MECHANICAL DESIGN ENGINEERING PORTFOLIO

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Portfolio Contents

1. ABOUT ME

Like drumming or stargazing, good design is about patterns; some you make, some you discover.

I design mechanical things that mostly behave, don't fall apart under pressure or load, and occasionally make people say, "Hey, that's clever."

I am Soham, a MEng in Mechanical Engineering candidate at UBC, a Certified SolidWorks Professional (CSWP) and a mechanical design engineer in progress, learning how to make metal, math, and motion agree with each other. I have spent the last couple of years sketching, modeling, simulating, and occasionally begging SolidWorks not to crash. I believe great design is less about making perfect parts and more about asking the right questions, listening to constraints, and not being afraid to Ctrl+Z your way back to clarity.

This portfolio is a record of lessons, iterations, and a handful of moments when everything finally lined up. It grew from curiosity, late night geometry fixes, and an ongoing obsession with making things fit in both form and purpose.

2. WORK EXPERIENCE

NanoSniff Technologies Pvt. Ltd.

Designation ***Design & Manufacturing Associate***
Experience ***July 2021 – July 2023***

Role Overview

NanoSniff Technologies is a product-based R&D organisation focused on developing microsensors and actuators. Being the sole mechanical engineer in team, I was responsible for all the mechanical tasks including idea generation, sketching, 3D modelling, optimizing, prototyping and testing, and finally making field ready solutions. I have worked towards productization of various prototypes like automatic dispensing of micro volume drops of liquid, sampling devices to collect low vapor pressure substances in particle and gas phase, experimental setup for detecting water leaks in pipelines and experimental setup for generating low ppm gas compositions for sensor characterization.

Note: Images of individual projects for this particular experience is omitted due to NDA with the company.

NanoSniff Technologies Pvt. Ltd.

Project – Design of a prototype to dispense micro volume drops of liquid

Challenge –

- *The main challenge was to design a prototype that will accommodate a moving platform, a dispensing mechanism to hold, position, and operate a micro-pipette, and have a lightweight structure*
- *The dispensing mechanism was to designed in such a way that the dispensing height can be varied manually and dispensing occurs at a fixed inclined angle.*
- *Incorporate a microscope to monitor the whole dispensing area.*

Skills *– SolidWorks | GD&T | Technical Drawing | Tolerance Stack Up | DFM | DFA | Mechanism Design | Assembly | Technical Documentation | Vendor Communication | Product Development*

Note: Images of individual projects for this particular experience is omitted due to NDA with the company.

NanoSniff Technologies Pvt. Ltd.

Project – Design of a prototype to dispense micro volume drops of liquid

My approach *– I began by sketching out all the essential constraints to visualize how components needed to be positioned and mounted. Once a preliminary layout was ready, I utilized SolidWorks to initiate detailed modeling. Starting from the dimensions of the moving platform, I designed a base plate large enough to accommodate all required components. Using the fixed dispensing position of the micro-pipette as a reference, I developed a lead-screw mechanism that allowed manual adjustment of the dispensing height via a hand knob. Precise calculations were performed to determine the optimal diameter, pitch, and height for the screw. Subsequently, I designed and selected appropriate guideways and actuators to achieve micron-level accuracy in positioning the micro-pipette. To reduce the overall weight of the machine, I incorporated SLS 3D-printed parts while using aluminum components to maintain structural integrity.*

Note: Images of individual projects for this particular experience is omitted due to NDA with the company.

NanoSniff Technologies Pvt. Ltd.

Project – Design and development of a sampling device to collect low vapor pressure substances in particle phase

Challenge –

- *The main challenge was to design a prototype that will collect low vapor pressure particles at a targeted location on a sampling paper.*
- *The sampling paper should remain as straight as possible and should avoid sharp bends as that will damage sensitive sensors.*
- *The handheld sampler should be ergonomic; the sampler insertion and removal should be effortless and reduce operator fatigue during testing.*

Skills – *SolidWorks | Ideation | GD&T | Technical Drawing | Tolerance Stack Up | DFM | DFA | Mechanism Design | Assembly | Vendor Communication | Product Development*

Note: Images of individual projects for this particular experience is omitted due to NDA with the company.

NanoSniff Technologies Pvt. Ltd.

Project – Design and development of a sampling device to collect low vapor pressure substances in particle phase

My approach – *My approach began with sketching the handheld sampler, focusing on the insertion, removal, and function of the sampling paper during collection. After presenting the concept to senior engineers, we refined the design through a collaborative brainstorming session. I then modeled the concept in SolidWorks and fabricated the first prototype using SLS 3D printing. This initial version revealed issues like excessive paper bending than expected and a cumbersome removal process. To resolve these, I used ANSYS Explicit Dynamics to simulate paper bending behavior, guiding key design changes. I also integrated a spring-return mechanism with a finger slider to simplify paper removal and reduce user fatigue. This design also had guideways which will aid the operator in paper insertion and ensuring accurate positioning before the particles are collected. Precise calculations were made for spring stiffness, wire diameter, and coil geometry to ensure reliability and comfort. After three focused iterations, the final prototype performed effectively, offering improved usability and accurate particle collection in field conditions.*

Note: Images of individual projects for this particular experience is omitted due to NDA with the company.

NanoSniff Technologies Pvt. Ltd.

Project – Design and development of a sampling device to collect low vapor pressure substances in vapor/gas phase

Challenge –

- *The main challenge was to design a prototype that will collect low vapor pressure particles in gas phase on a sampling paper*
- *Optimise the heating angle of the heaters to maximize the heat generation and formation of vapors.*
- *Integrate the collection attachment to an ergonomic light-weight handheld device that will house the batteries, pump, and electronic circuitry.*

Skills *– SolidWorks | Conceptual Design | GD&T | Technical Drawing | Tolerance Stack Up | DFM | DFA | Assembly | Vendor Communication | Product Development*

Note: Images of individual projects for this particular experience is omitted due to NDA with the company.

NanoSniff Technologies Pvt. Ltd.

Project – Design and development of a sampling device to collect low vapor pressure substances in vapor/gas phase

My approach – *For this project, I began by analyzing the datasheet of the heating source to calculate the distance at which maximum heat generation occurs. Using this as a design constraint, I created initial sketches to mount the heating sources at an angle that maintains this optimal distance. In the first SolidWorks iteration, I incorporated a mechanism that allowed the heating source angle to be adjusted in 10-degree increments. This gave the test team flexibility to experiment and determine the most effective angle. The overall form of the initial hand-held device was inspired by a hand drill for ease of use. But it was observed to be not ergonomic while sampling, thus the entire form was revamped into a unique design. The vapor collection attachment went through five iterative refinements based on testing feedback and observed limitations of each previous version. The final design generated sufficient heat and effectively captured vapors, while its balanced weight distribution allowed for comfortable use; even on inclined surfaces. The result was a compact and efficient hand-held device tailored for field use.*

Note: Images of individual projects for this particular experience is omitted due to NDA with the company.

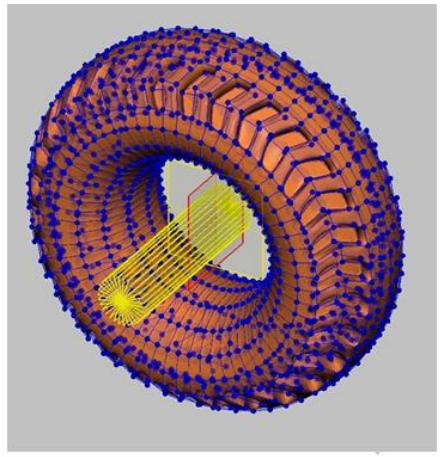
NanoSniff Technologies Pvt. Ltd.

Key Learnings

- ***Fail fast, fix smart:*** *Iteration isn't rework — it's refinement with purpose.*
- ***Simulation is a superpower:*** *Predicting behavior saved time, cost, and guesswork*
- ***Fit matters — literally:*** *Understanding GD&T made me design with intent, not just dimensions*
- ***Collaboration amplifies design:*** *The best ideas came from open minds, not just open models*
- ***Systems thinking wins:*** *Designing components is good. Designing how they work together is better.*

Note: Images of individual projects for this particular experience is omitted due to NDA with the company.

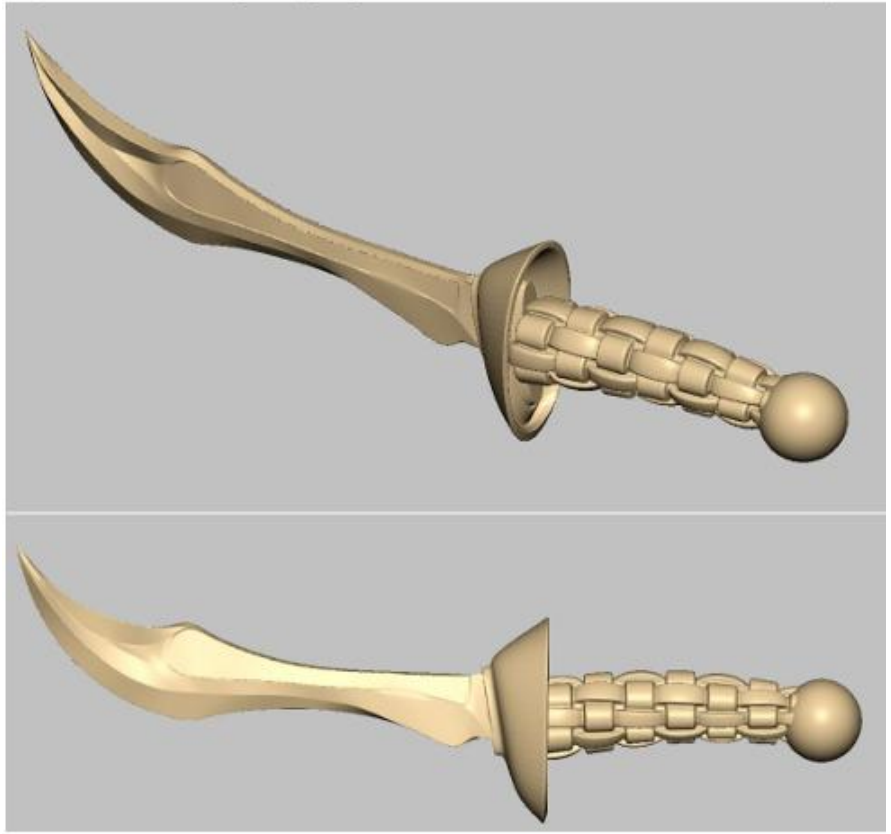
Solid Vision



Designation ***Trainee***
Experience ***December 2016 – June 2017***

Role Overview

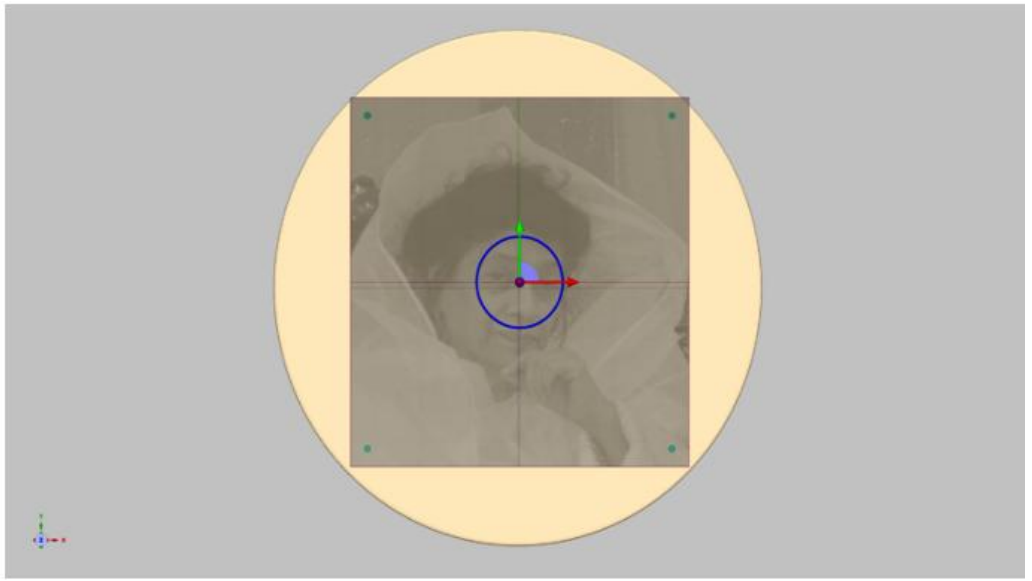
Solid Vision is a reverse engineering company that provides services in engineering design and inspection using 3D scanning and 3D printing techniques. I was working with the design department where my main tasks were to design moulds of freeform parts using 3D scanners like HP David Laser 3D Scanner and Sense 3D Scanner, using image based freeform modelling, and maintaining and operating FDM based 3D printers



Solid Vision

Project – Design of a coin embossing punch using FreeForm Plus

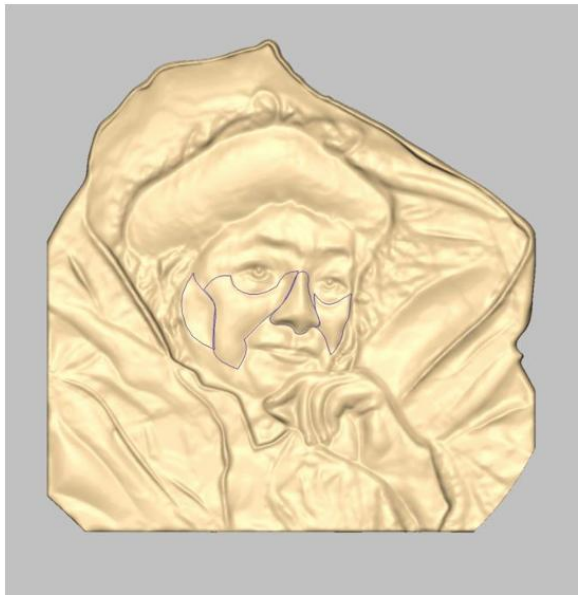
- *The main intent of this project was to design a coin embossing punch using an image of a spiritual figure.*
- *The customer wanted an ultra realistic embossing die with all human features.*
- *The embossing die was to be used to produce silver coins which were to be distributed as a part of the spiritual figure's 100th birth anniversary.*
- *I utilised the image embossing feature in FreeForm Plus and started building the actual coin model first.*

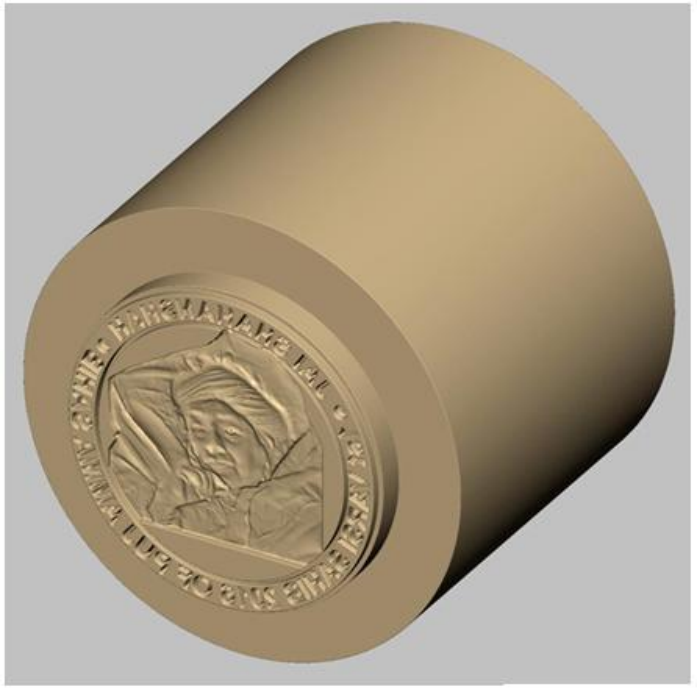


Solid Vision

Project – Design of a coin embossing punch using FreeForm Plus

- *Then with the basic structure ready, I started working on the various human features like eyes, nose, hair, and hands.*
- *With the advanced smoothing features in the software and by using various in-built sculpting tools I designed the final product – coin.*
- *Now to produce the die, I made use of Boolean operations in design, notably the subtract operation, to produce the final die.*

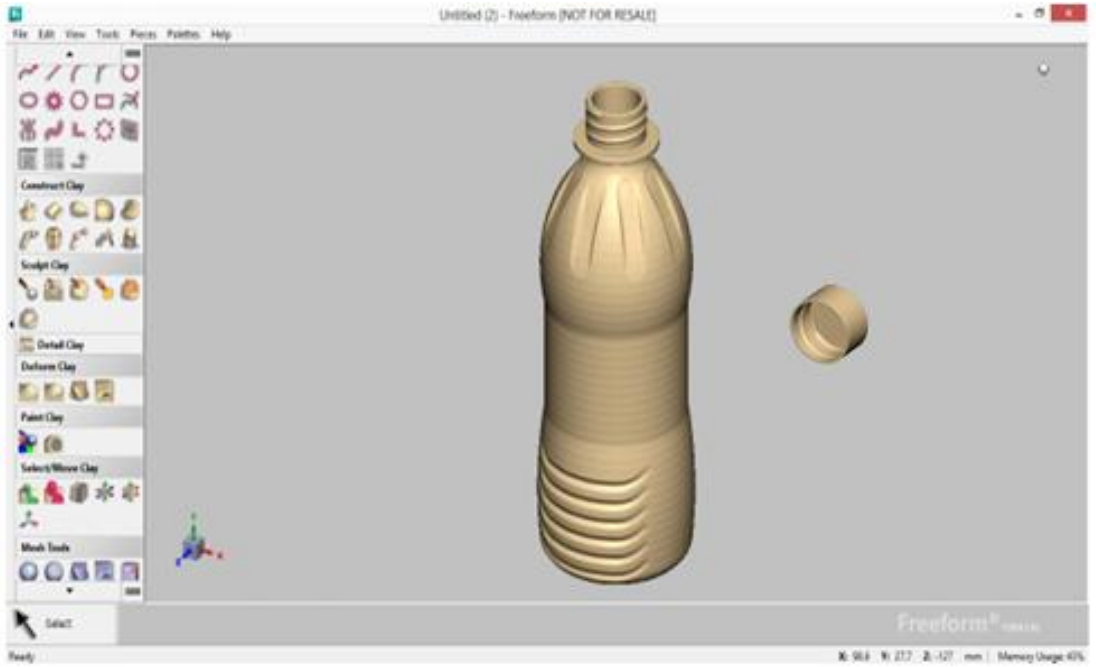


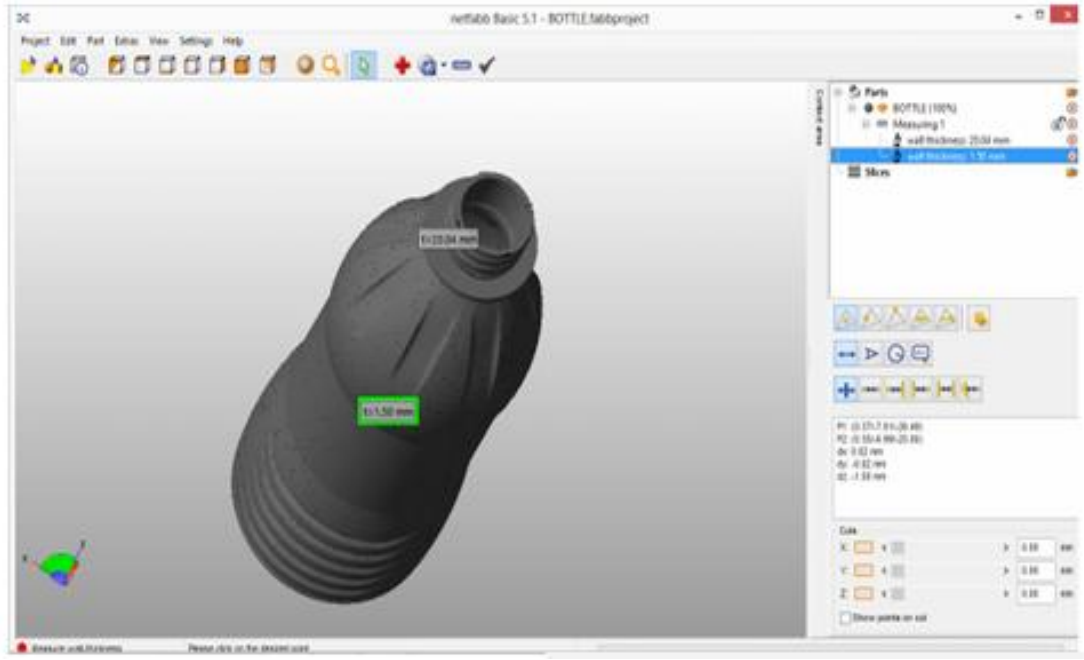


Solid Vision

Project – Design & 3D printing a water bottle

- *This project was for a prominent bottled water manufacturer in India.*
- *The customer wanted to change their original bottle design.*
- *Using FreeForm Plus, I designed 50 various design iterations from scratch, with each design being unique. I covered various themes like artistic, simple, and sporty design.*
- *With a simplistic design finalized by the customer, they wanted to test the ergonomics of the bottle.*

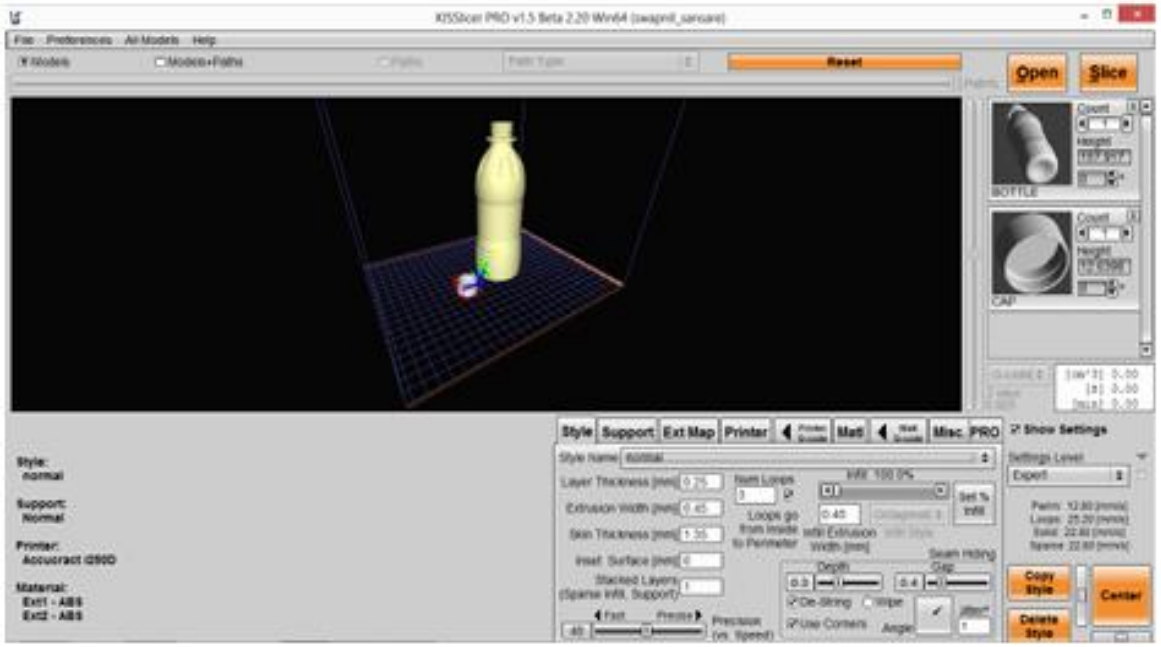


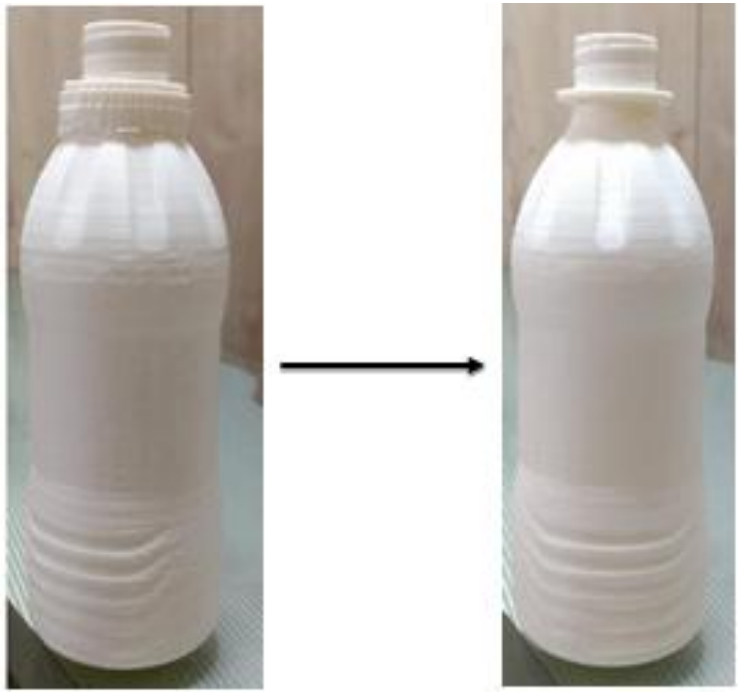


Solid Vision

Project – Design & 3D printing a water bottle

- *I made use of in-house FDM 3D printer (Accucraft i250+).*
- *This involved setting up the geometry in the slicing software, ensuring the wall thickness was adequate for printing, and setting up print parameters like infill percentage, infill structure etc.*
- *Then the slicing software was run to generate G-Codes which were then loaded in the printer*
- *I then diligently monitored the printing process and then carried post processing task like removing support structures, filing and sanding to give the prototype a pleasing look.*





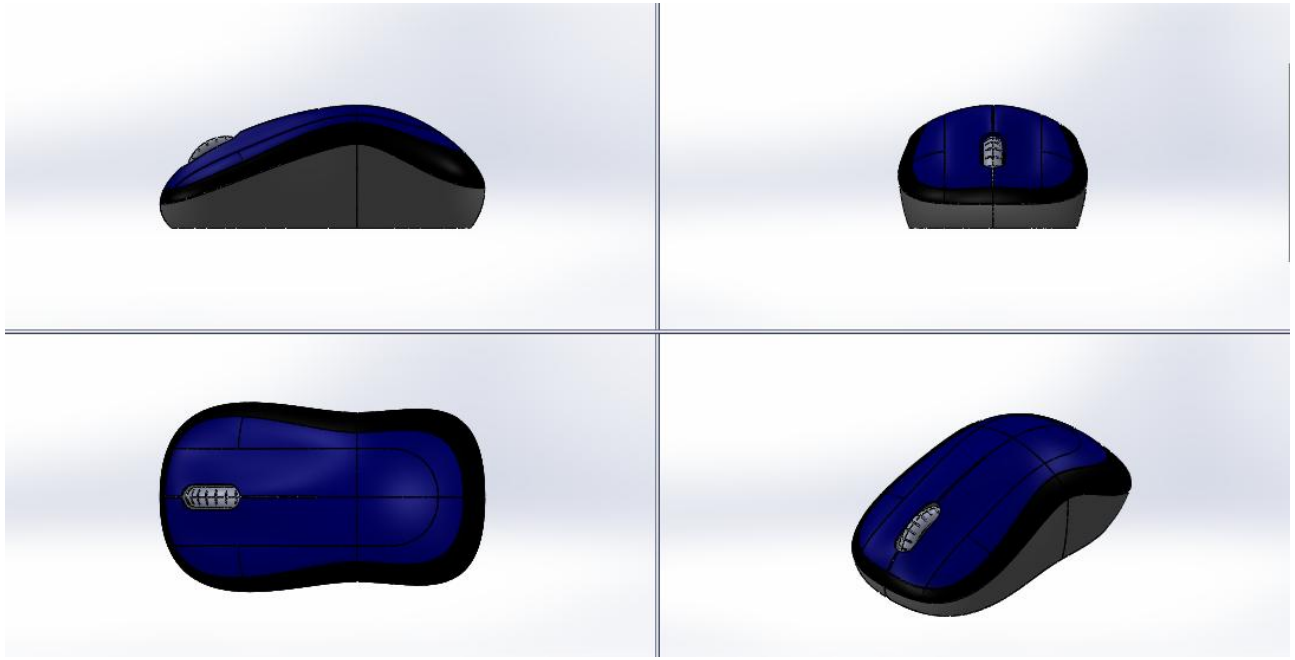
3. ACADEMIC PROJECTS

Design for Manufacturing – Ergonomic Mouse

University of British Columbia | January 2024 - April 2024

Project Overview

- *The project was done as a part of MANF 516 – Advanced Manufacturing course during my Master of Engineering program at UBC*
- *While the form of the modern mouse is already refined for comfort, the main aim of this project was how to manufacture the mouse accurately and efficiently.*
- *This involved taking an existing ergonomic design and make it manufacture-ready by using best GD&T practices and design for injection molding*

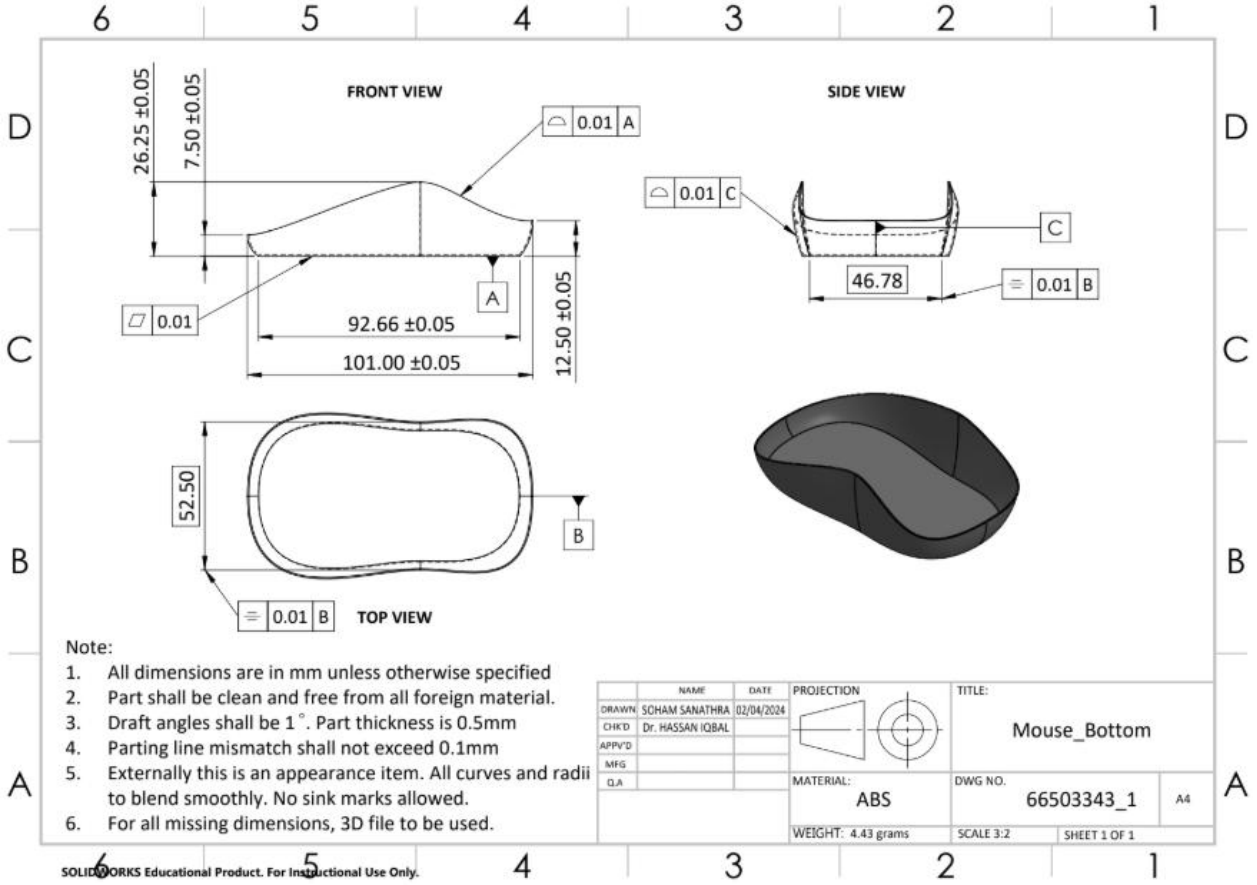


Design for Manufacturing – Ergonomic Mouse

University of British Columbia | January 2024 - April 2024

Approach to modeling

- *I started by modeling an existing design of mouse in SolidWorks.*
- *The design was made from an existing sketch and by taking dimensions from commercially available mouse.*
- *This includes main components like top and bottom housing, the scroll wheel and the lip.*
- *For the modeling, I made use of advanced surfacing tools in SolidWorks and designed accurate lip and groove features for mating surfaces.*

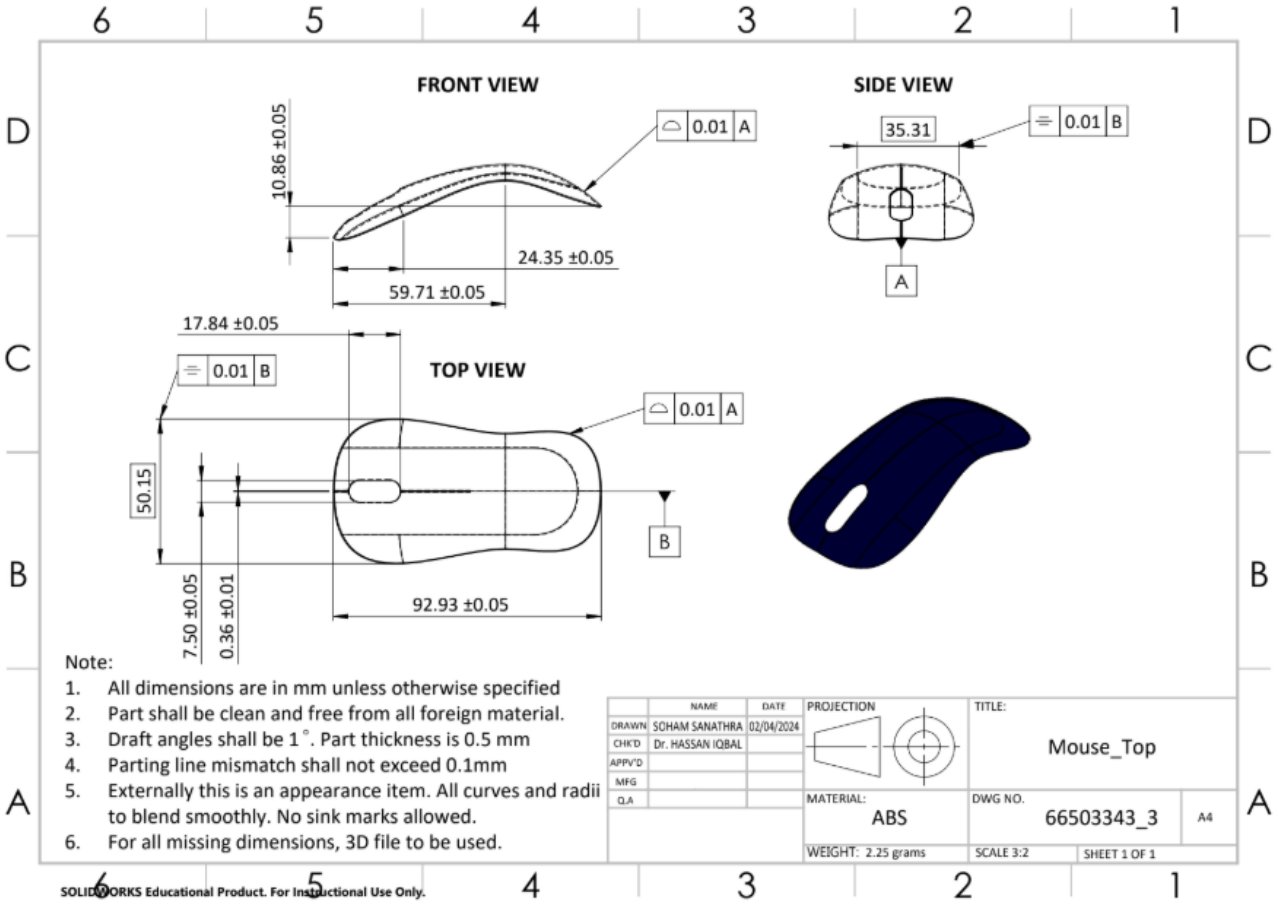


Design for Manufacturing – Ergonomic Mouse

University of British Columbia | January 2024 - April 2024

Technical Drawing Package

- *Once the design was complete, I produced thorough drawing packages for manufacturing.*
- *I applied GD&T principles that I learnt during the course to all critical features like mating surfaces, snap-fit joints, and alignment bosses.*
- *I introduced various datum planes and control feature locations, flatness, parallelism, and profile within ±0.05 mm tolerances*

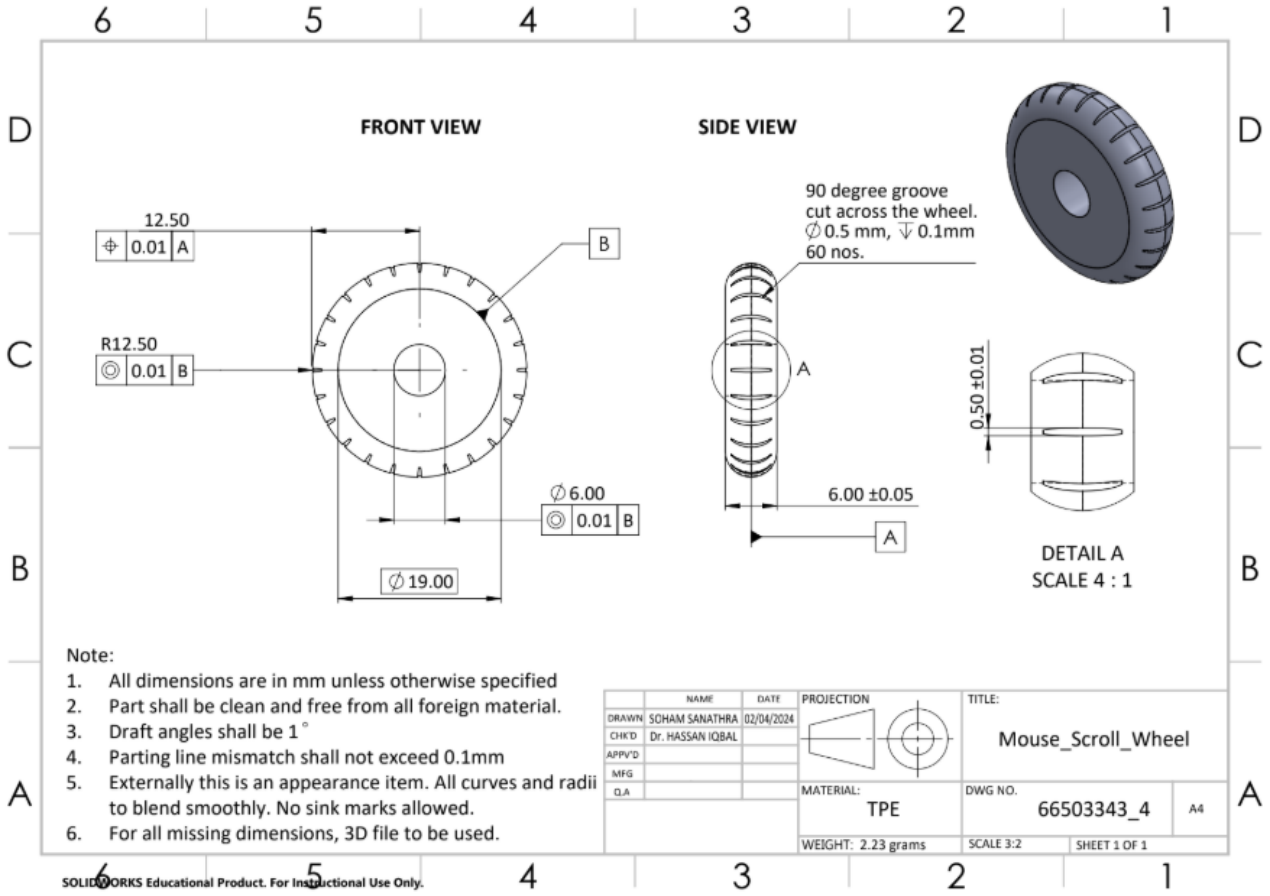


Design for Manufacturing – Ergonomic Mouse

University of British Columbia | January 2024 - April 2024

Technical Drawing Package

- *In the drawing packages, I included all the manufacturing related information like the surface finish required, maximum draft angle, and accepted parting line mismatch.*
- *The material for each of the part is also stated, along with weight and the type of projection used.*



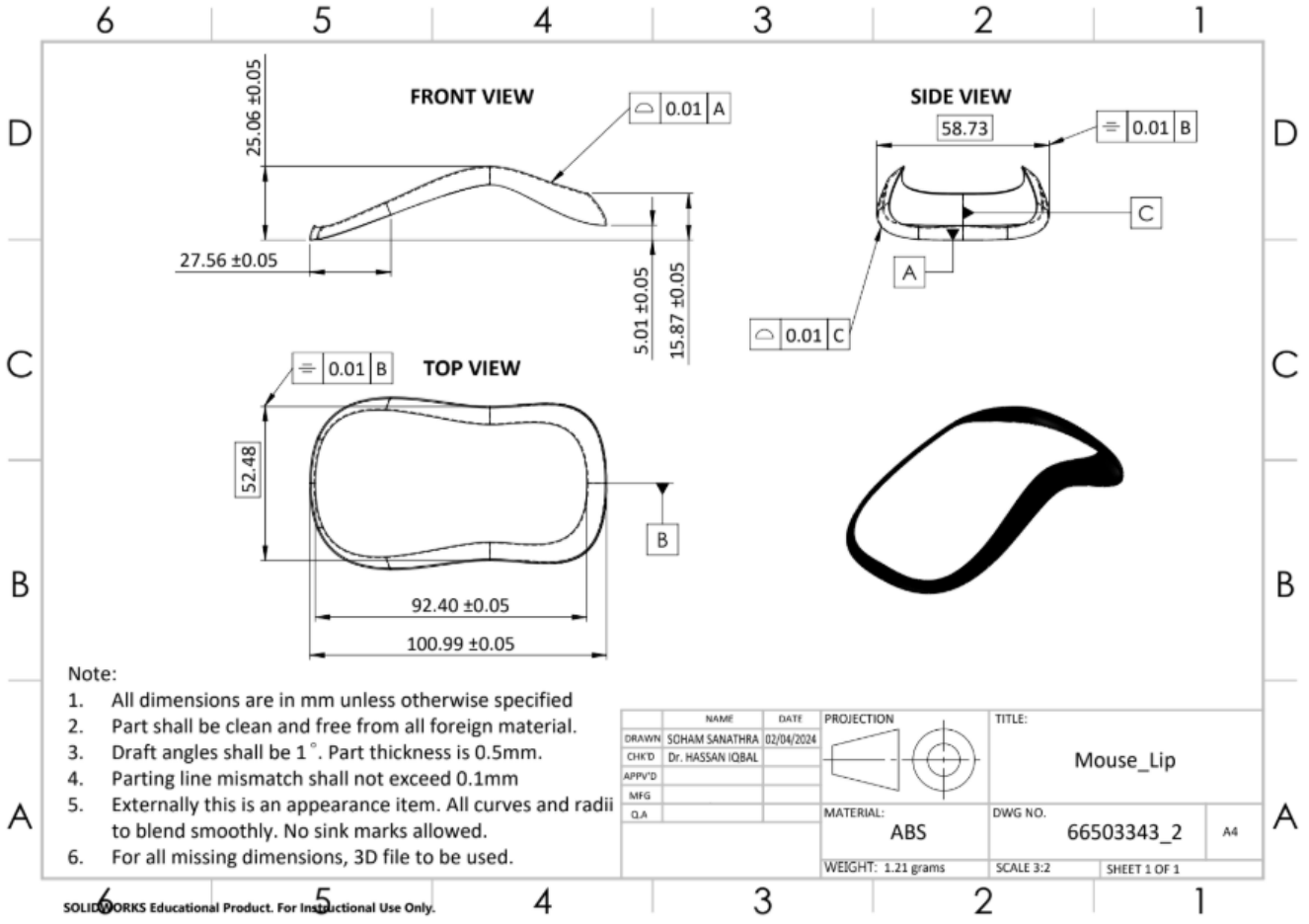
Design for Manufacturing – Ergonomic Mouse

University of British Columbia | January 2024 - April 2024

Outcome

- *This project sharpened my understanding of how precision, communication, and manufacturing constraints intersect in real world product development.*
- *It also taught me that design is only as good as its ability to be built – accurately, repeatably, and economically*

***Skills** – SolidWorks | GD&T | Technical Drawing | Tolerance Stack Up | DFM | DFA*

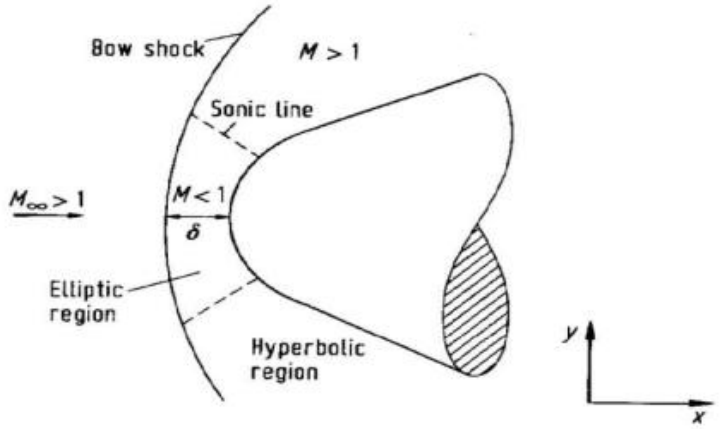


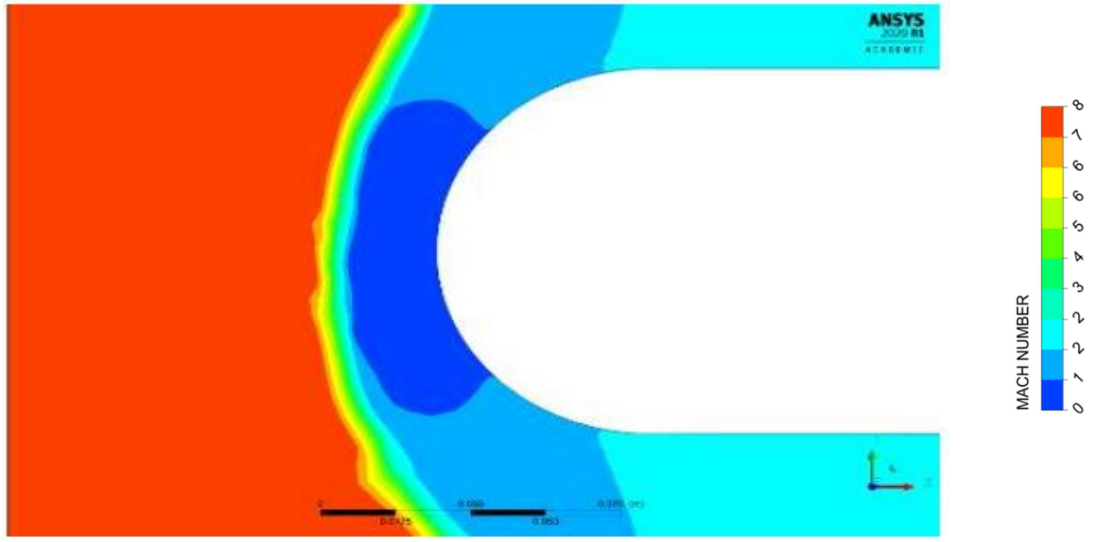
Estimation of shock standoff distance using CFD

University of Mumbai | September 2019 - September 2020

Project Overview

- *This capstone project was completed as a part of my bachelor's studies in mechanical engineering.*
- *The main aim of this project was to use ANSYS Fluent to calculate the standoff distance and then validate its results with the standard empirical correlations by Billig, Sieff and Lobb.*
- *The standoff distance greatly influences the design of hypersonic blunt bodies like space re entry vehicles, missiles, and supersonic commercial airlines.*



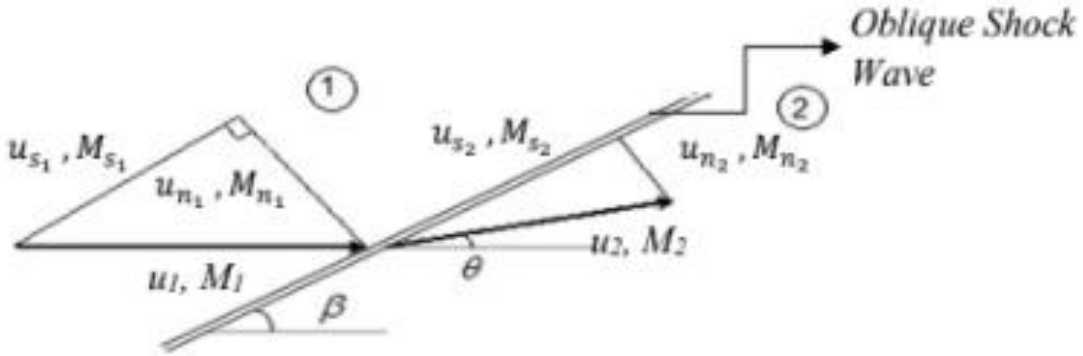


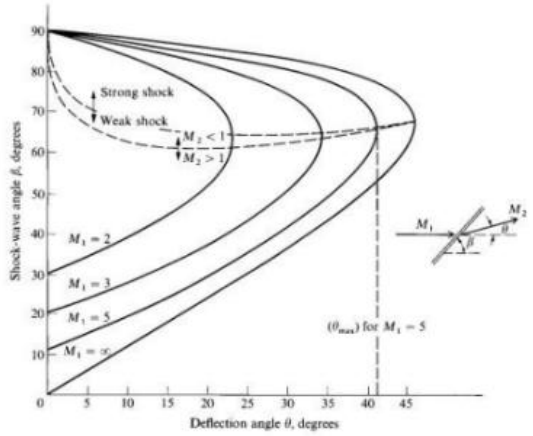
Estimation of shock standoff distance using CFD

University of Mumbai | September 2019 - September 2020

Setting up the base case

- *I and my team first started by formulating the governing equations of the blunt body aerodynamics.*
- *These equations will be used to find the analytical downstream Mach number after the shock wave and compared to the Mach number as calculated by ANSYS simulations.*
- *I referred standard literature books on Gas Dynamics to formulate the equations and enrolled in an online course on Gas Dynamics provided by Indian Institute of Technology (IIT) Madras.*





Note: The images are taken from the report submitted as a part of the project

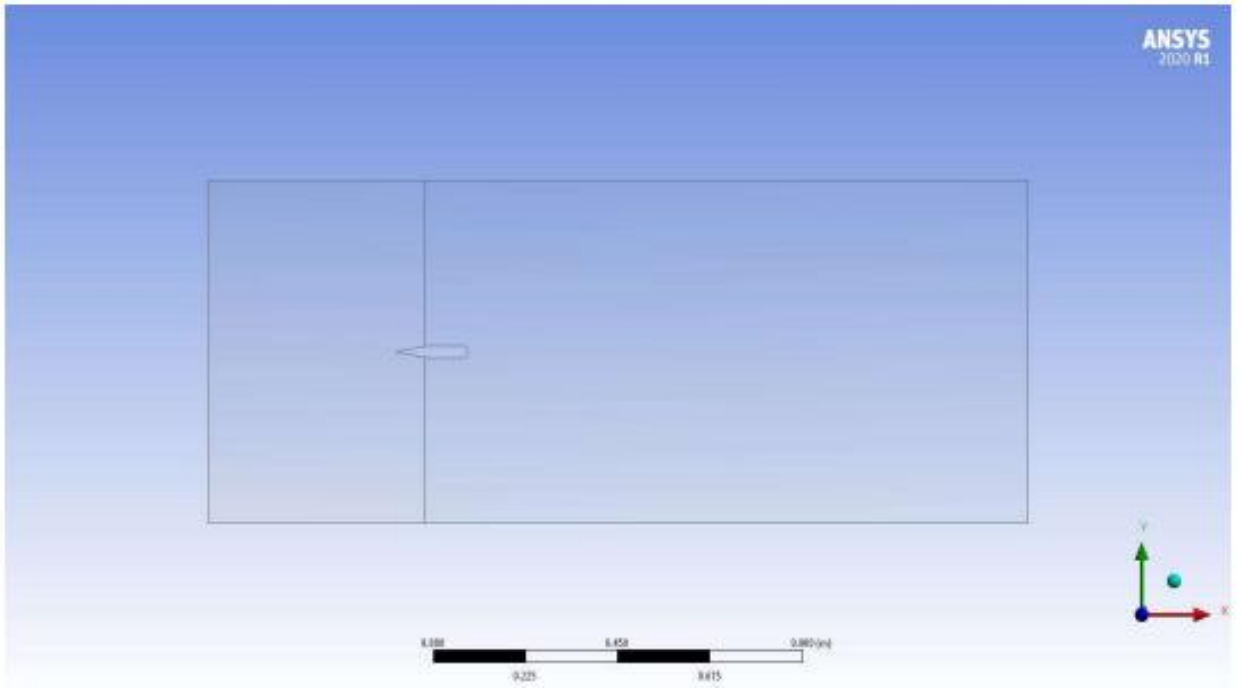
$$\tan\theta = \frac{2\cot\beta\left[M_1^2\sin^2\beta - 1\right]}{2 + M_1^2\left[\gamma + \cos^2\beta\right]} \qquad 3.30$$

Estimation of shock standoff distance using CFD

University of Mumbai | September 2019 - September 2020

Setting up the base case

- *Once the equations were formulated, we then referred ANSYS handbook and standard reference books in CFD solvers to select the most appropriate CFD solvers for our analysis.*
- *We then proceeded to model a 2D surface of the blunt body in ANSYS Design Modeler. This was the base case, wherein we demonstrated the efficacy of the CFD solvers selected for an oblique shock wave scenario.*

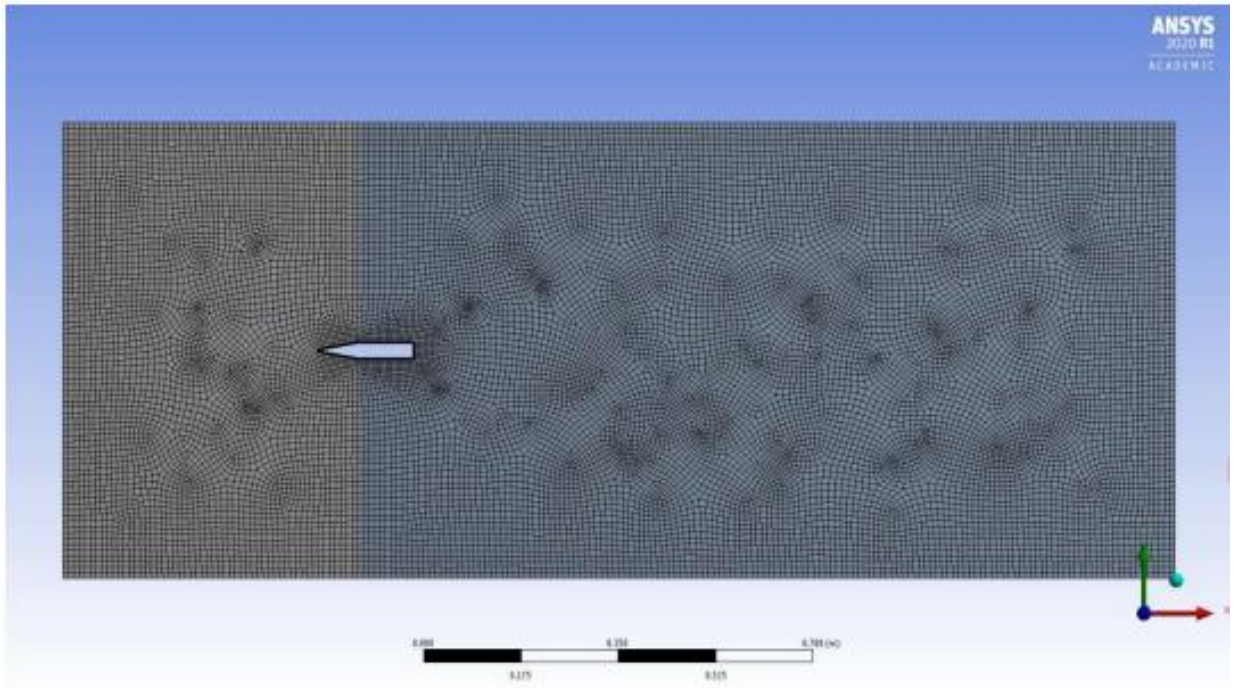


Estimation of shock standoff distance using CFD

University of Mumbai | September 2019 - September 2020

Setting up the base case

- *The 2D surface comprised of 2 regions, the actual blunt body and the farfield. The blunt body was removed from the farfield leaving a hollow structure.*
- *The next step was to convert the surface into a fine mesh. To accurately capture the boundary layer formation, the mesh at the boundary was ultra fine with 5 layers and then the mesh was uniform after it.*

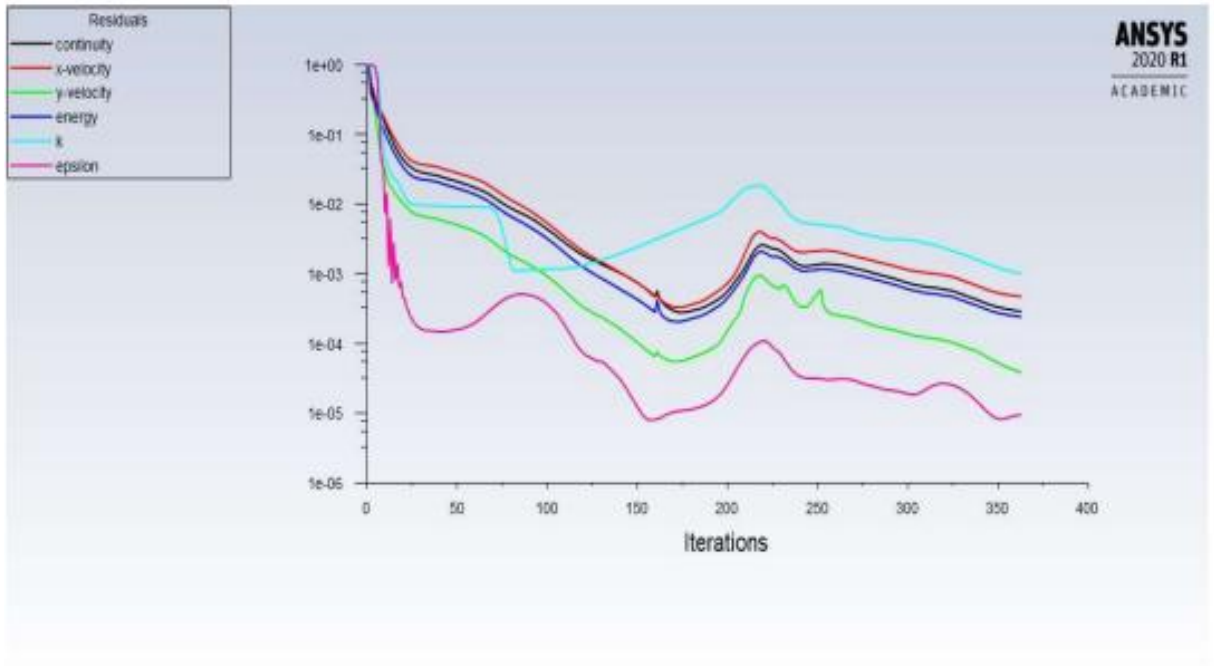


Estimation of shock standoff distance using CFD

University of Mumbai | September 2019 - September 2020

Setting up the base case

- *We demonstrated the simulation in standard atmospheric conditions. To view how the solver converges we set up a Convergence history plot and a residual plot.*
- *The limits of the residue was* 10^{-6} *which was way below the standard assumption thus proving the efficacy of our chosen solvers.*
- *We then ran the solver till convergence and then compared the downstream Mach number with the standard analytical solution that we developed.*

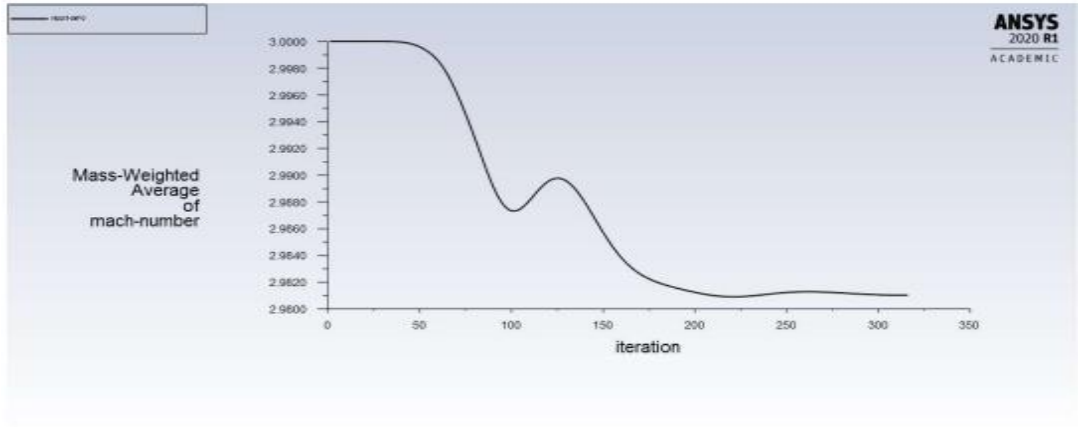


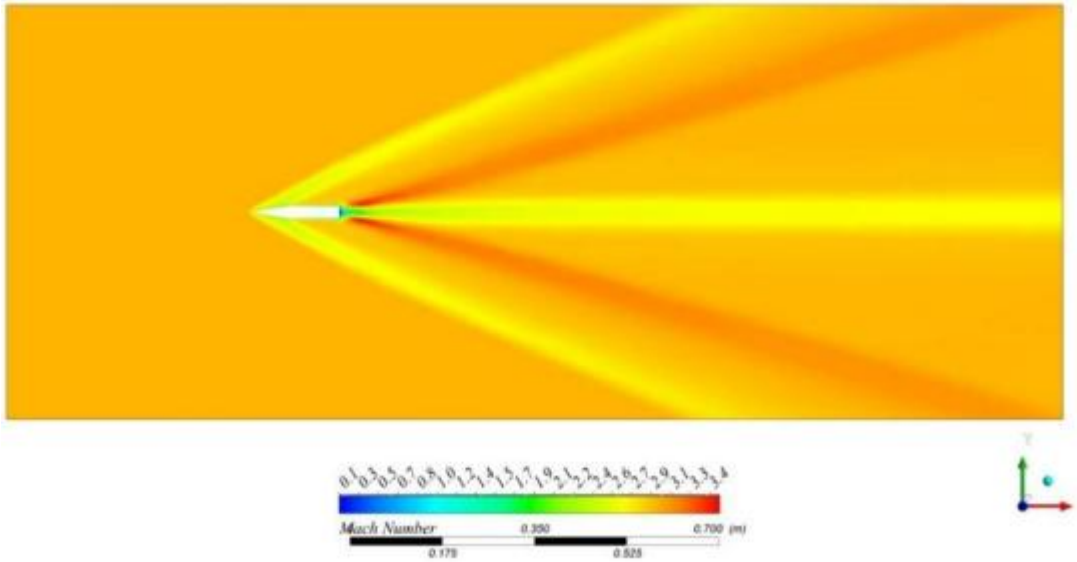
Estimation of shock standoff distance using CFD

University of Mumbai | September 2019 - September 2020

Result

Wedge angle (in degrees)	M_2 Analytical	M_2 Ansys	Error %	Mach Number
10	2.504998	2.47	-1.39716	3
15	2.254902	2.23019	-1.09594	3
20	1.994150	2.0010431	-0.346	3
25	1.71725	1.654038	-3.68	3
30	1.405950	1.834038	30.45	3
35	Detached	Detached	Detached	3
40	Detached	Detached	Detached	3
45	Detached	Detached	Detached	3
50	Detached	Detached	Detached	3



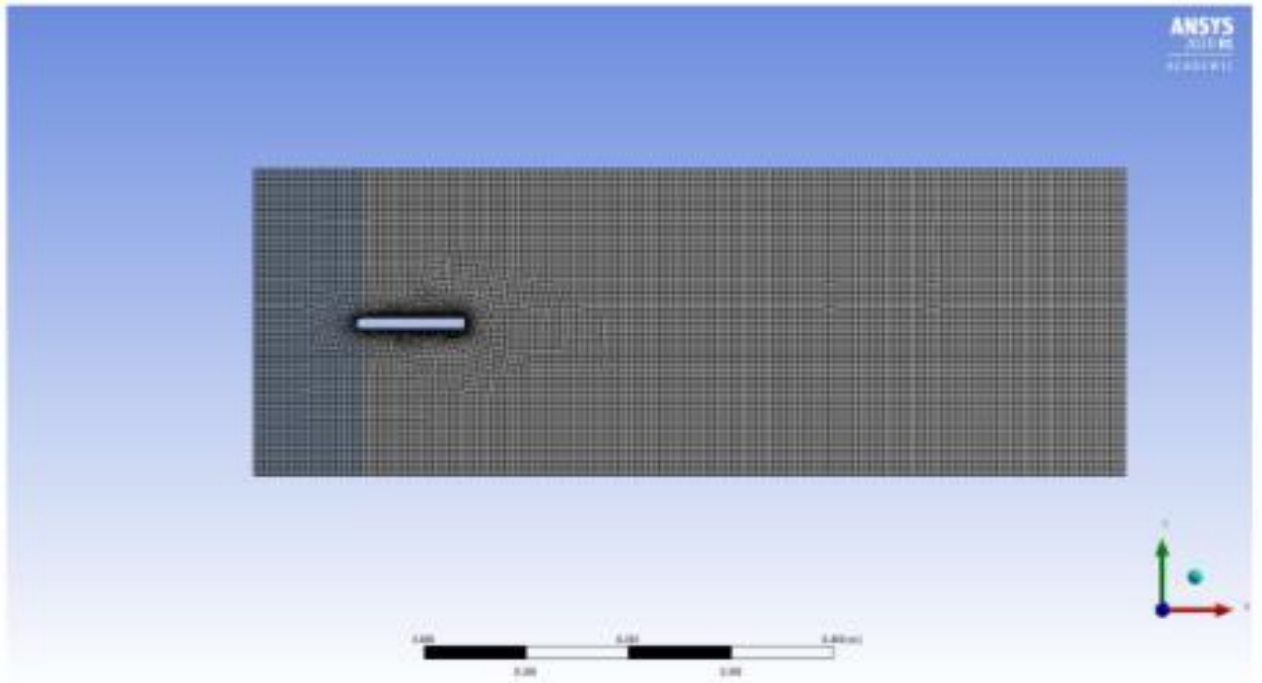


Estimation of shock standoff distance using CFD

University of Mumbai | September 2019 - September 2020

Setting up the actual case

- *Following the successful demonstration of our chosen solvers, we then ran simulations on blunt body with radius ranging from 5 mm to 50mm and Mach numbers varying from 2 to 8, for both planar and axisymmetric flows*
- *All the parameters were same except the type of the transport model. We found that Advection Upstream Splitting Scheme (AUSM) to be more robust for Mach numbers >5.*

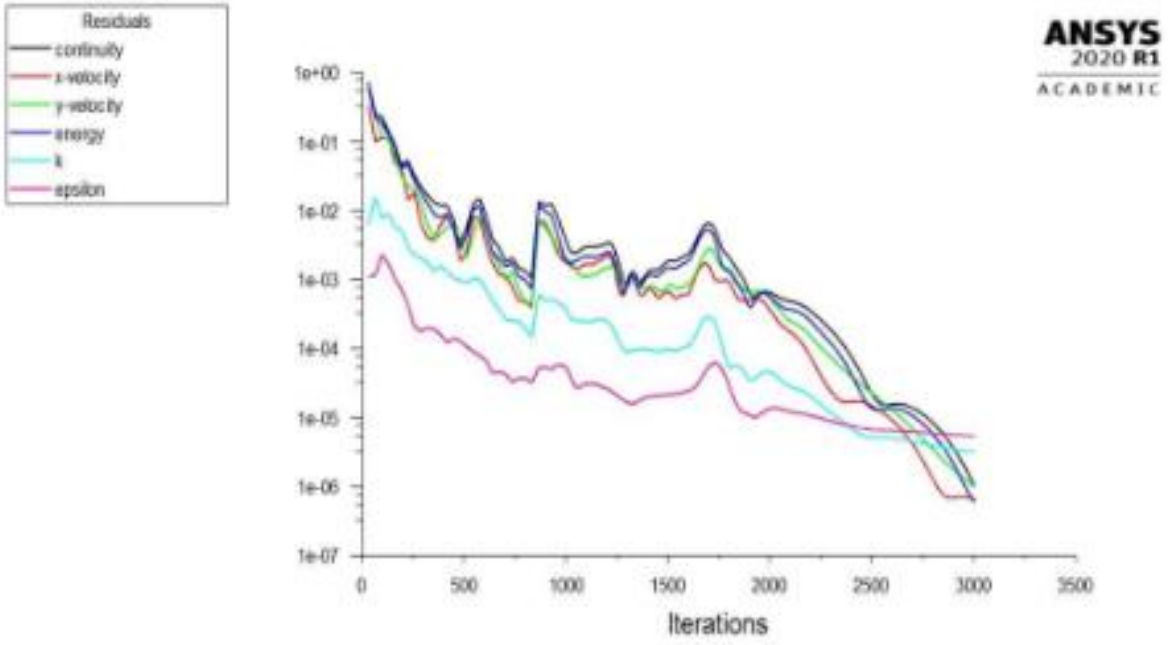


Estimation of shock standoff distance using CFD

University of Mumbai | September 2019 - September 2020

Result Analysis

- *Now, to calculate the standoff distance, I and my group faced a difficulty as none of the outputs directly gave that result.*
- *Thus, I came up with a unique solution. The standoff distance starts from the point where Mach number becomes zero till the nose surface. Thus, instead of viewing the results as contour bands, I converted them to contour lines.*

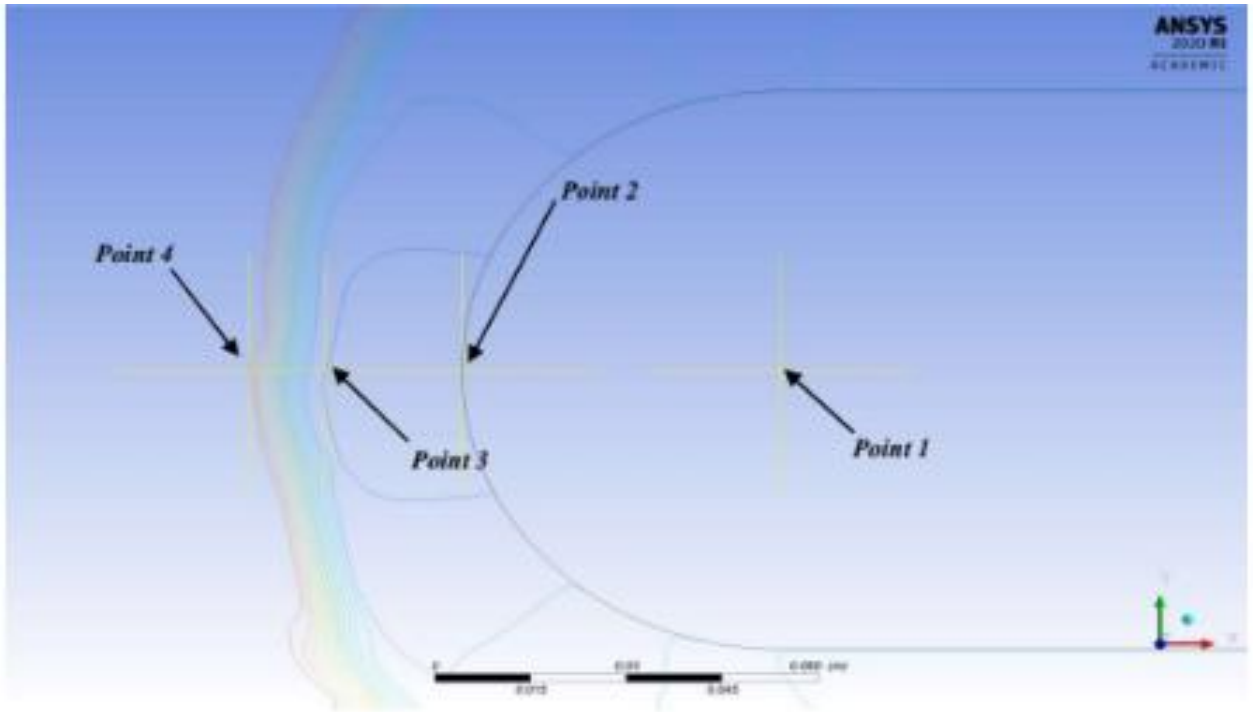


Estimation of shock standoff distance using CFD

University of Mumbai | September 2019 - September 2020

Result Analysis

- *This enables us to insert points which then made it easy to calculate the standoff distance. Using that methodology we prepared an Excel sheet of the distances calculated from the simulated results and graphed them against the standard correlations.*
- *The graphs seemed to align closely with the Billigs correlation which was expected. Thus, we successfully demonstrated the use of Ansys in calculating the stand off distance.*



$$\text{Minimum Standoff Ratio} = \frac{\text{Point 3} - \text{Point 2}}{R}$$

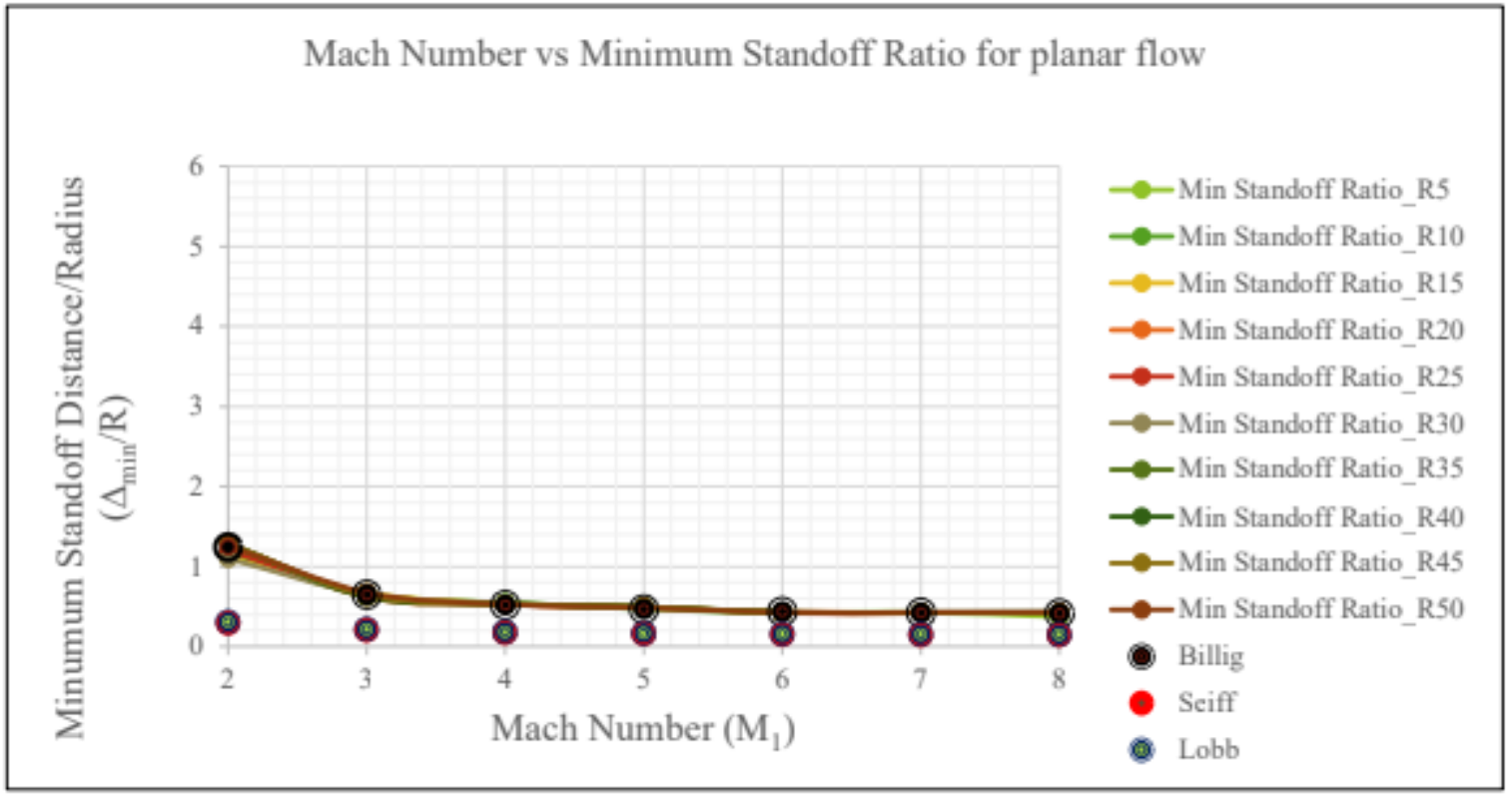
$$\text{Maximum Standoff Ratio} = \frac{\text{Point 4} - \text{Point 2}}{R}$$

Estimation of shock standoff distance using CFD

University of Mumbai | September 2019 - September 2020

Result Analysis

- *Our analysis can be further used to develop a correlation that unifies all the aspect of blunt body aerodynamics and can be used to design commercial hypersonic flights.*

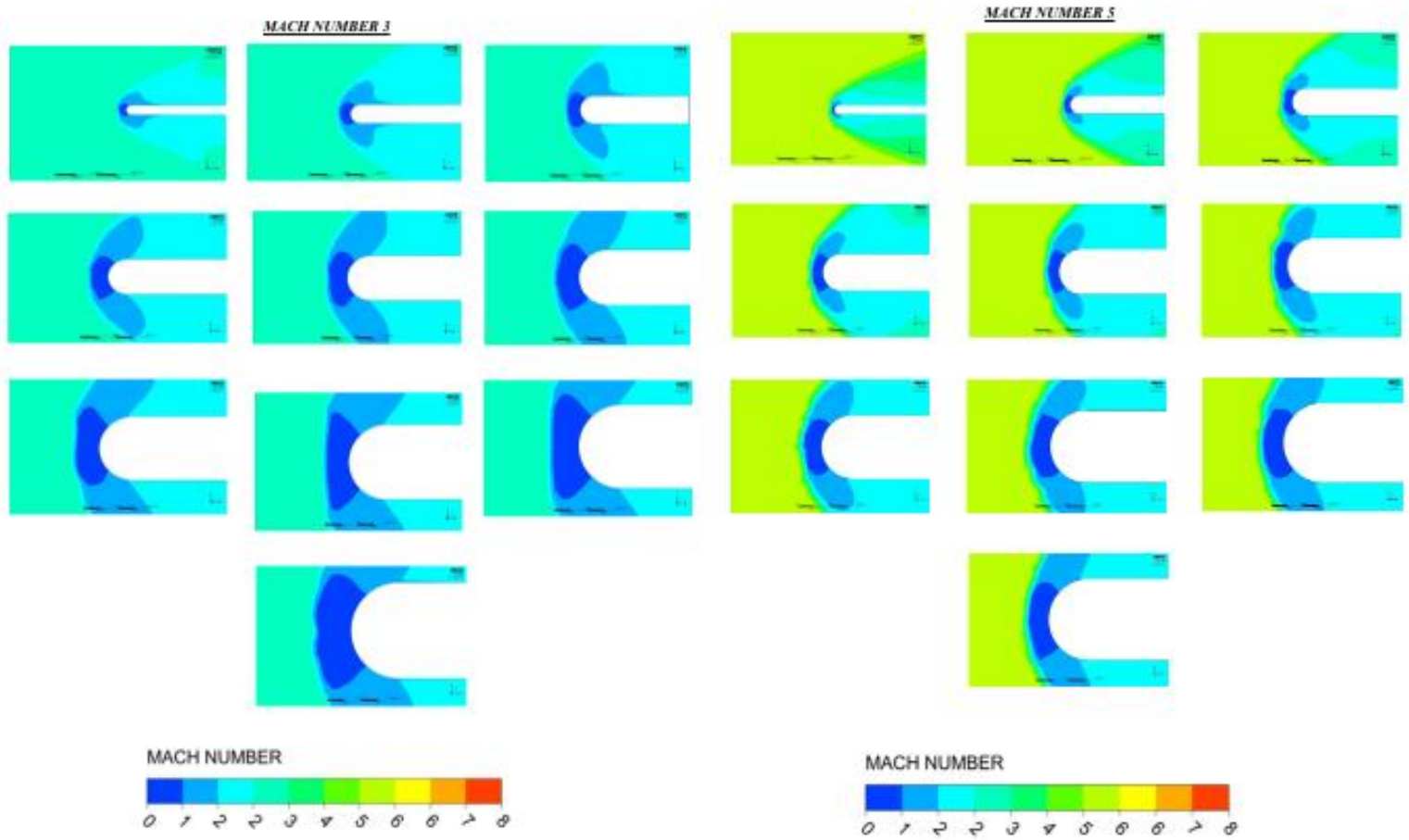


Skills: *Numerical modeling | CFD | ANSYS Fluent | ANSYS CFX | Post-processing | Fluid simulation | Aerodynamics*

Estimation of shock standoff distance using CFD

University of Mumbai | September 2019 - September 2020

Result Analysis



Design & fabrication of pedal operated washing machine

Shri Bhagubhai Mafatlal Polytechnic | September 2016 - December 2016

Project Overview

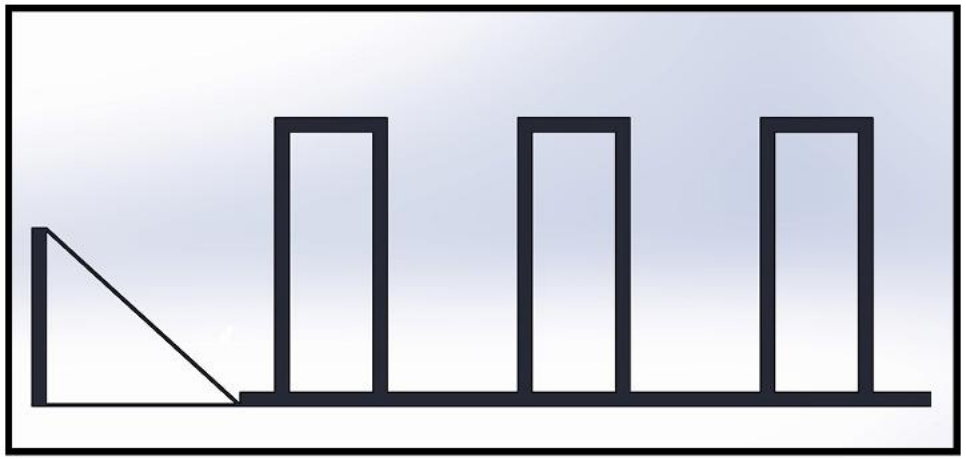
- *This capstone project was done as a part of my diploma in mechanical engineering.*
- *We wanted to address the plight of people in rural India. Due to lack of electricity in very remote regions and washing machines being costly, the men and women in rural parts had to travel long distances to wash their clothes.*
- *We thought of using human power (pedaling) to power the washing machines. Every household in rural India at least haa a small bicycle. So, we came up with an innovative solution to connect the bicycle with the washing machine.*

Design & fabrication of pedal operated washing machine

Shri Bhagubhai Mafatlal Polytechnic | September 2016 - December 2016

Design Approach

- *The main challenge was to connect the bicycle with the washing machine drum. I then came up with a transmission design structure that enabled us to connect the bicycle with the drum effortlessly.*
- *The next stage was to design the transmission. We employed a chain drive mechanism due to lower losses and being a cheaper and a better alternative to gear trains.*
- *I calculated the optimal chain length, chain sprocket, number of sprocket teeth and number of chain links by referring Machine Design course notes*

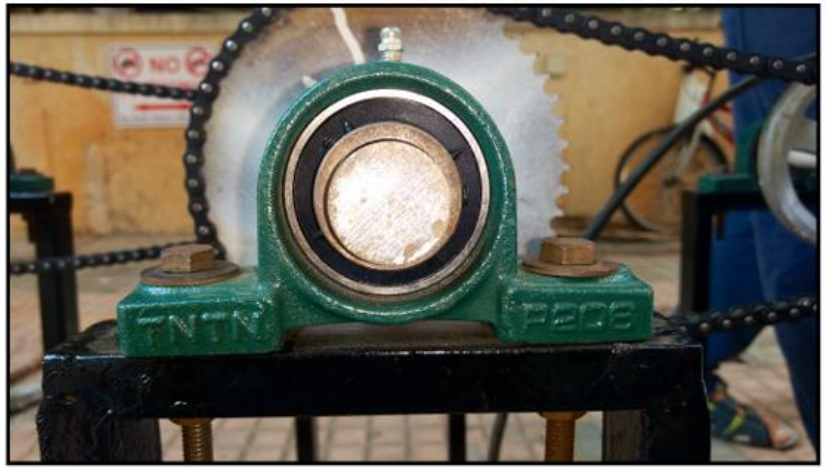


Design & fabrication of pedal operated washing machine

Shri Bhagubhai Mafatlal Polytechnic | September 2016 - December 2016

Design Approach

- *Similarly using Machine Design and Theory of Failures, I designed the shafts on which the sprockets were welded. The shafts were supported by Plummer block; the capacity being calculated on maximum forces applied.*
- *The frame was welded using standard grade mild steel. The next step was to calculate the torque available and the power generated.*



Design & fabrication of pedal operated washing machine

Shri Bhagubhai Mafatlal Polytechnic | September 2016 - December 2016

Design Approach

- *Considering a maximum human force of 300 N and pedaling at the rate of 60 rpm, the transmission system will generate a power of upto 500 W which is somewhat similar to the power produced by small sized front load machines.*
- *We verified the speed and the power at the drum using a tachometer. The machine was assembled and the use case was demonstrated.*

TORQUE CALCULATIONS

Let ,

T be the Torque

We know that,

Torque = Force x Perpendicular Distance

$\therefore$ Torque, T = 300 x 200

= 60,000 N.mm

$\therefore$ T max = 60 N.m

T max = 1.25 T mean

$\therefore$ T mean = 60/12.5 = 48 N.m

$\therefore$ T mean = 48 N.m

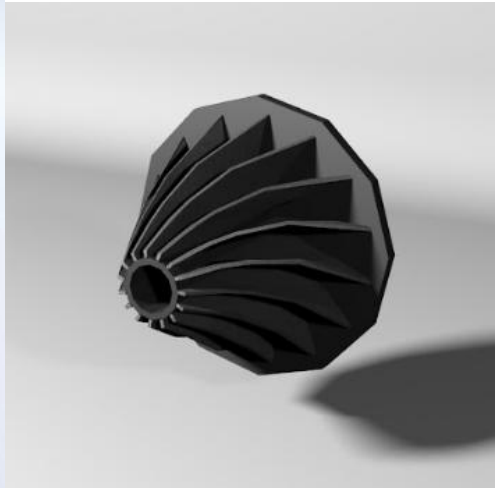
PERSONAL PROJECTS

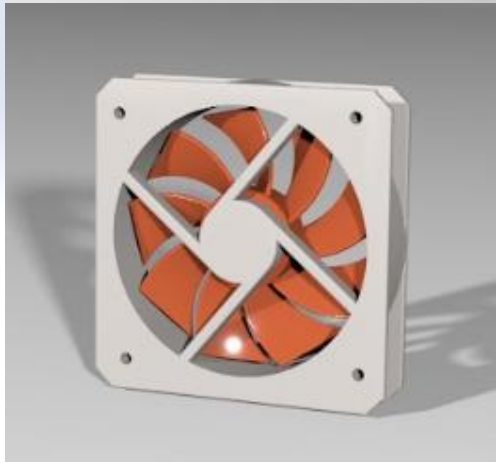
Design Explorations – Fueling My Passion for 3D Modeling

- ***Learning through purposeful practice:***
  These models reflect my passion for 3D modeling and were created to strengthen my SolidWorks proficiency. Each project challenged me to improve both technique and design thinking.

- ***Developing skills through hands-on exploration***
  Applied advanced features like surfacing, thread generation, and ergonomic shaping to transform design ideas into realistic, manufacturable models.

- ***Real-World Relevance:***
  Focused on designs that balance function and form, aiming to create models that are not just visually accurate, but also relevant to real product use.





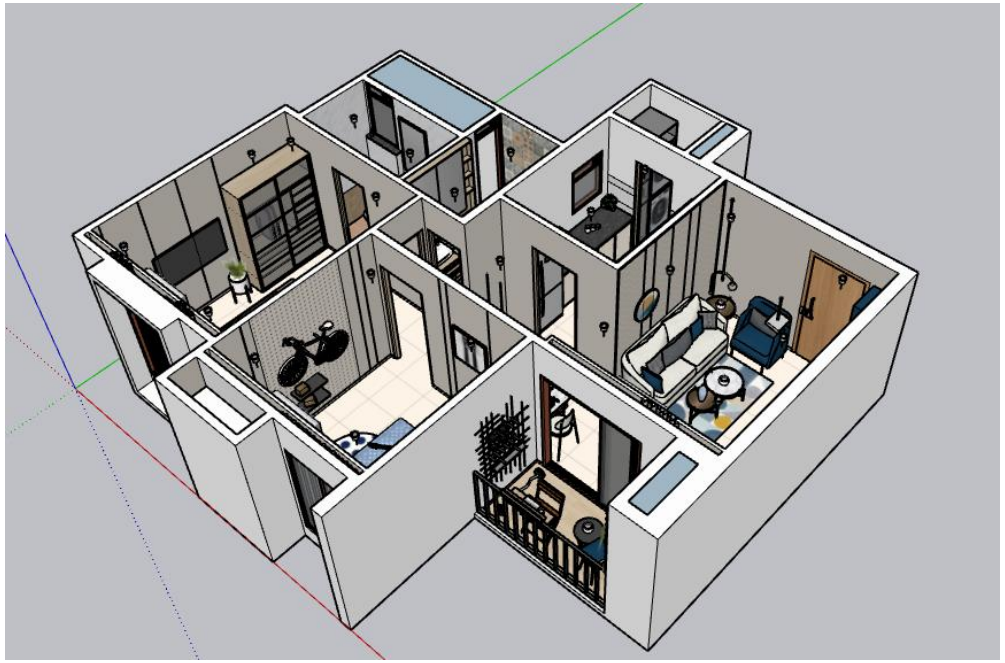
OTHER 3D MODELING WORK

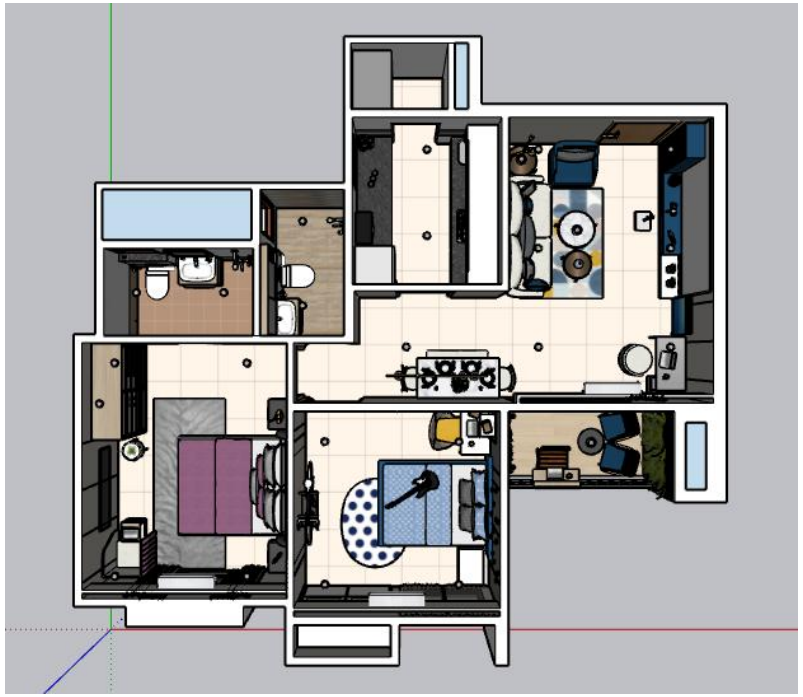
Virtual Homes

Designation ***3D Modeling Executive***
Experience ***August 2016 – June 2021***

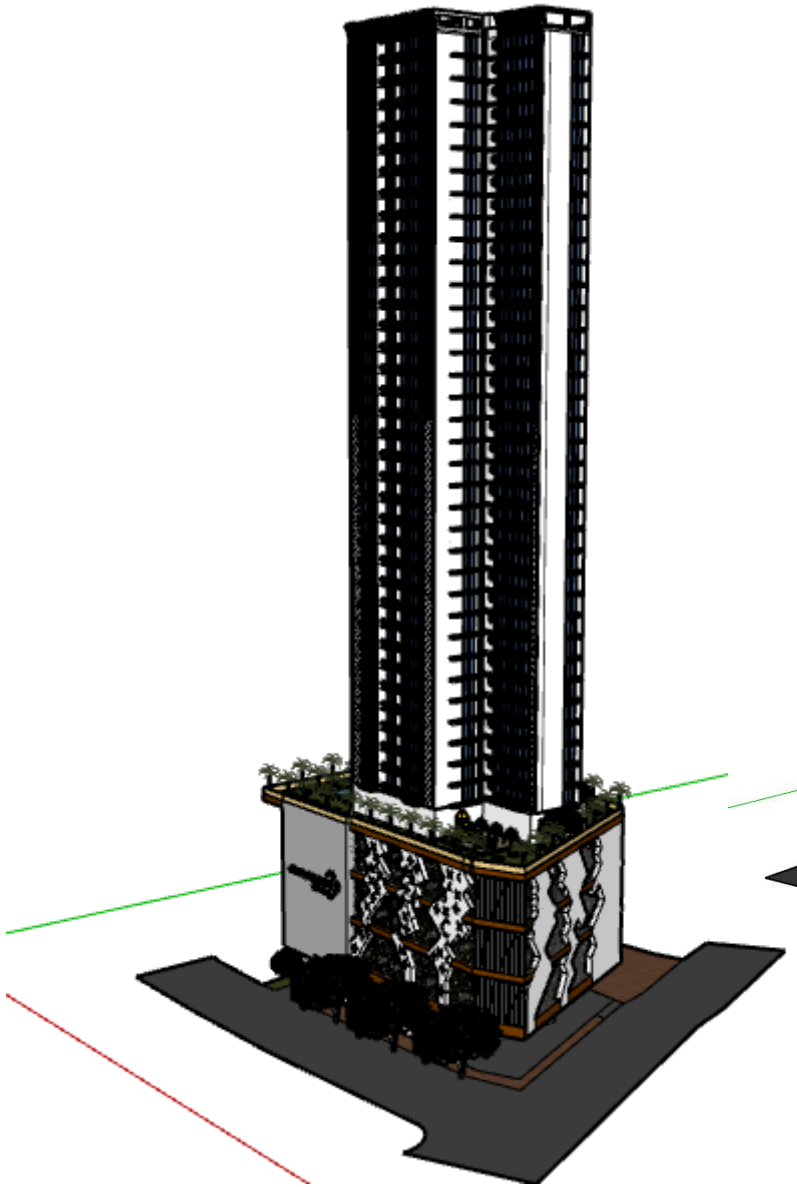
Role Overview

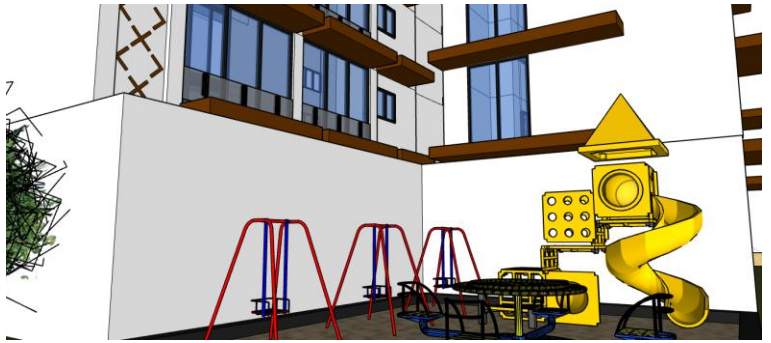
Virtual Homes is a real estate company that utilises VR technology to create walk throughs of the homes and buildings to sell houses. My role was to create entire building models, landscapes, entire house modeling with interior furniture. Then I rendered the models in Corona Renderer and made virtual walkthroughs using Shapespark.

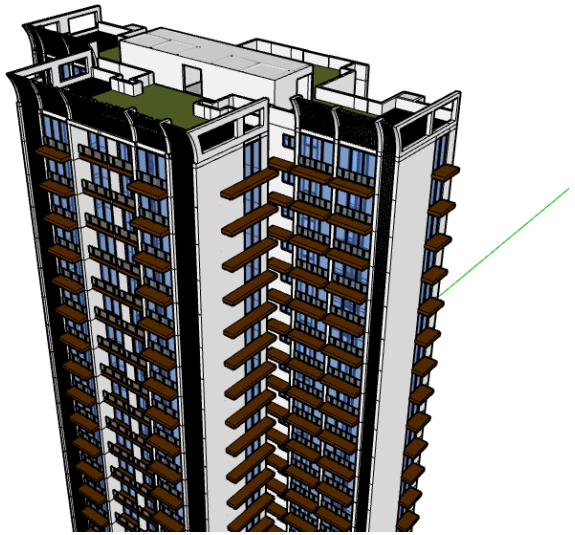


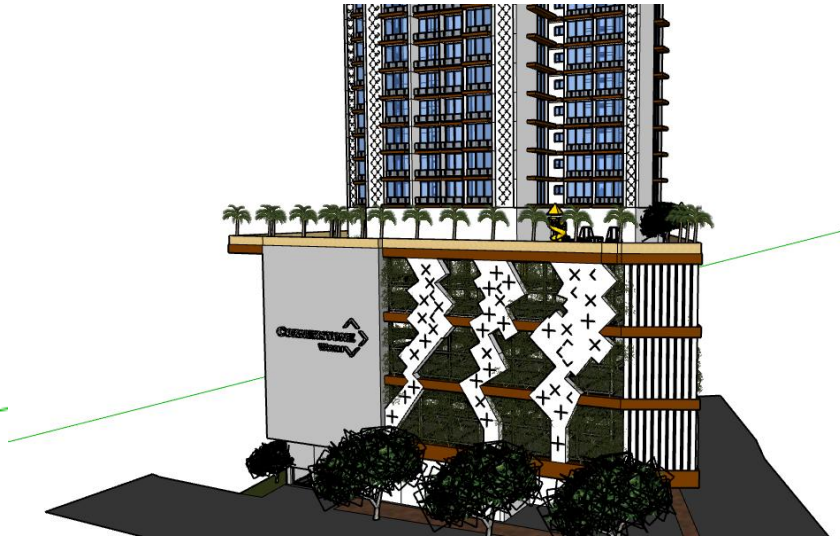


Virtual Homes





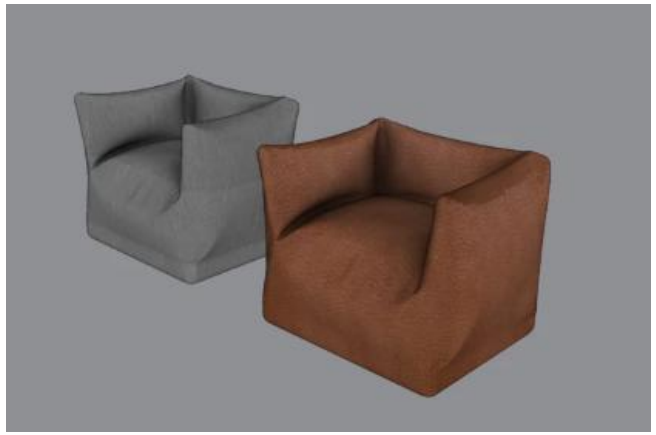


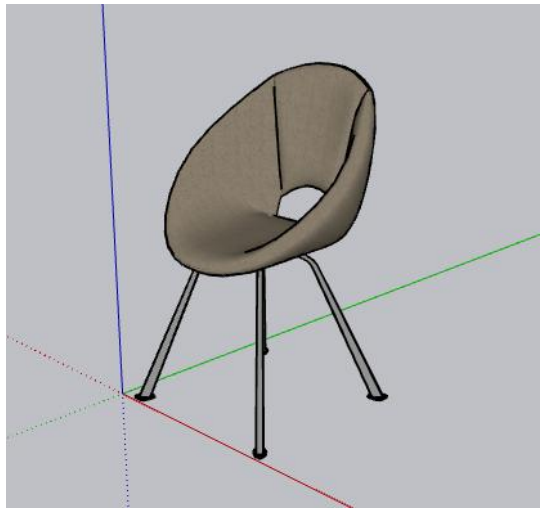


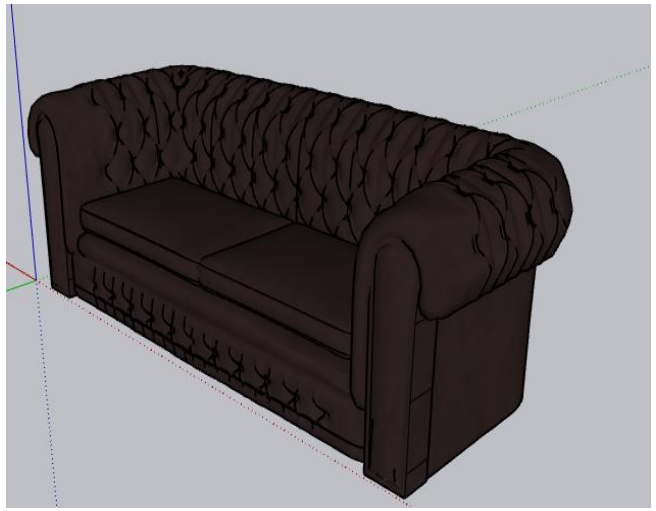
Virtual Homes

Reusable Library Asset

- *Created a library of 100+ high-quality 3D furniture models, including beds, sofas, chairs, tables, and storage units.*
- *Ensured each model followed accurate dimensions, clean geometry, and was optimized for performance and render quality.*
- *Enabled the design team to reuse assets efficiently, cutting down modeling time and allowing faster iterations.*







Library Link: *https://3dwarehouse.sketchup.com/user/3180ee47-c565-4905-8b90-2d4efa42af56/Soham-S*

WHAT'S NEXT?

What's Next

While I don't have all the answers yet, I have learned how to ask the right questions, solve tricky design problems, and see the value in simple, clear solutions.

This portfolio is not the final goal; it's a step along the way. I am still learning how to design with more accuracy, work smarter with constraints, and turn rough ideas into working solutions.

If anything here caught your interest, be it a project, a process, or just the way I approach design , I would be happy to connect. Feel free to reach out through LinkedIn or email. I am always open to meaningful conversations.

*As Leonardo da Vinci said, "**Learning never exhausts the mind**." That's the energy I bring into every project.*

THANK YOU FOR TAKING THE TIME TO SEE MY PORTFOLIO!

Soham Sanathra, CSWP
Mechanical Designer | CAD & Product Development Enthusiast

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