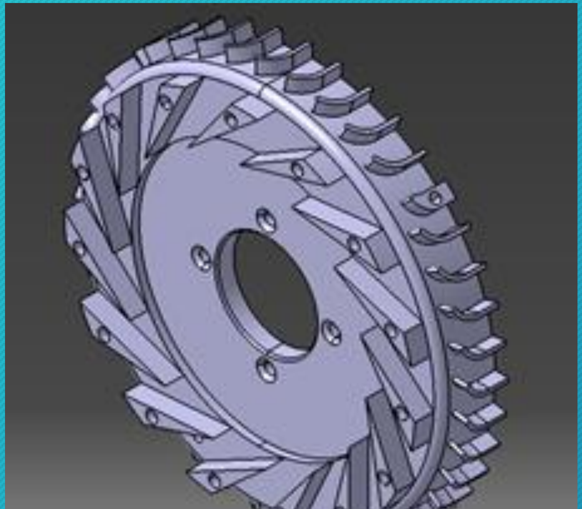
KJ-66 Micro Turbine Jet Engine Side View

Project: KJ-66 Micro Turbine Jet Engine

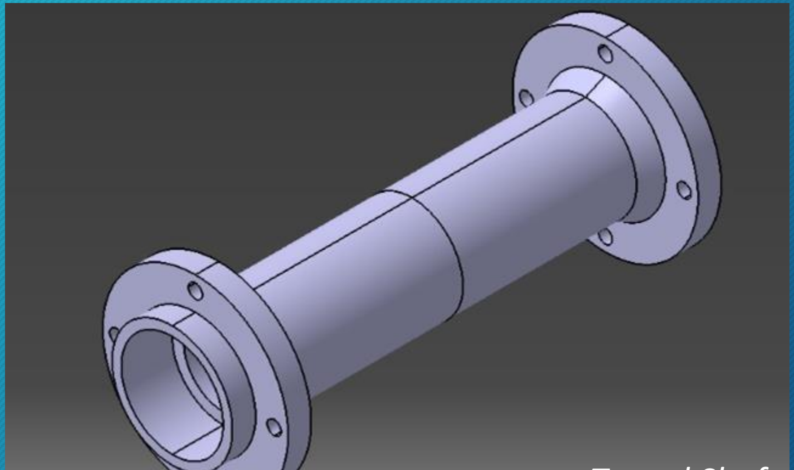
A Few Engine Components



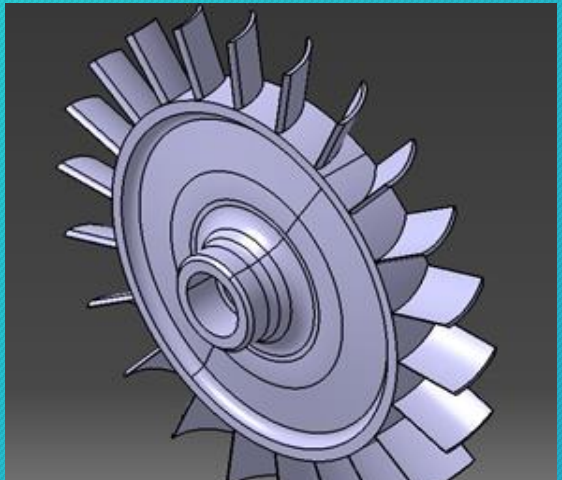
Front Cone



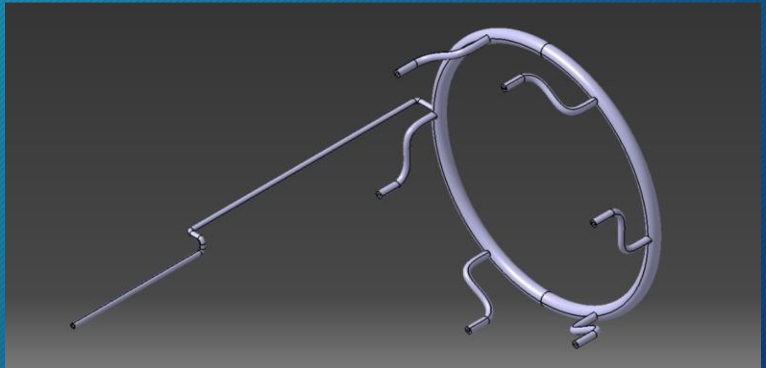
Diffuser



Tunnel Shaft



NGV



Fuel Supply Lines

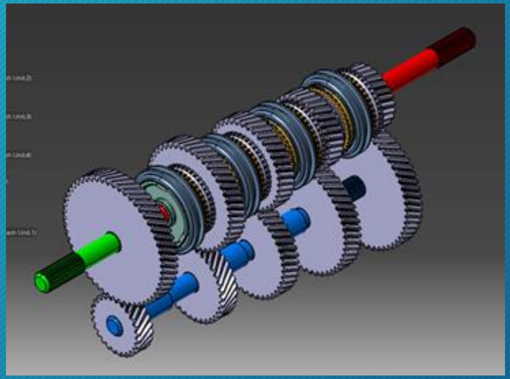
Project: 5 Speed Transmission

- **Software:** CATIA, Matlab, Excel

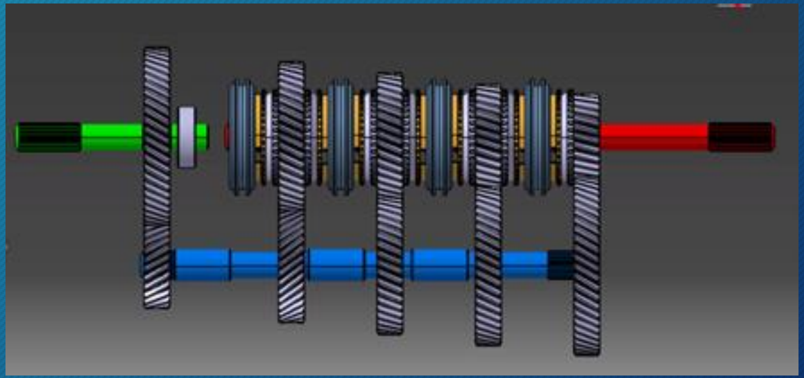
- **Aim:** To calculate transmission ratios using “MATLAB” and create graphs of optimum shifting times, distance travelled in each gear and the respective vehicle speeds. Used the advanced parametric functionality of CATIA in conjunction with the above-generated data to automate the generation of the Helical and Spur Gear 3D models. Further optimized the transmission by designing and implementing a Machine Learning (ML) classification algorithm using various numerical inputs to evaluate the relationship between the gear module, gear thickness and the bending stress to identify the optimum material to be used.

- **Challenges:** There were quite a few challenges that I had faced when doing this project; though, the main one was the MATALB programming. This was the first major project I had done in MATLAB as before starting this project, I had only been exposed to some MATLAB at university. Therefore, I taught myself all the various codes of the program such as functions, non-linear equations, plots, loops etc. Another challenge I faced was learning all the theory behind the calculations.

- **Solution:** The method I undertook to learning all the codes for the program was to use a project-based approach where I looked up tutorial videos on the general area of what I was trying to achieve, then created a small dummy program to get the layout of the steps for the codes and finally applied it to the main program. Using this method for all the different parts of the code i.e. functions, nonlinear equations, plots, loops etc., I significantly improved my coding skills which I can now apply to future projects. The other issue was about understanding the background theory which I got from a combination of research papers and other books on the subject. However, the main source of my information was from my GrabCAD discussion group that I had set up, as I was able to confer with knowledgeable people on the topic, ask the relevant questions and understand a lot more about this subject.



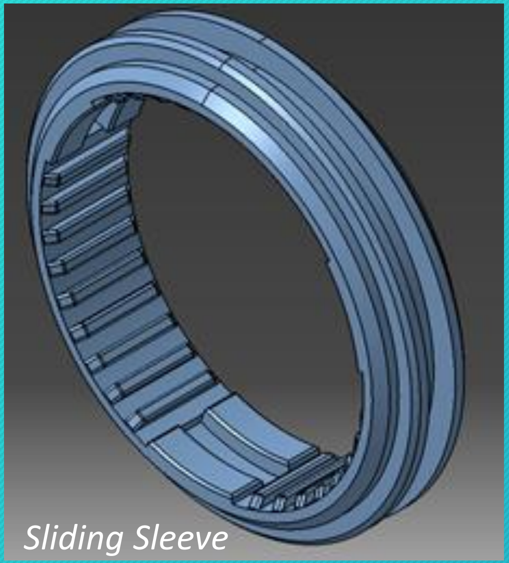
5 Speed Transmission ISO View



5 Speed Transmission Side View

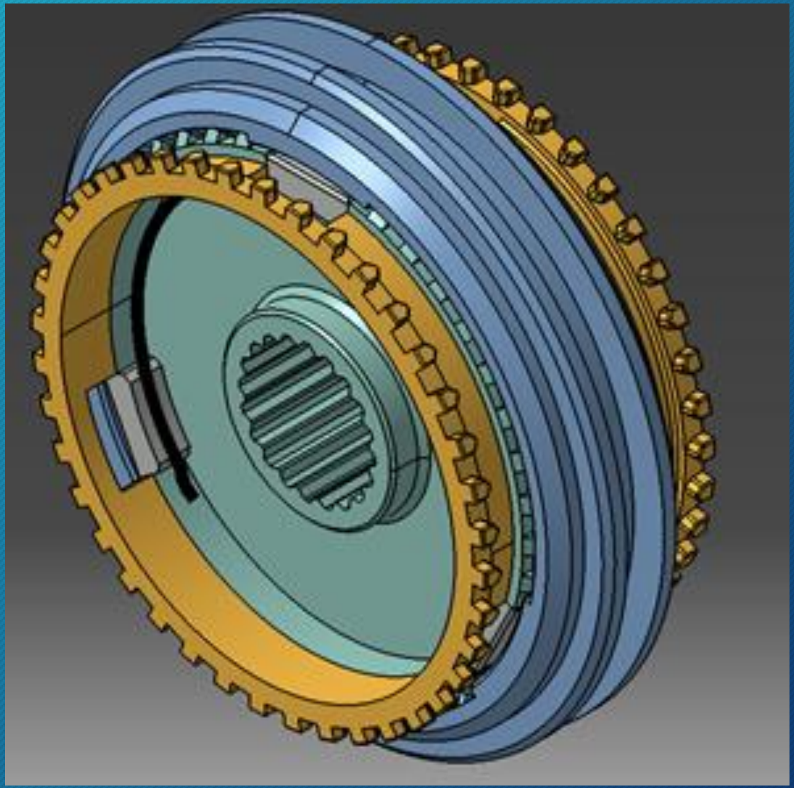
Project: 5 Speed Transmission

A Few Assembly Components

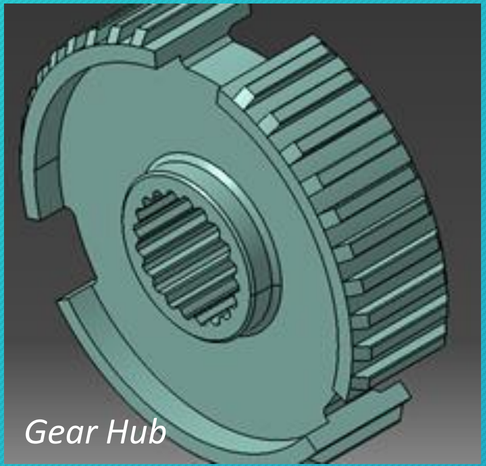


Sliding Sleeve

Synchroniser Ring



Blocker Ring Synchromesh Unit

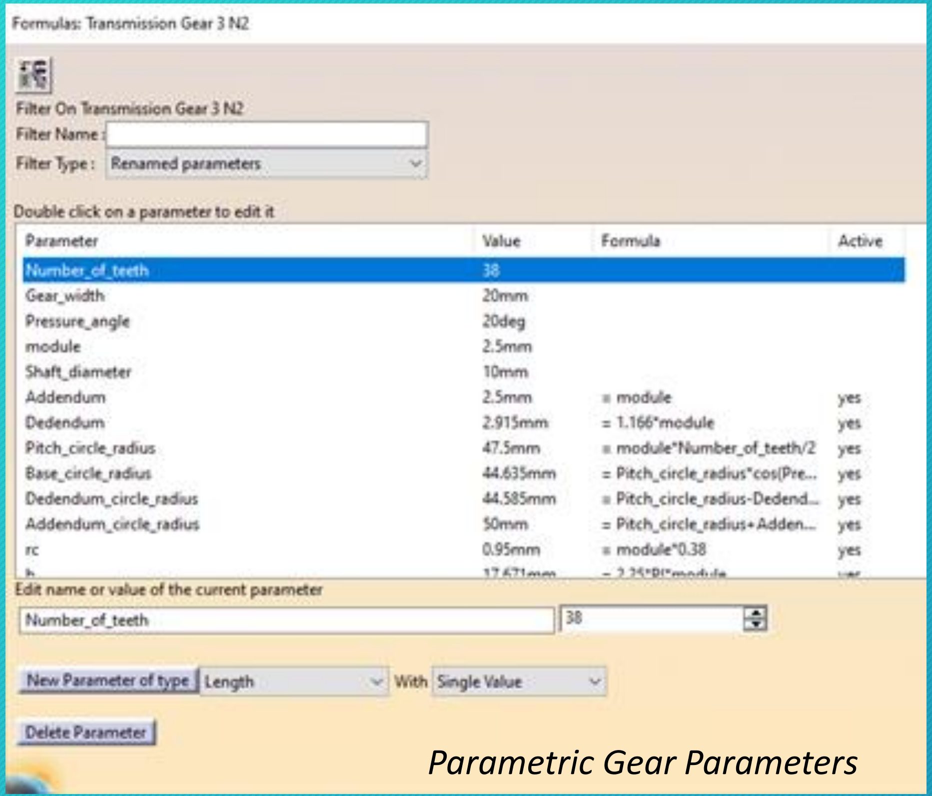


Gear Hub

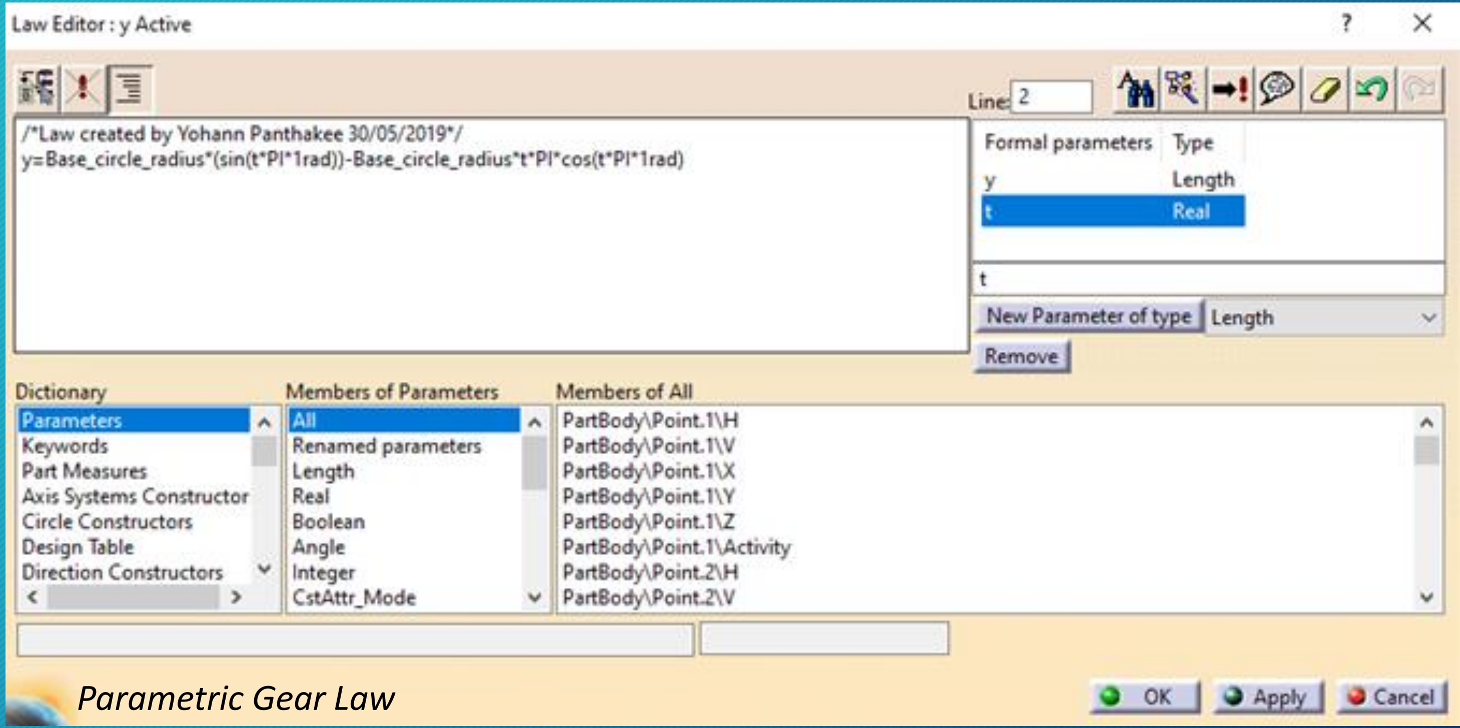
Parametric Helical Gear

Project: 5 Speed Transmission

CATIA Parametric Head Gear



Parametric Gear Parameters



Parametric Gear Law

Project: 5 Speed Transmission

Matlab Program

Data_File.m | Transmission_Calculator.m

```matlab
% Before using the program fill in the relevent data

Number_Of_Gears = 6;
Transmission_Type = 2;  %synchromesh transmission (1) or a sequential transmissions (2)

%Vehicle Data
Wheel_drive = 'RWD';  % Is the vehicle front or rear wheel drive
bl = 0.45;            % Front Weight Bias to wheelbase ratio
al = 0.55;            % Rear Weight Bias to wheelbase ratio
hl = 0.4;             % CG height to wheelbase ratio
fr = 0.01;            % Rolling resistance coefficient
mu = 0.8;             % Maximum coefficient of adhesion
rw = 0.3;             % CG height to wheelbase ratio  (0.8433/1.874)
W = 955*9.81;         % weight of the vehicle (N)
nd = 0.85;            % driveline efficiency
C = 0.43;             % Overall aerodynamic coefficient

%Engine Data
Start_val = 0.1;      % Starting Parameter for the Highest Gear Calcualtion
Velo_max = 50;        % Maximum Velocity (ms^-1)
te = 390;             % Max engine torque at Max RPM (NM)  120
RPM_MP = 7500;        % Max RPM at Max power
Power = (460/1.36);   % power of the engine (kW)

%Vehicle Dynamics
m = W/9.81;           % Vehicle mass (kg)
rW= (0.6/2);          % Wheel effective radius (m)
Tm=220;               % Constant torque (Nm)
wm=1000;              % Minimum engine speed (rpm)
wM=7200;              % Maximum engine speed (rpm)
Rrf=m*9.81*fr;        % Rolling Resistive force
t0 = 0;               % Initial condition
v0 = 0;               % Initial condition
s0 = 0;               % Initial condition
wmin(1)=0;            % Assume the engine speed can start from zero in gear 1

% %Number of Teeth
```

Transmission Calculator Data File

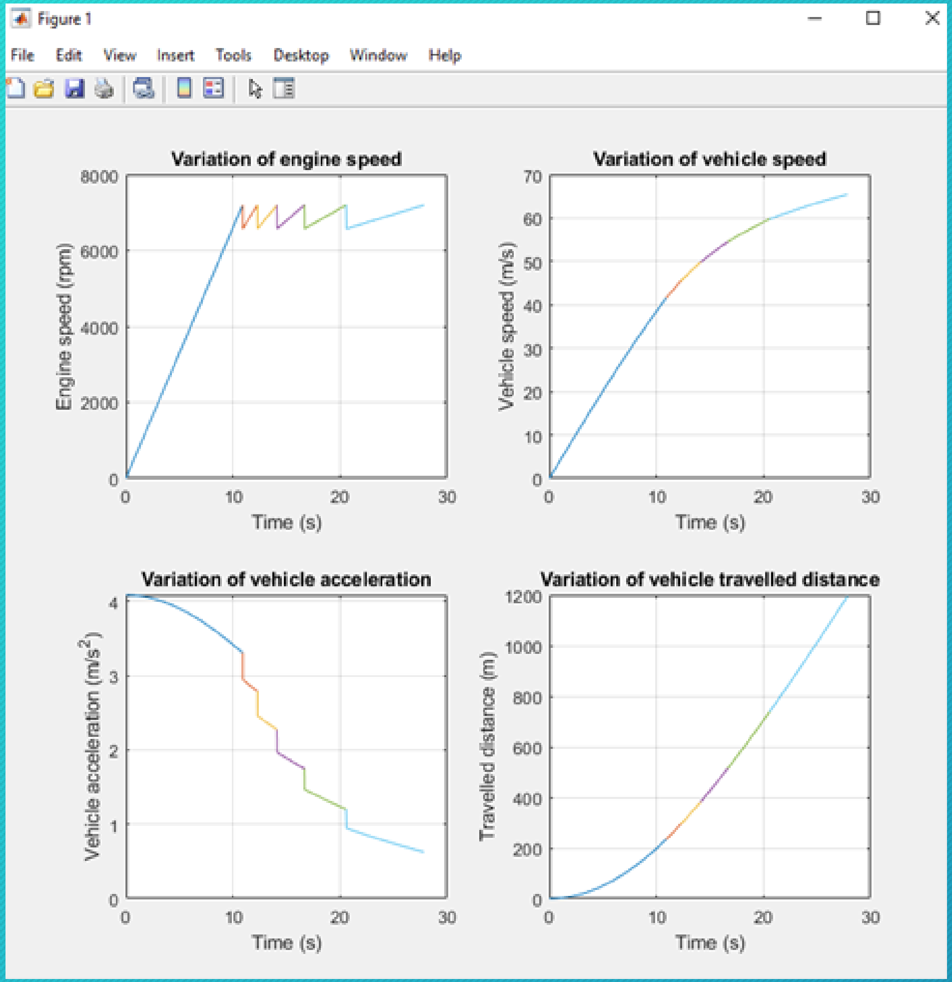
Data_File.m | Transmission_Calculator.m

```matlab
% Fill in the Data_file.m file with the relevent data that is required
clc, close all, clear all
%Update the Data_file.m file with the relevent data from the comparison graphs
Data_File
%%
%Calculat Lowest Gear Ratio
 Lowest_Ratio = LowestGear(Wheel_drive,bl,al,hl,fr,mu,rw,W,nd,te);
 Engine_Speed = HighestGearTorque(fr,W,C,Velo_max,Start_val);
 Highest_Ratio = Engine_Speed*(rw/Velo_max)*(pi/30);
%%
% Using Geometric Progression Calculate the intermitant Gear ratios
FGR = flip((Geometric_Progression(Number_Of_Gears,Highest_Ratio,Lowest_Ratio))); %Final Gear Ratios
PRC = FGR(end); %Pure Ratio Constant
PGR = (FGR/PRC).'; %Pure Gear Ratios
PGR_ML = (FGR/PRC);
PGR_Start = PGR(1);
PGR_Rest = (PGR(2:end));
%%
 % Vehicle Dynamics
 for i=1:length(FGR) % Loop for gears
    FT(i)=FGR(i)*Tm/rW; % Traction force of each gear
    b=sqrt((FT(i)-Rrf)/C); % Beta Equation
    phi=atanh(v0/b); % Phi Theta Equation
    vmax(i)=min(wM*rW*pi/FGR(i)/30, b); % Maximum speed of each gear
    tmax(i)=t0+m*(atanh(vmax(i)/b)-phi)/b/C; % Maximum time of each gear
    smax(i)=s0+m*log(sqrt((b^2-v0^2)/(b^2-vmax(i)^2)))/C; % Maximum distance at each gear

    if i<length(FGR)
        wmin(i+1)=30*vmax(i)*FGR(i+1)/rW/pi;
    end % Minimum engine speed at next gear

for j=1: 200 % Start the loop for 200 intermediate points at each gear
    w(j, i)=wmin(i)+(j-1)*(wM-wmin(i))/199; % Divide the speed span into 200 segments
    t(j, i)=t0+(j-1)*(tmax(i)-t0)/199; % Divide the time span into 200 segments
    v(j, i)=min(b*tanh(b*C*(t(j, i)-t0)/m+phi), b); % values for velocity at each gear
    a(j, i)=(FT(i)-Rrf-C*v(j,i)^2)/m; % values for acceleration at each gear
    s(j, i)=s0+m*log(sqrt((b^2-v0^2)/(b^2-v(j, i)^2)))/C; % values for distance at each gear
end

% Set initial conditions for next gear
t0=tmax(i);
v0=vmax(i);
s0=smax(i);
```

Transmission Calculator Code

Project: 5 Speed Transmission

Matlab Program (Continued)



Transmission Calculator Output Plots

Command Window

```
Gear_Ratio_Table =

  6×6 table
```

Var1	GearRatio	PureRatio	Velocity	Time	Distance
1	5.45	1.58	41.53	10.9	234
2	4.97	1.44	45.49	12.28	294
3	4.54	1.31	49.82	14.11	382
4	4.15	1.2	54.56	16.67	515
5	3.79	1.1	59.75	20.56	738
6	3.46	1	65.44	27.86	1196

Transmission Calculator Output Ratios

Project: 5 Speed Transmission

Matlab Machine Learning Classification

Application	Price Grade	Fatigue strength 10^7 cycles	Youngs Modulus	Machinability	Number_of_teeth	Module	Bending_stress	Thickness	Centre_distance	Material
Commercial	Low	High	High	Low	12	2.5	1206.98	25	95	Medium carbon steel
Commercial	Low	High	High	Low	13	3	907.84	20	95	Medium carbon steel
Commercial	Low	High	Mid	High	15	3	708.12	20	95	Cast iron, ductile (nodular)
Commercial	Low	High	Mid	High	19	3	516.31	20	95	Cast iron, ductile (nodular)
Commercial	Low	High	Mid	High	33	2	585.02	20	95	Cast iron, ductile (nodular)
Commercial	Low	High	Low	High	39	2	462.79	20	95	Cast iron, ductile (nodular)
Commercial	Low	High	Low	High	45	2	387.95	20	95	Cast iron, ductile (nodular)
Commercial	Low	High	Low	High	60	2.5	28.80	25	95	Cast iron, ductile (nodular)
Commercial	Low	High	Low	High	47	3	44.17	20	95	Cast iron, ductile (nodular)
Commercial	Low	High	Low	High	45	3	60.05	20	95	Cast iron, ductile (nodular)
Commercial	Low	High	Low	High	41	3	88.70	20	95	Cast iron, ductile (nodular)
Commercial	Low	High	Mid	High	57	2	175.44	20	95	Cast iron, ductile (nodular)
Commercial	Low	High	Mid	High	51	2	255.25	20	95	Cast iron, ductile (nodular)
Commercial	Low	High	Mid	High	45	2	387.95	20	95	Cast iron, ductile (nodular)
Commercial	Mid	Mid	Mid	High	14	2.5	1039.82	22	95	Medium carbon steel
Commercial	Mid	Mid	Mid	Mid	14	3	836.11	19	95	Cast iron, ductile (nodular)
Commercial	Mid	Mid	Mid	Mid	16	3	684.64	19	95	Cast iron, ductile (nodular)
Commercial	Mid	High	High	Mid	20	3	562.72	17	95	Age-hardening wrought Al-alloys
Commercial	Mid	Mid	Mid	Mid	34	2	646.41	17	95	Low carbon steel
Commercial	Mid	High	High	Mid	40	2	564.02	16	95	Age-hardening wrought Al-alloys
Commercial	Mid	High	High	Mid	45	2	517.27	15	95	Age-hardening wrought Al-alloys
Commercial	Mid	Mid	Low	Mid	58	2.5	39.52	22	95	Cast Al-alloys
Commercial	Mid	Mid	Low	Mid	46	3	52.64	19	95	Cast Al-alloys

Training Data for Classification Algorithm

ML_Material_Model.ClassificationEnsemble

Property	Value
Y	53x1 categorical
X	53x10 table
RowsUsed	[]
W	53x1 double
ModelParameters	1x1 EnsembleParams
NumObservations	53
HyperparameterOptimizati...	[]
PredictorNames	1x10 cell
CategoricalPredictors	[1,2,3,4,5]
ResponseName	'Y'
ExpandedPredictorNames	1x10 cell
ClassNames	10x1 categorical
Prior	[0.0755,0.0943,0.2642,...
Cost	10x10 double
ScoreTransform	'none'
Method	'Bag'
LearnerNames	1x1 cell
ReasonForTermination	'Terminated normally...
FitInfo	[]
FitInfoDescription	'None'
UsePredForLearner	[]
NumTrained	30
Trained	30x1 cell
TrainedWeights	30x1 double
CombineWeights	'WeightedAverage'
FResample	1
Replace	1
UseObsForLearner	53x30 logical

Classification Algorithm

Project: 5 Speed Transmission

Excel Program

All Dimension are in MM			
Gear Ratios	Data Value		
1	3.46	9.3	3.83
2			3.06
3			2.45
4			1.96
5			1.56
6			1.25
7			1
8			3

Constant	90.2	
Module	2	mm
Pressure Angle	20	deg
Initial value	1.05	
K1	44	
K2	21	

Gear	N1	N2
1	21	69
2	90	0
3	90	0
4	90	0
5	90	0
6	90	0
7	90	0
8	[redacted]	

P1	44
G1	46

N2	Drive
N1	Driven
G1	Drive
P1	Driven

Gear 1		
Split Values	1.05	
	3.30	
K1	44	2.05
K2	21	4.30
N1	21	
N2	69	
P1	44	
G1	46	
N Ratio	3.30	
P/G Ratio	1.05	
Final Ratio	3.46	
Addendum	2.00	2.00
Dedendum	3.32	3.32
Pitch Circle Radius	21.00	69.20
Base Circle Radius	8.57	28.24
Dedendum Radius	17.68	65.88
Addendum Radius	23.00	71.20
Fillet Radius	0.76	0.76
Centre Distance	90.20	90.20

Gear 2		
Split Values	1.05	
	0.00	
K1	44	2.05
K2	90	1.00
N1	90	
N2	0	
P1	44	
G1	46	
N Ratio	0.00	
P/G Ratio	1.05	
Final Ratio	0.00	
Addendum	2.00	2.00
Dedendum	3.32	3.32
Pitch Circle Radius	90.20	0.00
Base Circle Radius	36.81	0.00
Dedendum Radius	86.88	-3.32
Addendum Radius	92.20	2.00
Fillet Radius	0.76	0.76
Centre Distance	90.20	#DIV/0!

Gear 3		
Split Values	1.05	
	0.00	
K1	44	2.05
K2	90	1.00
N1	90	
N2	0	
P1	44	
G1	46	
N Ratio	0.00	
P/G Ratio	1.05	
Final Ratio	0	
Addendum	2.00	2.00
Dedendum	3.32	3.32
Pitch Circle Radius	90.20	0.00
Base Circle Radius	36.81	0.00
Dedendum Radius	86.88	-3.32
Addendum Radius	92.20	2.00
Fillet Radius	0.76	0.76
Centre Distance	90.20	#DIV/0!

Gear 4		
Split Values	1.05	
	0.00	
K1	44	2.05
K2	90	1.00
N1	90	
N2	0	
P1	44	
G1	46	
N Ratio	0.00	
P/G Ratio	1.05	
Final Ratio	0	
Addendum	2.00	2.00
Dedendum	3.32	3.32
Pitch Circle Radius	90.20	0.00
Base Circle Radius	36.81	0.00
Dedendum Radius	86.88	-3.32
Addendum Radius	92.20	2.00
Fillet Radius	0.76	0.76
Centre Distance	90.20	#DIV/0!

Gear 5		
Split Values	1.05	
	0.00	
K1	44	2.05
K2	90	1.00
N1	90	
N2	0	
P1	44	
G1	46	
N Ratio	0.00	
P/G Ratio	1.05	
Final Ratio	0	
Addendum	2.00	2.00
Dedendum	3.32	3.32
Pitch Circle Radius	90.20	0.00
Base Circle Radius	36.81	0.00
Dedendum Radius	86.88	-3.32
Addendum Radius	92.20	2.00
Fillet Radius	0.76	0.76
Centre Distance	90.20	#DIV/0!

Gear 6		
Split Values	1.05	
	0.00	
K1	44	2.05
K2	90	1.00
N1	90	
N2	0	
P1	44	
G1	46	
N Ratio	0.00	

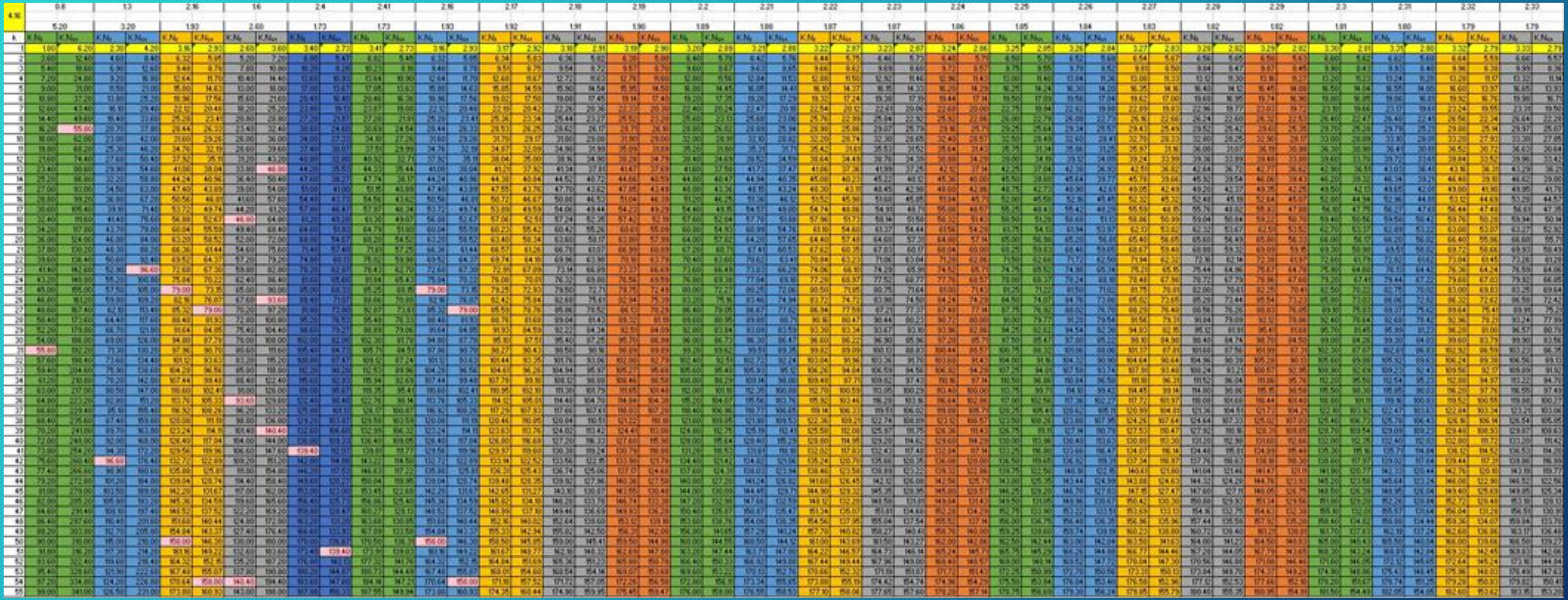
Gear 7		
Split Values	1.05	
	0.00	
K1	44	2.05
K2	90	1.00
N1	90	
N2	0	
P1	44	
G1	46	
N Ratio	0.00	

Gear 8		
Split Values	1.05	
	0.00	
K1	44	2.05
K2	90	1.00
N1	90	
N2	0	
P1	44	
G1	46	
N Ratio	0.00	

Gear Ratio to Number of Teeth Calculator

Project: 5 Speed Transmission

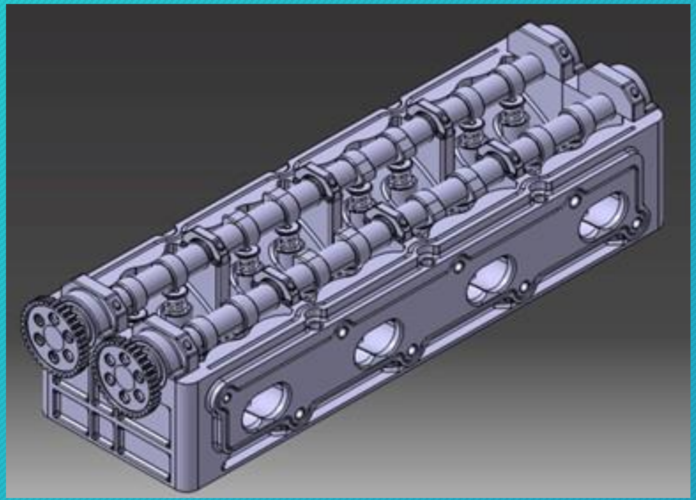
Excel Program (Continued)



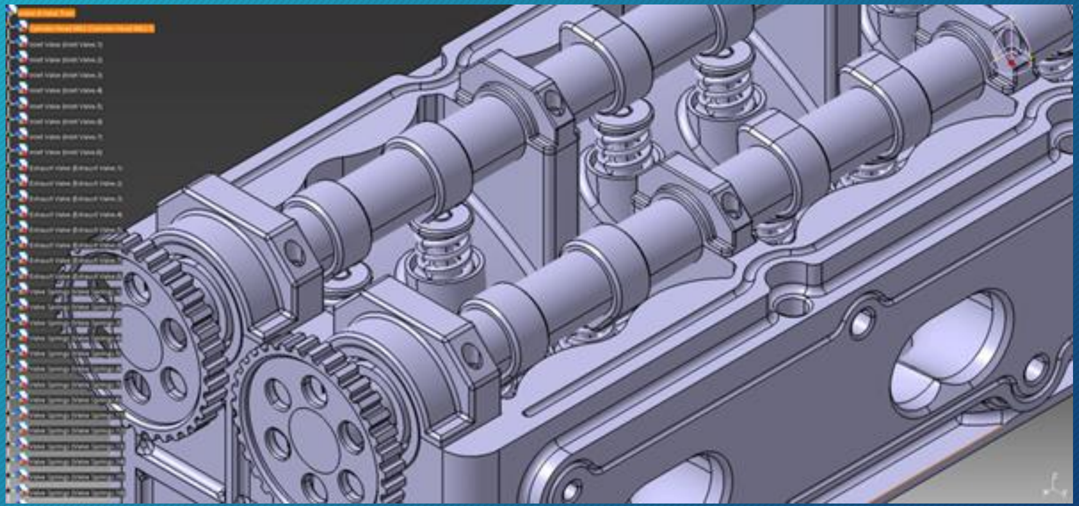
Gear Ration Constant Table

Project: Inline 4 Valve Train

- **Software:** CATIA
- **Aim:** To model an Inline 4 Valve Train with all its components and with an assembled final product. The Inline 4 Valve Train was modelled based of my own research off the internet.
- **Challenges:** The main challenge I had faced was regarding how to approach designing such a complicated component.
- **Solution:** Pre-planning was the key to modelling the Inline 4 Valve Train efficiently. Also, the skills I learnt from the KJ-66 Micro Turbine Jet Engine project where I used GSD was very helpful when designing the internal inlet and exhaust ports.



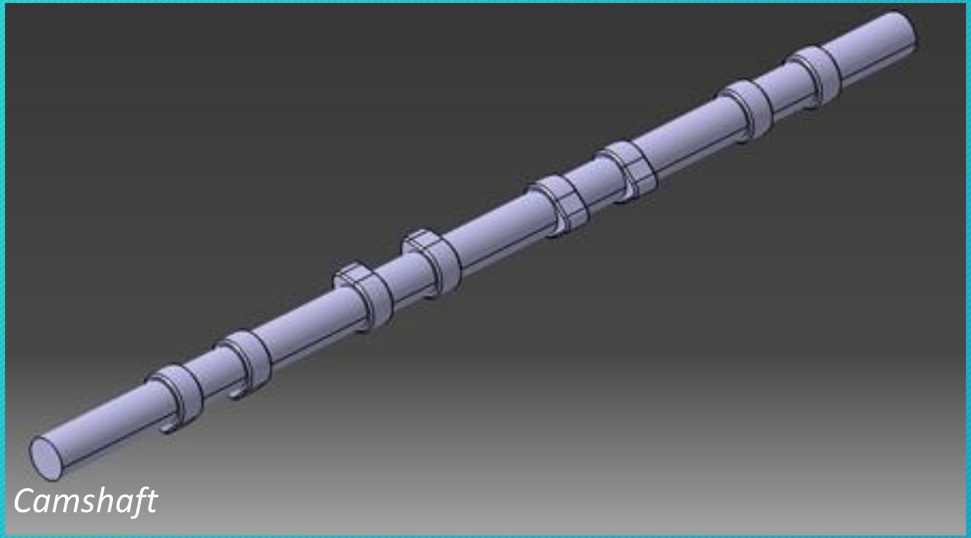
Valve Train Assembly ISO View



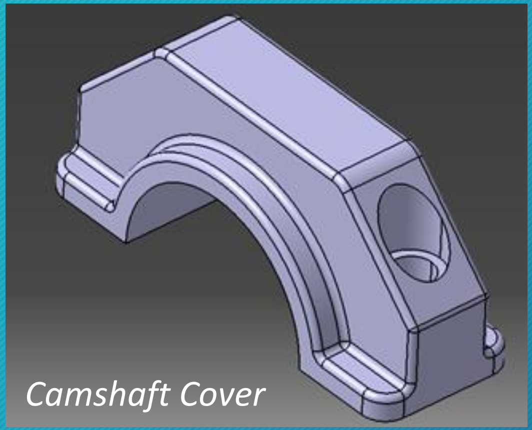
Valve Train Assembly Side View

Project: Inline 4 Valve Train

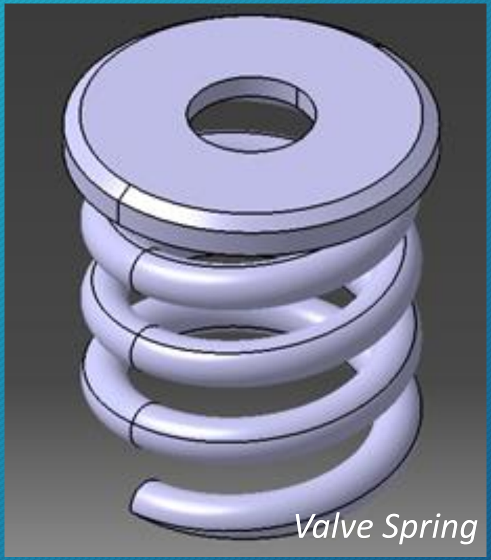
A Few Assembly Components



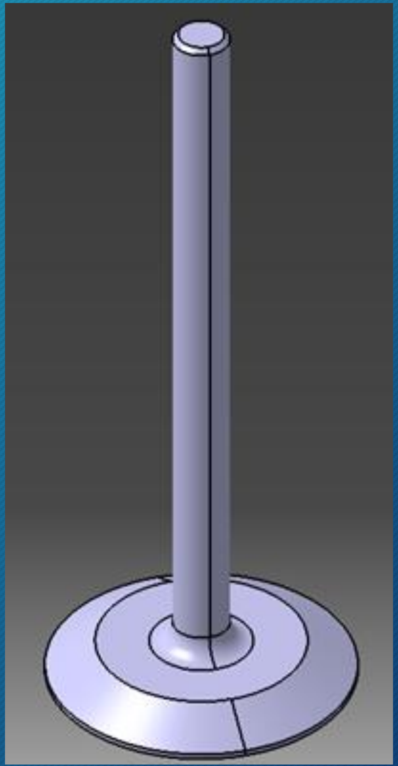
Camshaft



Camshaft Cover



Valve Spring



Tunnel Shaft

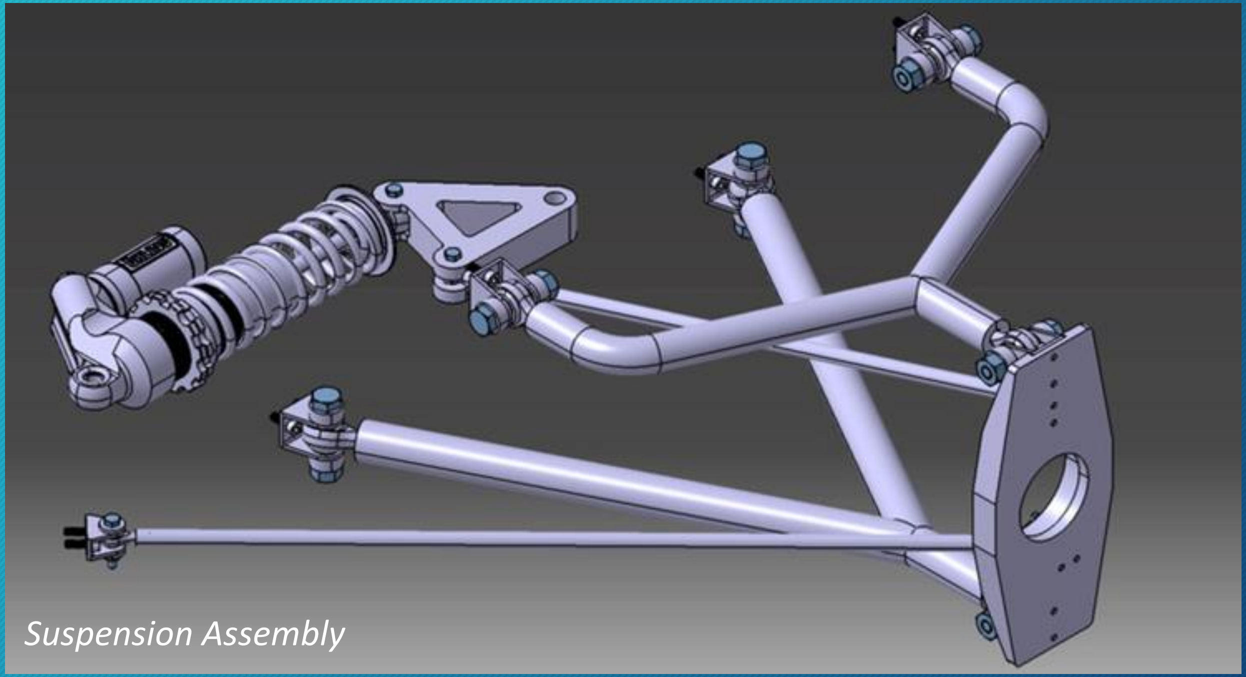
Project: Suspension Assembly

- **Software:** CATIA

- **Aim:** To model a Suspension Assembly with all its components and with an assembled final product. The Suspension Assembly was modelled as part of our university course work project. The aim of the project was to design and model an autonomous vehicle for a disabled person.

- **Challenges:** The main challenge that I faced was the concentric alignment of all the components in the assembly. Since one of the main criteria in the design brief was to have an assembly which can move in the CAD assembly, it was vital that every component was lined up perfectly.

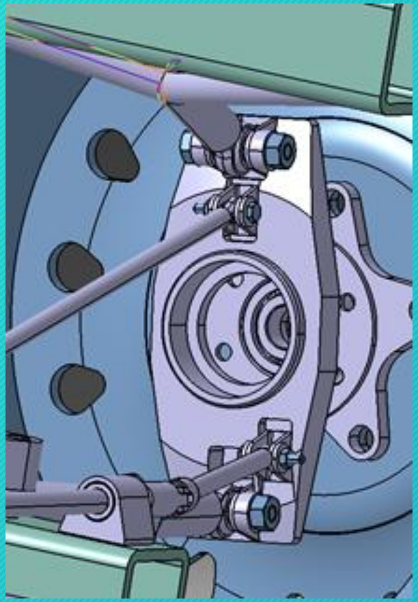
- **Solution:** Pre-planning was the key to modelling the Suspension Assembly efficiently. Also, the use of a 2D CATIA sketch allowed me to play with the dimensions and accurately produce the length of the control arms.



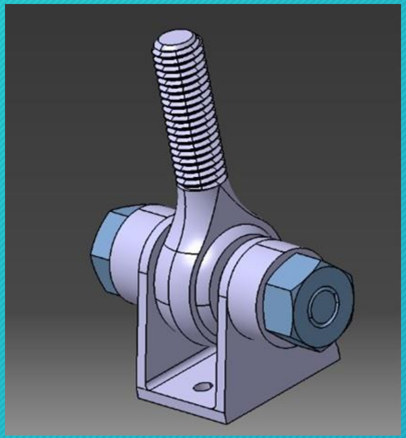
Suspension Assembly

Project: Suspension Assembly

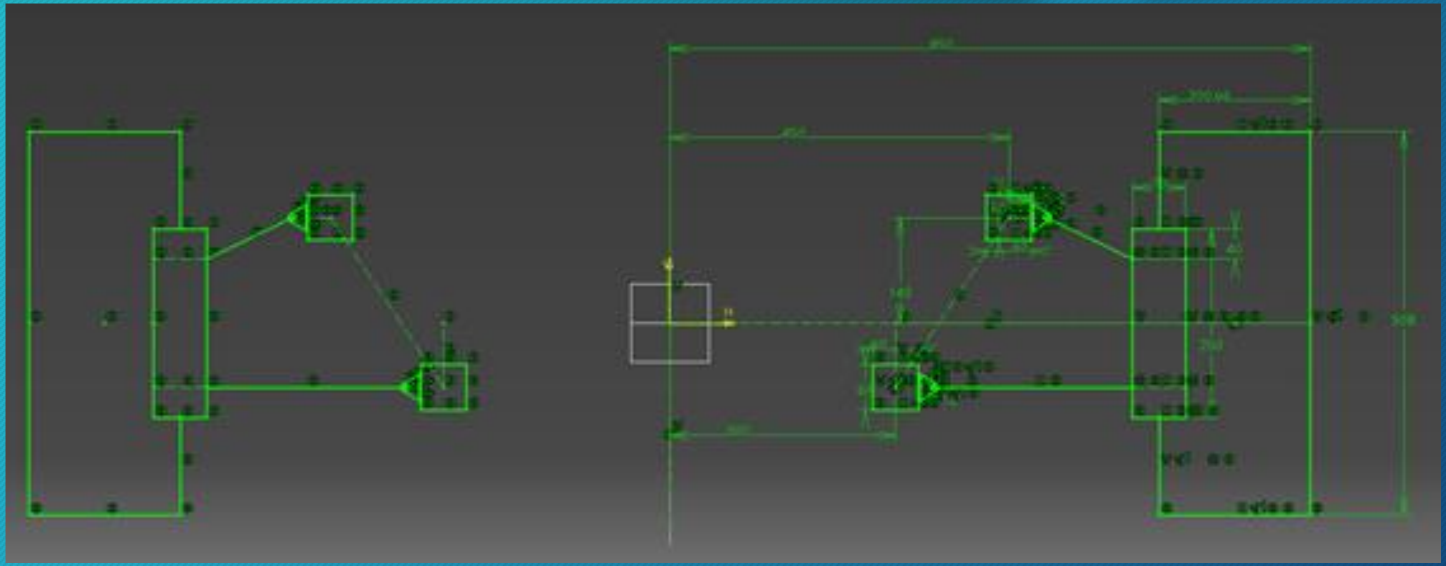
A Few Assembly Components



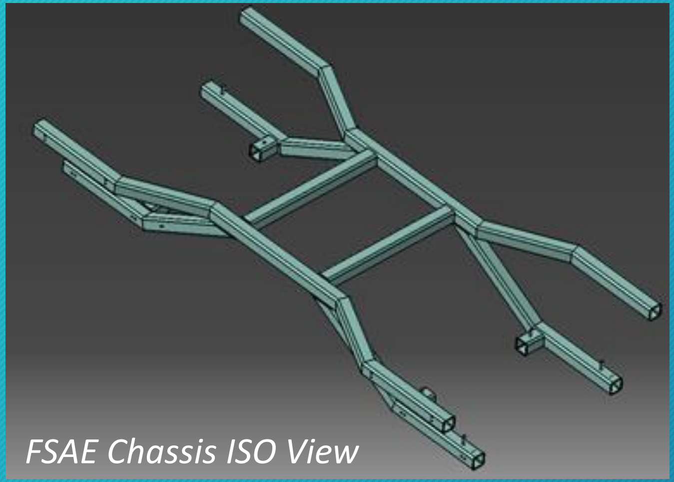
Suspension View



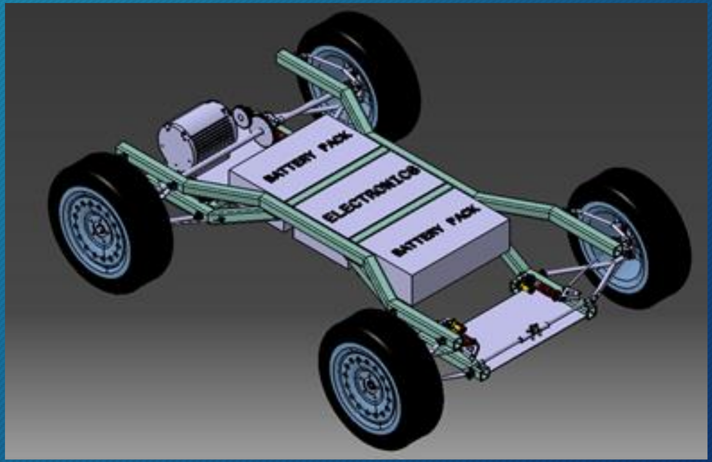
Suspension Bracket Assembly



2D Suspension CATIA Sketch



FSAE Chassis ISO View



University Project Complete Assembly

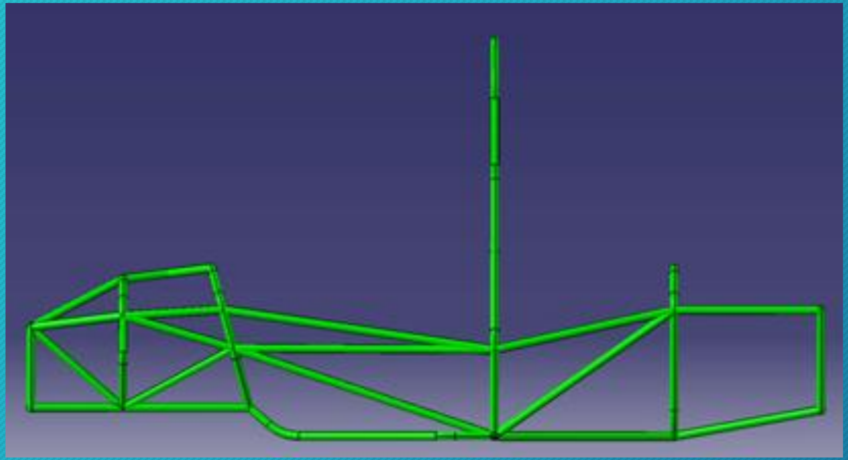
Project: FSAE Chassis

- **Software:** CATIA

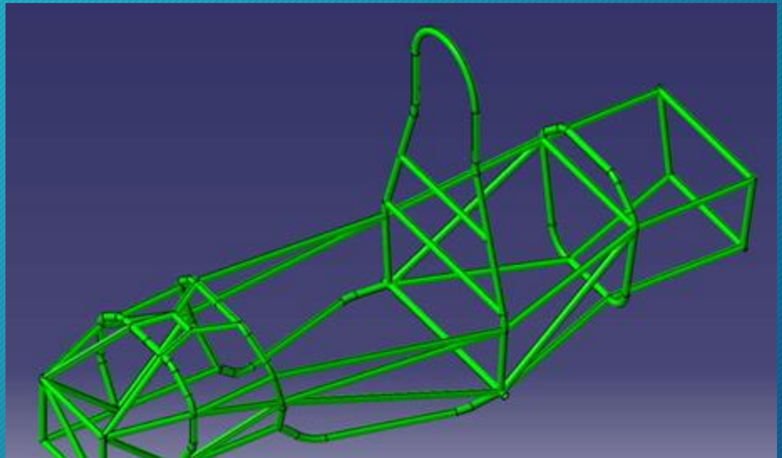
- **Aim:** To model a FSAE Chassis with all its components and with an assembled final product. The FSAE Chassis was modelled based of my own research off the internet.

- **Challenges:** The main challenge that I faced was learning how to model a chassis using GSD Sweeps, Trim and to thicken the 2D surfaces.

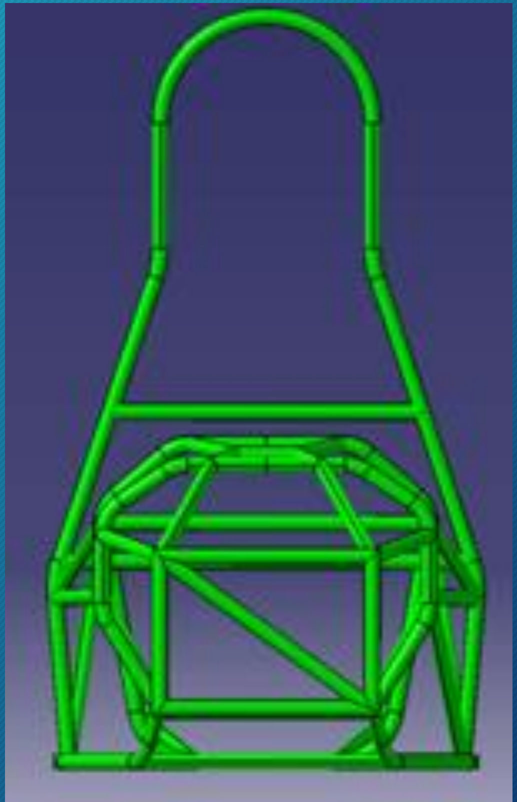
- **Solution:** I followed a useful online tutorial on creating a 3D sketch using lines and points. With this, I sketched the chassis layout and applied the sweep to all the line segments. The trimming of the surfaces was new to me and I learnt that the trimming order is vital for a well-designed model.



FSAE Chassis Side View



FSAE Chassis ISO View

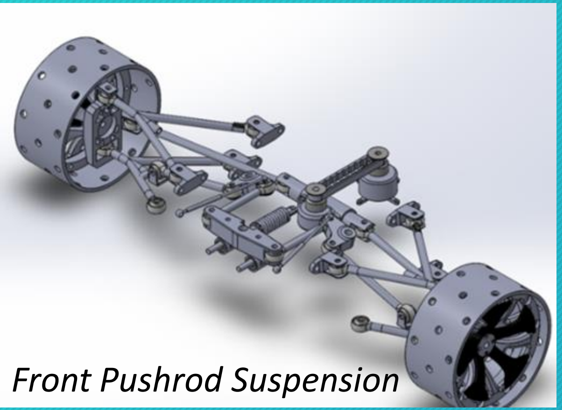


FSAE Chassis Front View

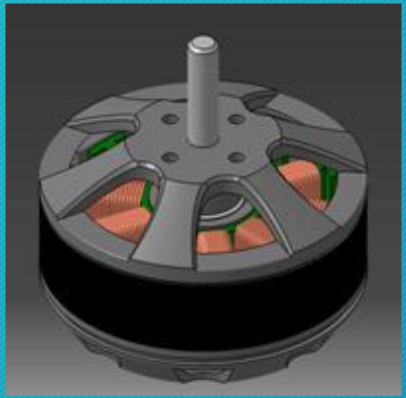
Project: FSAE Chassis

A Few Assembly Components

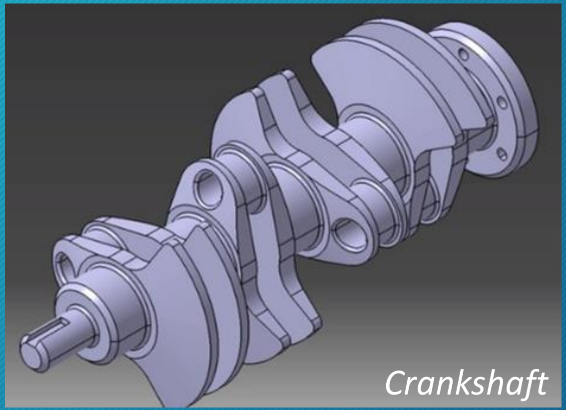
Clutch and Flywheel



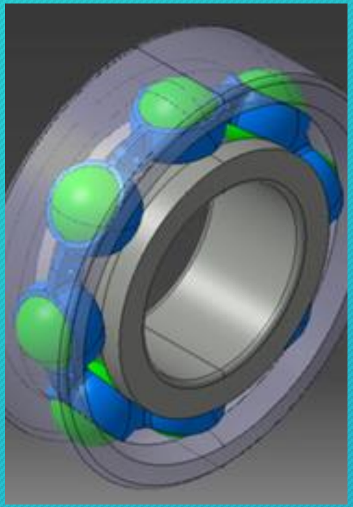
Front Pushrod Suspension



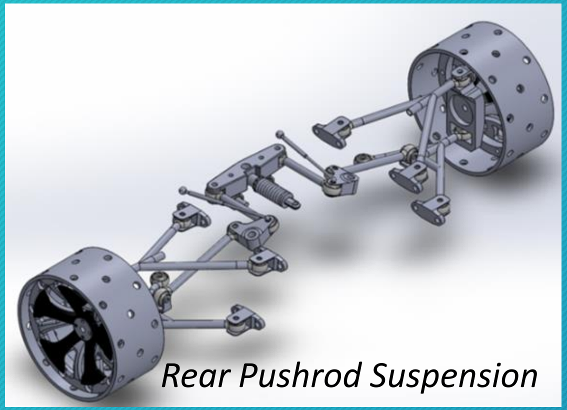
Brushless DC Motor



Crankshaft



Rolling Element Bearing



Rear Pushrod Suspension

Intake / Exhaust Manifold

CFL Lightbulb