ARTEMIS

DESIGN & ENGINEERING PORTFOLIO

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ENGINEERING PROCESS

THE MOST EXCITING, ENGAGING,INTERESTING AND THE LENGTHIEST PROCESS OF F1 IN SCHOOLS COMPETITION IS THE CAR DESIGNING , ENGINEERING AND MANUFACTURING PROCESS. EVERY STAGE OF THIS PROCESS IS FULL OF LEARNING, MAKING MISTAKES , EVALUATION, FRUSTRATION ,CORRECTION AND MOVING FORWARD. AS THE DESIGN ENGINEER FOR MY TEAM,I HAVE TRIED MY BEST TO EXPLAIN EVERY MOMENT OF THE CAR CREATION JOURNEY FROM A ' BLOCK' TO OUR 'RACING CAR' !

WE HAD TO GO STEP BY STEP. THERE WERE NO SHORTCUTS. WHEN SHORTCUTS WERE TRIED THEY WEREN'T FRUITFUL. BEFORE COMING UP WITH THE FINAL CAR IT WAS CRUCIAL TO GO BY THE LEARNINGS FROM OTHER TEAMS AROUND THE WORLD. LISTED BELOW ARE THE ACTIONS THAT WERE UNDERTOOK TO CREATE A SUCCESSFUL CAR FOR THE TEAM.

RESEARCH

A LOT OF RESEARCH WAS PUT INTO SHAPE AND ENGINEERING OF THE DESIGN (INDIVIDUAL PARTS AS WELL) BEFORE WE ACTUALLY STARTED OFF.

ENGINEERING & DEVELOPMENT

IT WAS IMPORTANT TO COME UP WITH SKETCHES BEFORE GOING ON TO THE CAD/CAM AS IT WOULD SAVE TIME AND EFFORT AND ERROR FIXING WOULD BE EASIER.

TESTING

SINCE SCHOOL WAS HOSTING AN INTERNATIONAL EVENT AND SO WAS NOT AVAILABLE FOR TESTING SO WE HAD TO DEVISE WAYS TO DO TESTING ON OUR OWN. WE INDIANS PROUDLY CALL IT JUGAAD !

EVALUATION

THIS WAS THE MOST IMPORTANT PART OF OUR ENGINEERING PROCESS. THOUGH THE RESULTS MIGHT NOT HAVE BEEN THAT ACCURATE, BUT THE TESTING MADE US EVALUATE LOT OF AREAS LIKE AERODYNAMICS, SPEED, BEARING PERFORMANCE, PRACTICAL ASSEMBLY GLITCHES.

MANUFACTURING

THE FINAL STAGE OF OUR CAR, COMING TO LIFE.

ASSEMBLY

IN THIS STAGE WE HADE TO MAKE SURE THAT BOTH THE CAR WERE SMOOTH AND WERE FUNCTIONING AS EXPECTED.

ENGINEERING MANAGEMENT

CONTROL ENGINEERING RISKS

RISK ASSESSMENT

AN IMPORTANT PART OF ENGINEERING MANAGEMENT IS TO ANALYSE ISSUES WE MIGHT FACE IN PREPARATION FOR THE COMPETITION, AS WELL AS THE COMPETITION ITSELF. A RISK ANALYSIS AND ASSESSMENT TABLE WAS WAS PRODUCED TO TO HELP US IDENTIFY AND CONTROL THESE RISKS WITH THE BEST OF OUR ABILITY. THIS ALOWED US TO GET ON WITH THE JOB WITHOUT WORRY OF FALLING BEHIND SCHEDULE DUE TO UNFORESEEN RISKS. AN EXTRACT IS SHOWN BELOW.

Risk	Cause	Rating	Control
Car is out of rules causing penalties	Complex design and strict design rules.	Medium	Both design engineers review car for compliance. Leave a week between completion of car and the start of the manufacturing process.
Car breaks during racing	Weak points in car design and/or components.	Medium	Extensive testing E.g. FEA analysis. Change design to remove weak points.
No organisation to show design evolution	Lack of a naming convention to manage design developments in the car.	High	Create a template to order all design elements and document the testing processes.

DEVELOP A WAY OF DOCUMENTING OUR PROCESS

ENGINEERING TEMPLATES

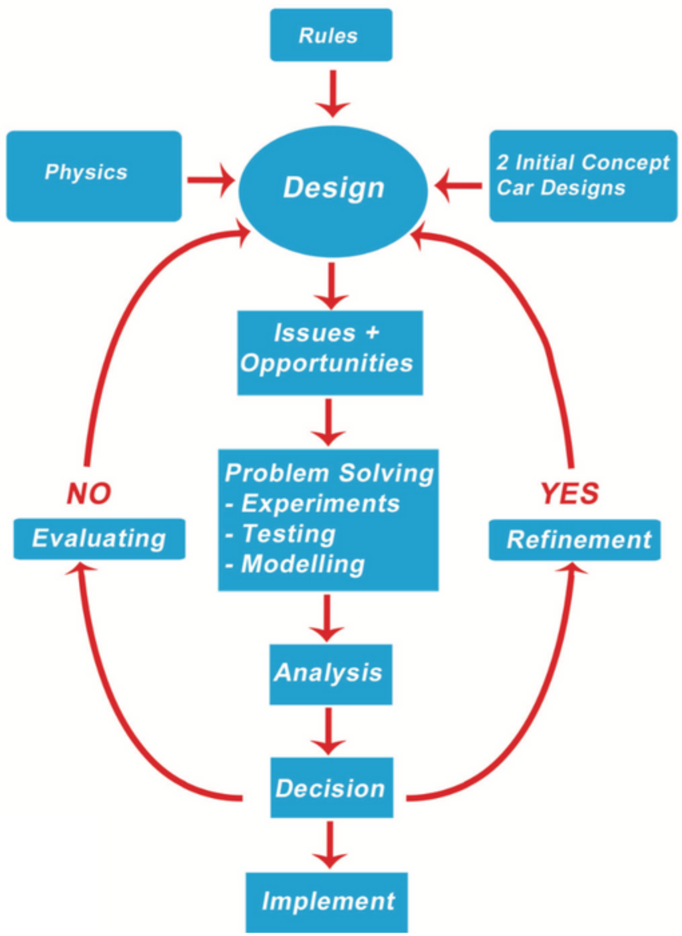
IT IS IMPORTANT TO SHOW THE EVOLUTIONARY AND REVOLUTIONARY DESIGN PROCESS. THIS PROCESS HAS ALLOWED US TO ACHIEVE A HIGHLY DETAILED ASSESSMENT OF ALL DESIGN COMPONENTS AND SUCCESSFULLY IMPLEMENTED THEM INTO OUR CAR.

CHALLENGES AND OPPORTUNITIES:

- CONTROL ENGINEERING RISKS
- DEVELOP A WAY OF DOCUMENTING OUR PROCESS
- USE A PLAN OF OPERATION FOR ALL PROCESSES

USE A PLAN OF OPERATION FOR ALL PROCESSES

WE NEEDED THE DESIGN PROCESS TO BE EFFICIENT AS POSSIBLE IN ORDER TO GET THE BEST RESULTS WITHIN A LIMITED AMOUNT OF TIME. A DESIGN PROCESS FLOW CHART WAS FOLLOWED AND RECORDED IN THE ENGINEERING TEMPLATES.



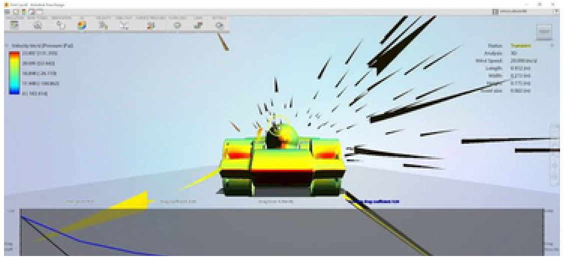
RESEARCH

PRINCIPLES OF A CO_2 DRAGSTER

TO DRAG OR NOT TO DRAG. ACTUALLY, THESE ARE NOT TRUE DRAGSTERS THOUGH WE MAY CALL THEM THAT. THEY ARE ACTUALLY MORE LIKE JETS OR ROCKETS. ESCAPING CO_2 GAS FROM THE CARTRIDGE PUSHES THE CAR DOWN THE TRACK. THESE ARE LSAVS (LAND SPEED ASSAULT VEHICLES)

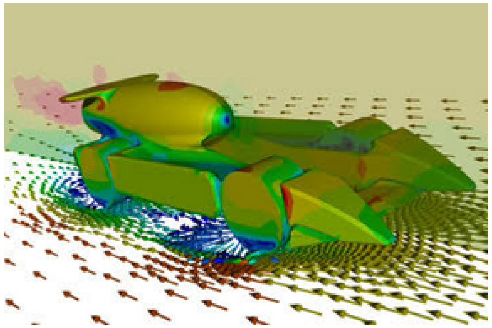
CO_2 CAR ENGINEERING PRINCIPLES

// PRINCIPLE 1- MASS-LIGHTER THE CAR THE FASTER IT WILL GO...
// PRINCIPLE 2 – DRAG- THE RESISTANCE OF THE AIR MOVING OVER THE CAR WILL CREATE
DRAG. THE MORE AERODYNAMICALLY 'CLEAN' THE BODY IS THE LESS DRAG WILL BE CREATED.



// ADVANTAGE: AERODYNAMICALLY SHAPED CARS ARE LESS AFFECTED BY DRAG, SO THEY GO FASTER.

// DISADVANTAGE: AERODYNAMICALLY 'CLEAN' CARS ARE MORE DIFFICULT AND TAKE LONGER TO BUILD. THESE CARS ALL TEND TO LOOKALIKE EXCEPT FOR THE PAINT JOBS.
-PRINCIPLE 3 – FRICTION- FLUID FRICTION AND SURFACE FRICTION- IT IS ONE OF THE GREATEST FACTORS AFFECTING THE SPEED OF THE CAR AND IS THE HARDEST TO REDUCE
FLUID FRICTION-FLUID FRICTION CONTRIBUTES TO AERODYNAMIC DRAG, WHICH IS A RESISTANCE TO THE FORWARD MOTION OF A BODY THROUGH A FLUID (THE AIR). AS THE RACE CAR TRAVELS DOWN THE TRACK, IT MOVES THROUGH A FLUID. MOST PEOPLE DON'T THINK OF AIR AS A FLUID, BUT IT IS. WHILE IN MOTION, THE CAR'S SURFACE CONTACTS AIR MOLECULES. BECAUSE THERE IS RELATIVE MOTION BETWEEN THE CAR AND AIR MOLECULES (THE CAR IS IN MOTION WHILE THE AIR IS STATIONARY), FRICTION OCCURS. A WIND TUNNEL SIMULATES ROAD AIRFLOW CONDITIONS BY MOVING A STREAM OF AIR AROUND A STATIONARY CAR. BY USING A FOGGER IN A WIND TUNNEL WE CAN SEE TURBULENT AIR POCKETS (EDDIES) BEING FORMED AROUND THE CAR IF THERE IS FRICTION. HENCE WE TRIED BOTH VIRTUAL AND REAL WIND TUNNEL TESTING.



// SURFACE FRICTION - DEPENDING ON A CAR'S DESIGN, FRICTION MIGHT OCCUR BETWEEN EITHER THE WHEEL AND AXLE OR THE AXLE AND BODY MATERIAL. FRICTION ALSO OCCURS BETWEEN THE WHEEL AND THE TRACK SURFACE. WHEELS, HOWEVER, DO NOT PROPEL A CO_2 CAR, SO THE LESS WHEEL-ROAD SURFACE FRICTION, THE BETTER. WHILE FRICTION CAN BE REDUCED FOR BETTER PERFORMANCE, IT CANNOT BE TOTALLY ELIMINATED.

RESEARCH

RESEARCH ON FRONT WING AND BACK WING

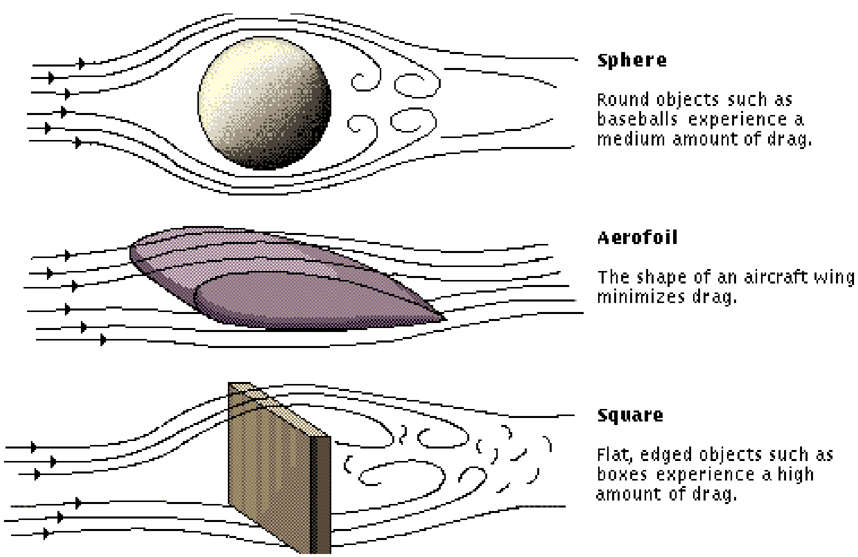
FROM OUR RESEARCH WE COULD INFER THAT F1 IN SCHOOLS CAR'S WINGS SHOULD NOT CREATE DOWN FORCE AS DOWN FORCE CREATES FRICTION AND THAT IS BAD FOR CO2 DRAGSTERS. THE WINGS SHOULD INSTEAD HELP IN AERODYNAMICS BY LETTING THE AIR FLOW OVER PARTS THAT AREN'T AS AERODYNAMIC SUCH AS THE WHEEL. ANOTHER USE OF THE FRONT WING IS TO PROVIDE STABILITY TO THE CAR. THE USE OF THE BACK WING IS THE STABILIZE THE CAR AND KEEP IN A STRAIGHT LINE.

RESEARCH ON BALL BEARING

WE KNEW THAT F1 IN SCHOOL CARS WERE 1:32 SCALED IN RELATION TO ACTUAL F1 CARS. THAT MEANS THAT ARE BALL BEARING NEEDED TO HAVE AN OD BETWEEN 5 TO 8MM. WE FOUND OUT THAT FOR OUR JOB CERAMIC OR HYBRID BEARINGS WOULD BE NEEDED.

RESEARCH ON BODY

WHAT IS AERODYNAMICS
AERODYNAMICS IS THE STUDY OF HOW GASES INTERACT WITH MOVING BODIES. BECAUSE THE GAS THAT WE ENCOUNTER MOST IS AIR, AERODYNAMICS IS PRIMARILY CONCERNED WITH THE FORCES OF DRAG AND LIFT, WHICH ARE CAUSED BY AIR PASSING OVER AND AROUND SOLID BODIES.
MR. KRISHNA KUMAR SUBRMANYAM, A AERODYNAMICIST WITH 40 YEAR'S EXPERIENCE EXPLAINS US THE AERODYNAMICS OF OBJECTS BY THESE SIMPLE DIAGRAMS



CHALLENGES AND OPPORTUNITIES:

- OPTIMIZE DRAG AREODYNAMIC
- IMPROVE WHEEL SYSTEM BALANCE
- CONFORM WITH COMPETITION RULES

CAR DEVELOPMENT

START WITH THE BASICS

WE BEGAN THIS COMPETITION BY MAKING A LIST OF ALL THE BASIC RULES AND THE BASIC PRINCIPALS OF DRAG FORCE (FD=1/2CV^2CDA). WITH THIS OUR NEXT MOTO WAS TO MINIMISE THIS AND BRING THEM ALL TOGETHER. SO WE STARTED WITH SOME SKETCHES. IT WAS IMPORTANT TO COME UP WITH SKETCHES BEFORE GOING ON TO THE CAD/CAM AS IT WOULD SAVE TIME AND EFFORT .
-ERROR FIXING WAS EASIER.

STUDIED AND UNDERSTOOD VARIOUS WAYS TO USE FUSION 360

I WATCHED A LOT OF VIDEOS TO UNDERSTAND VARIOUS WAYS OF USING FUSION 360. I LEARNT NEW AND INTERESTING WAYS TO MAKE ARE DESIGNS BETTER LIKE USING 4 T-SPLINE FACES INSTEAD OF 1 T- SPLINE, WHICH I HAVE USED IN DESIGNING MY CAR WHICH WOULD BE CLEARLY VISIBLE TO YOU.

SCALED DRAWINGS

// AFTER MAKING THE SKETCHES ,IT WAS IMPORTANT TO DRAW ' MADE TO SCALE' DRAWINGS OF THE CAR ON GRAPH PAPER.

// THE SKETCHES ARE NOT IN PROPER RATIO AND THUS MIGHT NOT COMPLY WITH THE TECHNICAL SPECIFICATIONS. 'MADE TO SCALE ' DRAWINGS CAN GIVE YOU A PROPER MEASUREMENT OF THE CAR DESIGN BEFORE WE START MAKING IT ON FUSION 360 (DESIGN SOFTWARE). IT IS EASIER TO RECTIFY MISTAKES ON THE GRAPH PAPER THAT THE SOFTWARE

BUILD WORKING PROTOTYPE

// THE FINAL STEP IN DEVELOPMENT WAS TO BUILD A WORKING PROTOTYPE OF OUR CAR.

// WE HAD TO TEST THE VARIOUS COMPONENTS OF THE CAR IN REAL LIFE. THE MANUFACTURING FEASIBILITY, STRENGTH , WEIGHT ETC. HAD TO BE ANALYZED AND CHANGES TO BE MADE ACCORDINGLY.

CHALLENGES AND OPPORTUNITIES:

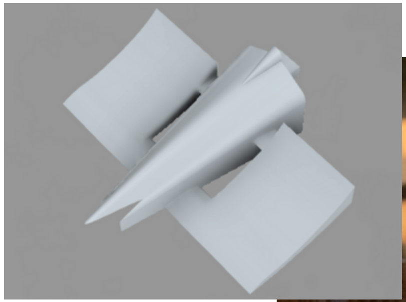
- START WITH THE BASICS
- INCREMENTAL CHANGES
- DEVELOP AND AND REFINE DESIGN

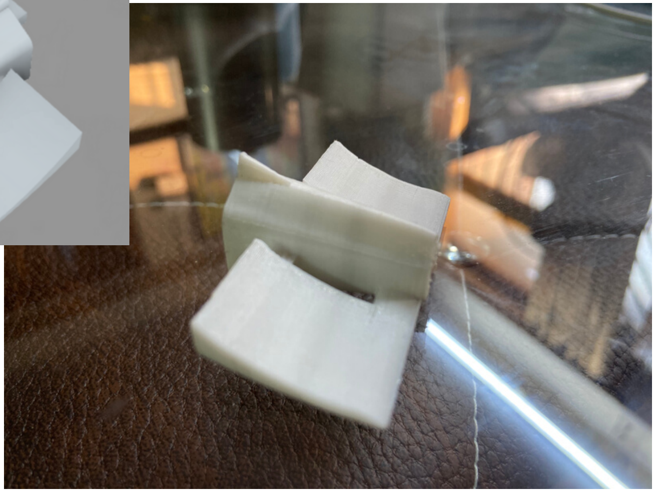
CAR COMPONENTS

OPTIMIZE DRAG AREODYNAMIC

FRONT AEROFOIL AND NOSE CONE

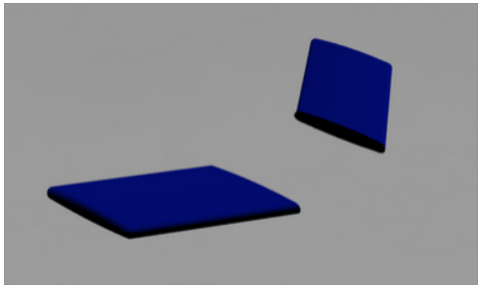
INSPIRED BY THE AEROFOILS ON A FORMULA 1 CAR, OUR FRONT WING WAS DESIGNED TO REFINED TO DIRECT IRFLOW OVER THE TOP OF THE FRONT WHEEL AND REDUCE THE CARS DRAG CO-EFFICIENT THE FRONT WING CAN ALSO GENERATE A LARGE AMOUNT OF DOWN FORCE OR LIFT, SO WE USED CFD ANALYSIS TO DETERMINE HOW TO NEUTRALISE THE EFFECT.





RARE AREOFOIL

THE TEAM USED MANY DIFFERENT COMBINATIONS OF AEROFOILS WITH MANY DIFFERENT ORITENTATIONS, SUCH AS DI-HEDRAL, ANA-HEDRAL, SWEPT BACK, SWEPT FORWARDS AND ALSO EXPERIMENTED WITH MANY DIFFERENT DRAG REDUCING DEVICES, SUCH AS WINGLETS, ENDPLATES, DIMPLES AND TUBULATORS.
IN THE END, THROUGHOUT ALL THE TESTING CONDUCTED BY THE TEAM, THE BEST RESULTS WERE GAINED THROUGH THE USE OF FLAT AEROFOILS, WITH A SLIGHT CHORD OF NACA 1023 ON THE FRONT AEROFOILS, NACA 1046 FOR THE REAR. THIS ALLOWED THE GREATEST ADHERANCE TO THE PARAMETRES DEFINED IN THE ORIGINAL CAR DESIGN AS POSSIBLE. ALTHOUGH LESS CONVENTIONAL DESIGN'S WERE DEVELOPED, THEY DID NOT ALWAYS FIT WITHIN THE PARAMETRES AND SHOWED DEGRADING PERFORMANCE THROUGHOUT BOTH VIRTUAL AND PHYSICAL TESTING, LEADING TO THE TEAM SCRAPPING THE CONCEPTS AND MOVING ON.



CHALLENGES AND OPPORTUNITIES:

- OPTIMIZE DRAG AREODYNAMIC
- MAINTAIN STRUCTURAL INTEGRITY
- CONFORM WITH COMPETITION RULES

EVALUATION

THROUGH TECHICALLY INSPIRED IDEAS WE OPTIMISED AERODYNAMICS AND MAINTAINED STRUCTURAL INTEGRITY IN ALL CAR COMPONENTS INCREMENTALLY IMPROVING THE PERFORMANCE OF OUR CAR.

CAR COMPONENTS

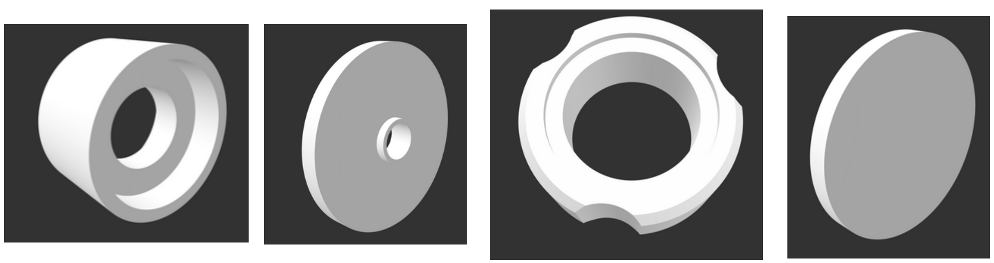
NEW WHEEL SYSTEM

LIGHTER WHEEL

WE WANTED OUR WHEELS TO BE SMALL AND LIGHT SO WE OPTED FOR THE 26MM OD WHEEL SIZE. WE PLANNED ON PUTTING IN A BEARING INTO THE WHEEL AS RTHUS WOULD HELP IMPROVE THE SPEED AND THE NUMBER OF REVOLUTIONS MADE BY THE WHEELS IN A GIVEN TIME FRAME.

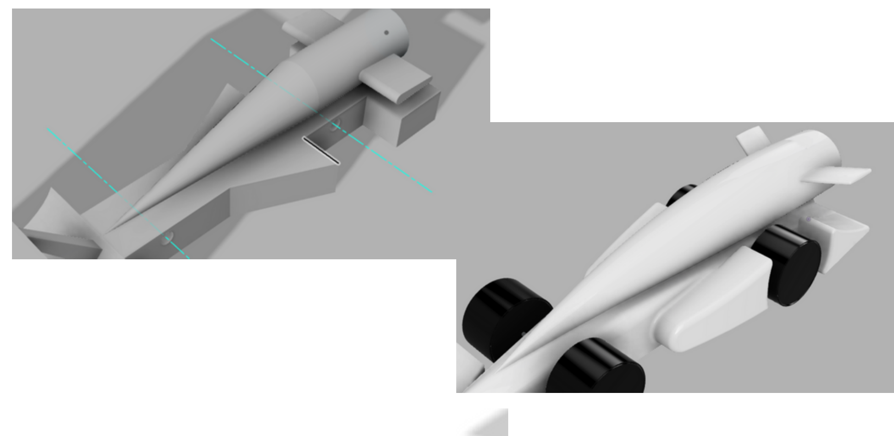
WE HAVE 6 COMPONENTS INDIDE A SINGLE WHEEL THIS ALSO MENT IT WOULD TAKE A LARGE AMOUNT OF OUR PRESENT BUDGET TO GET THESE PRINTED.

THE WHEEL CONSISTS OF INNER WHEEL COVER FOLLOWED BY A SMALL BEARING HOLDER COMPONENT THE THE MAIN OUTER SURFACE IN WHICH THE BEARING COMES IN AND FITS. THEN THIS IS FOLLOWED BY ANOTHER SMALL BEARING HOLDER COMPONENT AND FINALLY THE OUTER COVER.



MAIN BODY

WE STARTED DESIGNING THE MAIN BODY TO BE AS STREAMLINED AS POSSIBLE SO THAT IT WOULD CREATE A LOWER DRAG CO-EFFICIENT. WE STARTED WITH A BASIC DESIGN OF THE CAR BY CREATING A POINTED FRONT , WE JUST CREATED ONE SINGLE POINTED FRONT THAT MEANT THAT IT COULD BE PRONE TO DAMAGES. BUT THEN WE RECTIFIED THAT DESIGN AND MADE A MUCH MORE CURVED DESIGN THUS CREATINFG A SMOOTH SURFACE FOR THE AIR TO PASS BY THUS REDUCING THE DRAG CO-EFFIECENT.



CHALLENGES AND OPPORTUNITIES:

- OPTIMIZE DRAG AREODYNAMIC
- MAINTAIN STRUCTURAL INTEGRITY
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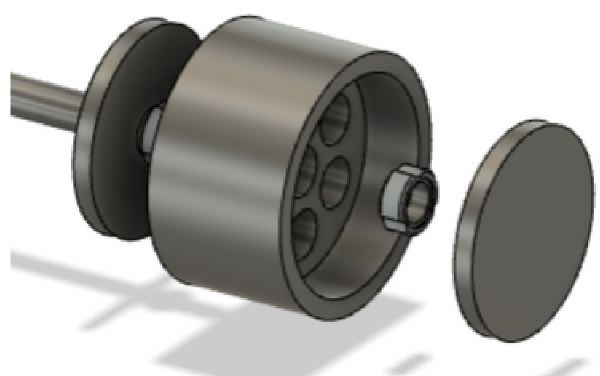


TESTING - VIRTUAL

ANALYSE THR CAR'S STRUCTURAL INTEGRITY

FINITE ELEMENT ANALYSIS (FEA)

FEA TESTE WERE CONDUCTED TO ASSESS THE STRENGTH OF VARIOUS CAR COMPONENTS FOR POTENTIAL WEAKNESSES. TO SIMULATE IMPACT FORCES, WE APPLIED 10 NEWTONS OF FORCE TO THE CAR COMPONENTS AND CONSIDERED THE STRESS IT PRODUCED. WHERE APPROPRIATE, THE IMPACT FORCES WERE APPLIED TO THR COMPONENTS AT VARIOUS ANGLES AND THE STRESSES ON THR COMPONENTS WERE COMPARED TO THE MATERIAL'S TENSILE STRENGHT.

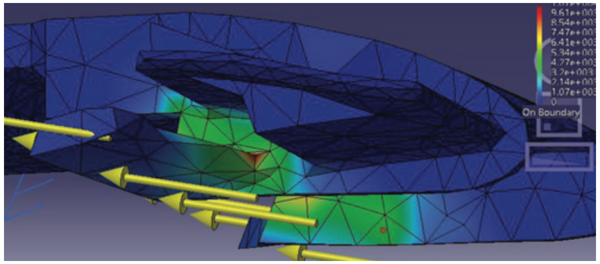
Material	Description	Tensile Strength
Balsa	Low Density	7.6 MPa
PLA PLastic	3D Printed	60 MPa
Acetal Plastic	Wheel Support	65 MPa

CHALLENGES AND OPPORTUNITIES:

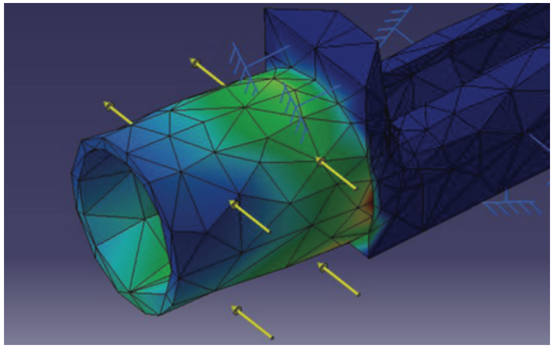
- ANALYSE THR CAR'S STRUCTURAL INTEGRITY
- CALCULATIONS TO INFORM DESIGN DEVELOPMENT AND MANUFACTURING

EVALUATION

VIRTUAL TESTING HAS ASSISTED US IN ANALYSING OUR CAR COMPONENTS FOR STRUCTURAL INTEGRITY AND CONFORMANCE WITH RULES. THROUGH THIS WE HAVE BEEN ABLE TO UNDERSTAND THE FACTORS IMPACTING THE CAR AND EVALUATE THEIR IMPACT



THE FRONT WING AND NOSE CONE MADE FROM 3D PRINTED PLASTIC SHOWED STRESS POINTS ON THE WING SUPPORT AND NOSE CONE FIN. THE STRESS LEVELS DIDN'T EXCEED THE ACCEPTABLE LEVELS FOR ABS PLASTIC



THE THICKNESS OF THE CANISTER HOUSING WAS ALSO TESTED AND WAS MAXIMISED TO IMPROVE CAR AERODYNAMICS.

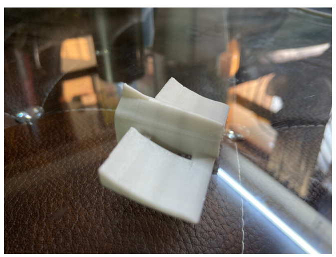
CAR MANUFACTURING

WEIGHT OF THE CNC CAR – 23 GMS

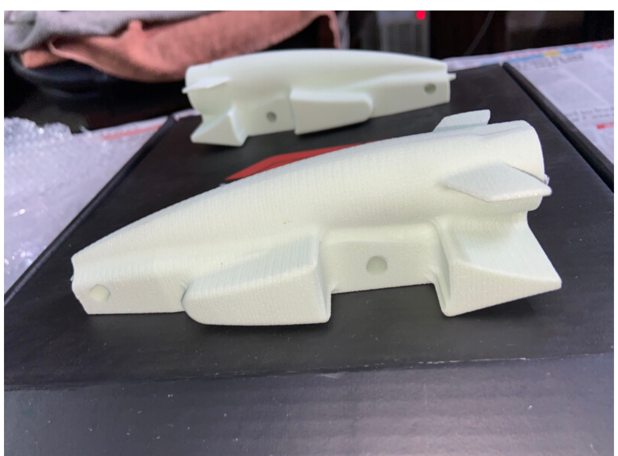
WEIGHT OF THE AXLE- 3.47 GMS X 2 = 7.88 GMS

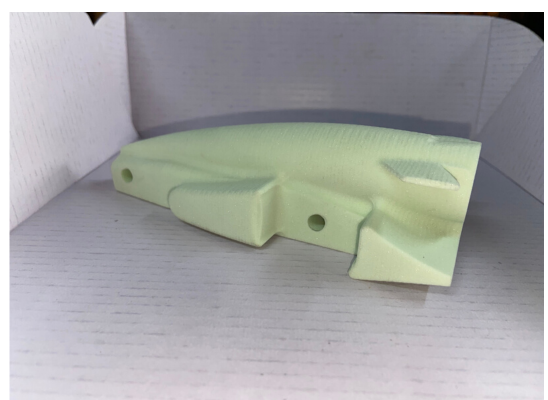
WEIGHT OF THE WHEELS (.......EACH) X 4 = 6 X 4 =10GMS

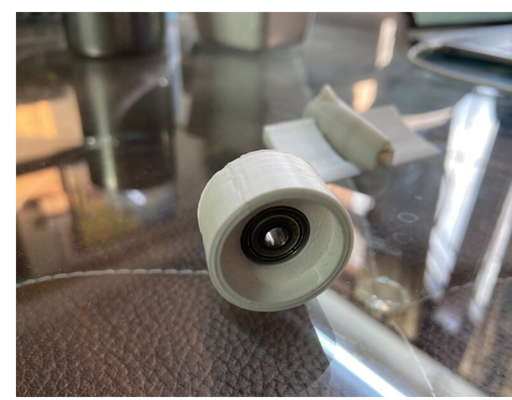
WEIGHT OF THE FRONT WING- 7GMS

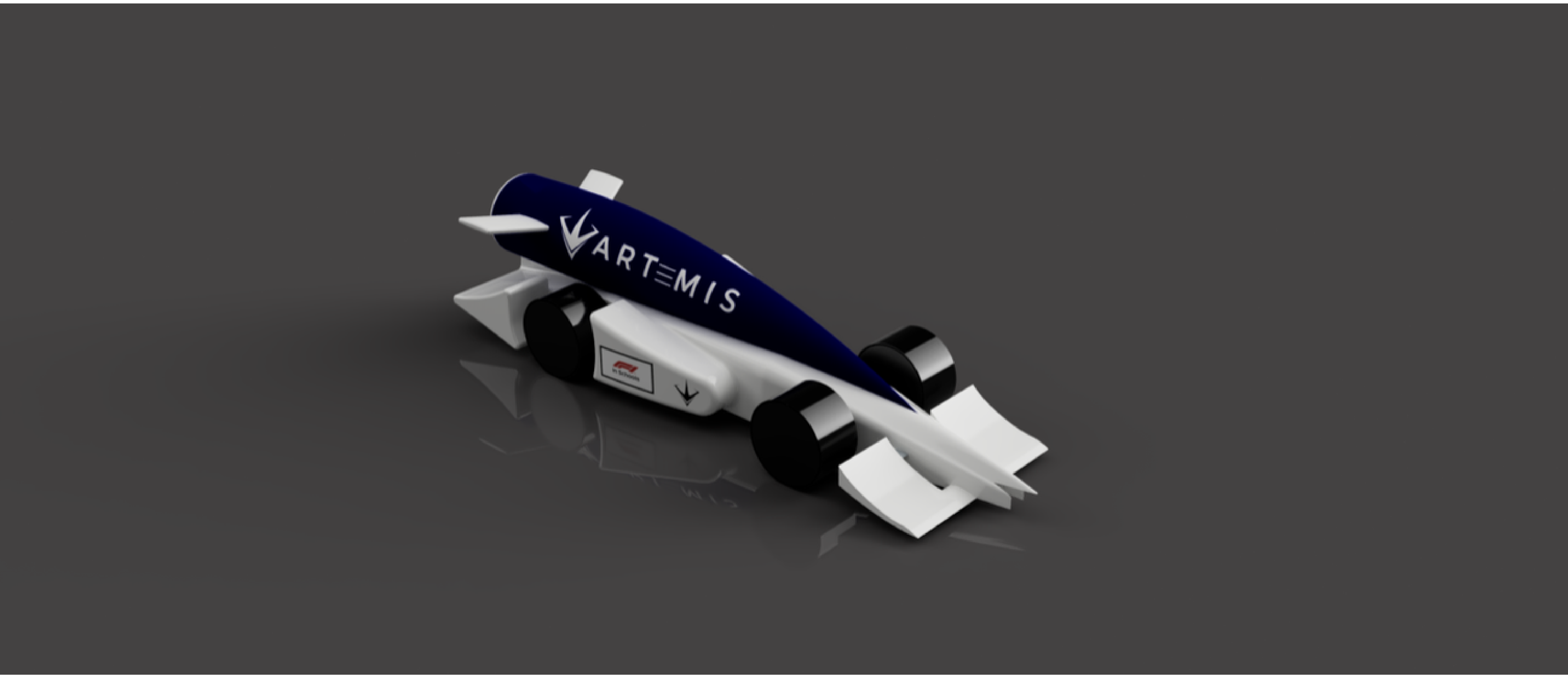


TOTAL WEIGHT
OF THE CAR – 61.88GMS(WITHOUT PAINT)





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