GROUP - 1

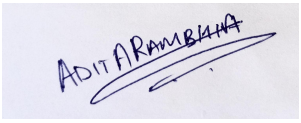
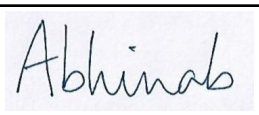
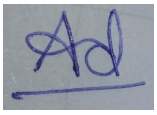
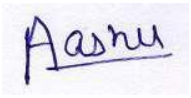
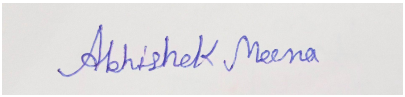
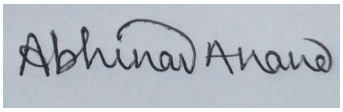
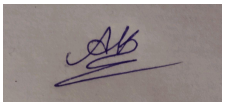
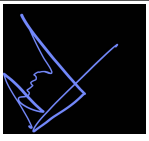
COMMERCIAL AIRCRAFT

Commercial Aircraft

Term: Spring 2022

Group 1

Submission date:

Si. No.	Student name	Signature
1	Adit Atul Rambhia	
2	Abhinab Mondal	
3	Aaryan Darad	
4	Aashu Singhal	
5	Adit Kaushik	
6	Abhishek Meena	
7	Abhinav Anand	
8	Abhinav Kumar	
9	Abdul Qadir Ronak	
10	Abhay Upparwal	

Motivation

Right from our childhood days, we have been admiring planes. As kids, you might recollect that we used to be fascinated when someone would point up at the sky and show us an aircraft flying miles above us. Soon as we grew up, most of us got a chance to see an aeroplane from a much closer distance, and the gigantic body, the wings, and the engines mesmerised us. Several flights later, every time I sit in a plane and look down at the diminutive buildings from my window seat flying tens of thousands of feet high in the sky, the experience still somehow feels surreal.

Flights have become an increasingly mainstream mode of travel across the world and even in countries with weaker purchasing powers, such as India, thanks to competitive pricing in the aviation industry. India is the world's third-largest civil aviation market in the world. As per credit rating agency ICRA, even amidst sweeping travel bans, India recorded domestic traffic of 274.51 million passengers and international traffic of 66.54 million passengers. As flights gain widespread acceptance, we have perhaps forgotten how impressive a technological marvel they are. Just to step back and think that we can now travel in air at blazing speeds of 700 - 800 km/h feels slightly bizarre.

Arguably one of the most disruptive products of engineering, the aeroplane has proved to be a paradigm shift in the field of transport. From the early days of the humble Wright brothers model of the plane to top of the line commercial aircrafts, there has been tremendous development in shape, design, and utility. Initially, there were only elusive two-seater aeroplanes limited to the affluent classes. However, with groundbreaking progress in technology over the last few years and the increasing air network, even the average person can afford to have a plane journey. There has been a lot of research to modify the aeroplane's range, seating capacity, and efficiency.

Finalising a topic for the project was tricky. As we discussed the possible topics for our project, we stumbled across many machines, including the spot mini robot, a naval warship, Tesla Cybertruck, helicopter, and construction crane. Ultimately we unanimously decided to model the aeroplane. Everyone was interested in modelling the aeroplane as it seemed a bit challenging and new for us. We wanted our project to be complex but not at the cost of attention to detail. As engineering students, the challenge of breaking down a machine into its components, analysing the intricacies of each part and rebuilding the machine ground up thrilled us.

First, we saw a rough sketch of a commercial aeroplane and then broke it into the main sections- the main body, the wings, and the tail. Each section had multiple sub-sections, and we divided them amongst ourselves.

There is a lot of math and physics involved in designing an aeroplane, and each part has its own unique role and is equally vital in the functioning of the plane. Each part is governed by the laws of aerodynamics and fluid mechanics, various principles and theorems like Bernoulli's principle, newtons laws, and Gravitation was used all throughout the designing of the project.

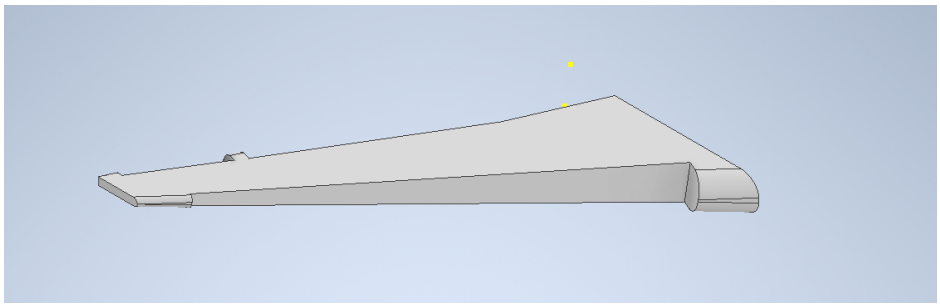
Designing such a complex object seemed very challenging and hence we divided the entire aeroplane into 3 parts:-

I. **The Main body - (Fuselage and Cockpit)**
II. **The Wings - (Wing, Slats, Flaps, Ailerons, Winglets and Engine)**
III. **The tail - (Tail cone, Rudder, Elevator, Horizontal and Vertical stabilizers)**

After this, according to the number and complexity of the parts we divided the group into subgroups. Inescapably not all parts are of the same complexity and intricacy, hence we have unanimously decided that it will be the responsibility of teammates with comparatively easier parts to take charge of the assembly of subparts and finalize it for final assembly.

Wings

by Aaryan Darad



What an exciting but painful experience it was! I had to design the wing of the plane which without any doubt was one of the most difficult parts to make for a variety of reasons. Firstly it was the mother part of many other parts like turbine engine, flaps, slats, aileron and landing gear. Not only that but, getting the exact dimensions of all the parts was not at all easy and we had to scale it down according to the ratios.

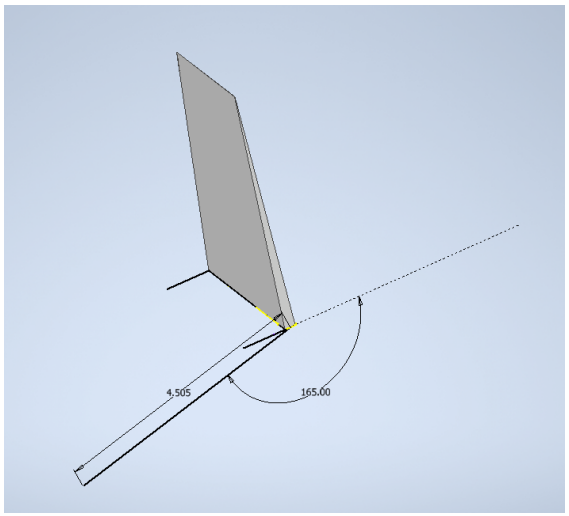
It was also very difficult to manage to make the exact curvy shape of the wing. I first tried to make the Top view and extruded it. Then I cut the parts appropriately but what final outcome was not what I exactly wanted. Then I came across this 'Loft' feature. By which we can join 2 planes precisely the way that we want. However, the most challenging part was to make exact dimensions and spaces for all the other parts of the wing. It was very difficult to coordinate and lead to a wastage of a lot of time. Atlast we sought help from our ADH mentor who helped us a lot.

This project helped me learn a lot. Me being the sub-captain of the wing part of the assembly, had to gather the team everytime in order to coordinate properly and have each part of the wing be made without any compromise. Moreover, it helped me learn time management as this project was right in the middle of so many assignments and quizzes from other courses. However, overall this was a great experience and I think I will always remember this as a unique project which helped me learn a lot about engineering.

There weren't a lot of changes in the dimensions, but I had to do slight changes in order to accomodate for the other parts. This seemed like a huge problem before but with the help of my other team members, it became like a piece of cake.

Winglet

by Abhishek Meena



Our modelling project is a mixture of very complex parts, and the dimensions are very hard to define precisely. After doing a lot of hard work with teammates, we finally completed the modelling project. My part in this project was a winglet. I took all my dimensions from the actual Boeing. But some measurements are not disclosed. Hence we had to approximate the dimensions.

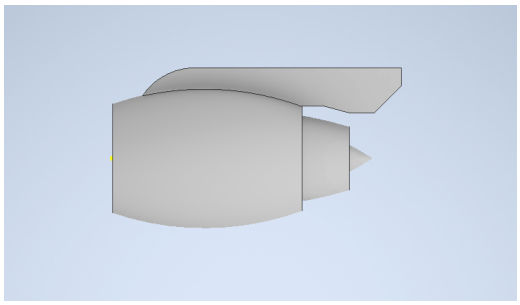
My part is not too complex, so I had not faced more significant challenges in creating it. I found some difficulty in making a 2D sketch in Autodesk with dimensions. I have drawn so many sketches, but after finishing the drawing, one side was found wrong, but finally, I made it correct. I extruded it

after drawing a 2D illustration, but it was not a winglet. It looks like a simple rectangle. I made two triangle sketches on the YZ plane and clicked on finishing the sketch. I went to extrude and choose both of the drawings and cut them. This way, my part is completed.

It is my first modelling project in my life. Through this project, I learned how to work and coordinate with teammates. My teammates are hardworking, and they always help me with this project. Our team leader always motivates us. After doing a lot of hard work with teammates, we finally completed the modelling project.

Turbofan Engine

by Abdul Qadir Ronak

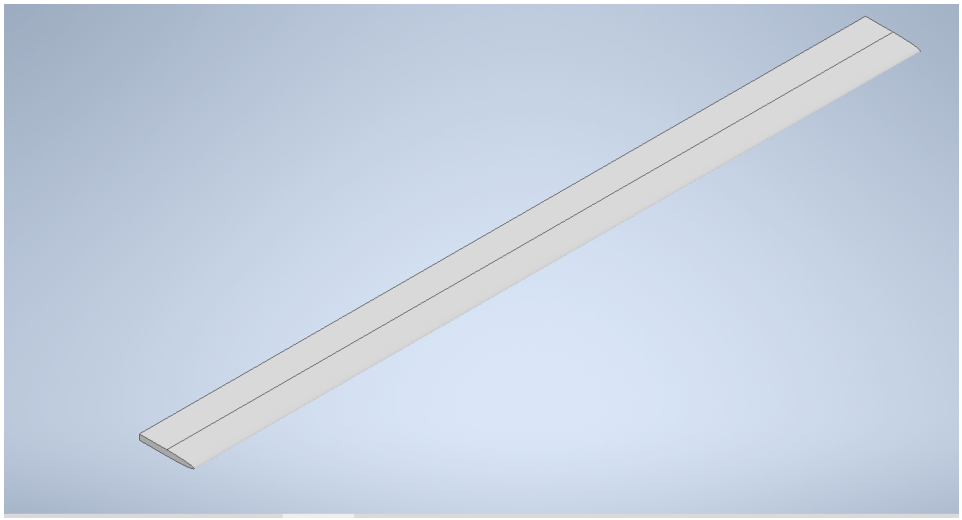


My part was the engine of the plane and needless to say, it is one of the most important parts of the plane. It powers the plane through the air and its failure is responsible for most accidents. I looked for the dimension and the best I found were the dimensions on the Boeing pdf that was used by my team. It was a difficult task but a few functions like rotate made it easier for me. There are some changes in dimensions from the sketch of the previous proposal in the final model.
In the model, the core engine(combustor, compressor and the turbine part) is just shown as a curved solid since this part is too complex to be 3D modelled. The main challenge was modelling the fan blades because that is curved and twisted, but after watching some videos on Youtube, I got the way to make it.

Making the Engine was a really exciting experience, though it was relatively tough. It was very fascinating to see it after completion, especially the fan. The main thing I learned was the loft function and revolving.

Aileron

by Adit Kaushik



To construct the aileron, I first drew a rectangle in the 2D plane and then attached a semi-ellipse to its shorter side. Then, I extruded it to the required length.

I thought aileron was done, but the real challenge came when we had to put it into the wing. I then realised that the shape of the Aileron was wrong because its cross-section was not rectangular. It was slanted to an angle, and the opposite sides of the extrusion were not equal. The shape was much more complex than I thought. Therefore, it did not fit into the wing. This is where the real challenge arose. There were many angles and slanted planes. For constructing this, I first took the cross-section of one of the faces of the aileron. Then, after extruding it, I took an offset plane at a distance equal to the length of the aileron. Then, I constructed another cross-section on this plane and joined the two using the loft command. Figuring out all this took me two days. But finally, the aileron was integrated into the wing.

Making the aileron taught me how to create curves and slanted planes in inventor. It also taught me the use of 2 new functions — loft and offset plane.

Landing gear
To construct the landing gear, I first made a wheel. Then, I made the rest of the body. After that, I assembled them together in the assembly mode by importing the wheel six times. Again, the real problem came with integrating it into the plane. It was tough to find the dimensions of the opening for the landing gear on the internet. After integrating the landing gear with the body, I observed that the wheels were looking too small for the aeroplane's body. Constructing the full gear again would be

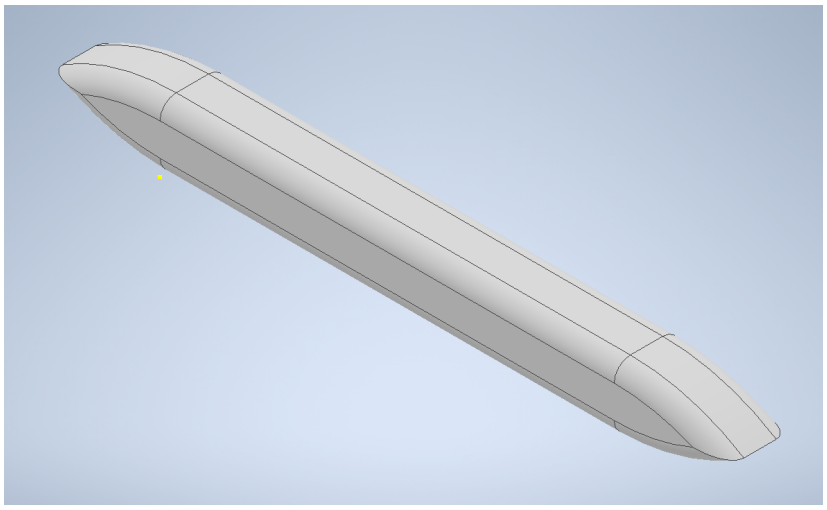
cumbersome. So, after trying out different options in i. inventor, I finally figured out how to adjust the size of the model.

First, open the 3D Model tab. Then, click on direct edit. Select the image that has to be scaled. Click on scale and give the required scale.

Overall, this project taught me teamwork. I learned how to coordinate with other people working on the same project. I was also in the assembling team and had to contact all my teammates almost every day because integrating the parts into the final model always required some changes in the parts.

Flaps and slats

By Abhinav Kumar



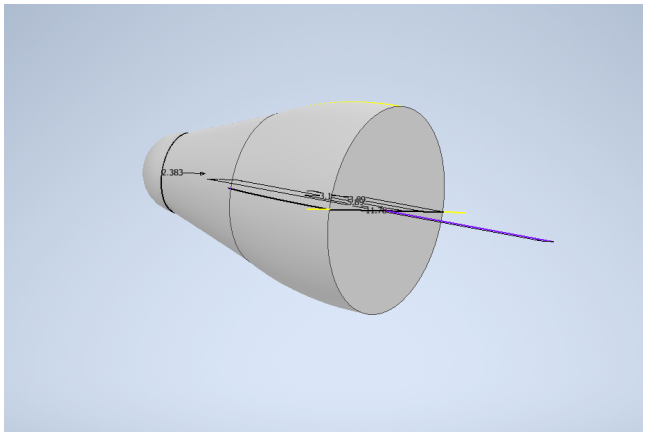
Our project is to make a 3-D model of a plane. We faced problems in deciding on the dimensions of different parts. Finally, we decided to use the dimension of the Boeing. But still, some dimensions are missing so we used some approximations. My parts are slats and flaps which are located at leading edge and trailing edge of the wings of an airplane. Overall I faced some difficulties because flaps and slats are having unique shapes.

Shapes of flaps and slats are not regular the width decreases continuously and also their edges are not spherical. During making a 3-D model of these two I had faced some problems previously I didn't about the loft feature so I tried making with exclude, cut, and fillet feature but I was not able to make it. After that, I met an ADH mentor, who suggested me use the loft feature to make flaps and slats. Also, flaps have a very unique structure due to their unique work so I made it in three-part first one is the lower part which connects the flaps from the wing and helps to open and close. This part is simple to make on AUTODESK, I made a cuboid and just used the fillet feature. The second part of flaps is that part that is nearer to the main body. I faced some difficulties during making its 3-D model as I mentioned earlier it has a very unique shape and I made it using the loft feature. And the third part is mostly similar to the second one so I just repeated the same step and made it.

Overall it was difficult to make but i enjoyed doing all this and also I learned a lot from this project about AUTODESK features, drawing, and writing.

Cockpit

by Abhinab Mondal



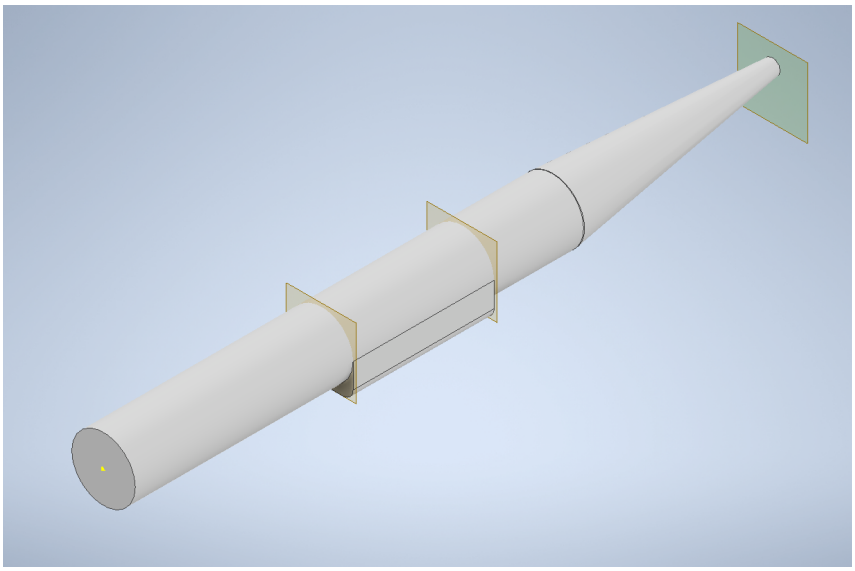
The modelling project has been an immense learning experience. At times, it has been very difficult and stressful however the final product that I ended up with was extremely rewarding. It eluded me as to why we were told to dive headfirst into the modelling project without a little more preparation and familiarisation with Autodesk, however now perhaps I do understand that it did enable me to learn much more on my own than I would have with a graded tutorial.

I faced a fair share of challenges while completing the project. I was of the impression that I would find all the necessary dimensions and other relevant information in publicly available documents. Unfortunately for me, since my part was fairly intricate with complex irregular curves I did not find all the dimensions that I would need. I had to use a variety of methods to make logical estimations for those dimensions.

The next challenge was to finally model what I had initially visualised. After making the drawings for the model, I spent a great deal of time figuring out how to make a solid structure from the drawings. I understood that the "extrude" or "revolve" function was not going to cut it for this model. After reviewing a lot of material on the internet, I discovered the "loft" function. I concluded that I would need some permutation of the "loft" function to make my 3D model. While my problem was nearly solved there were still some issues left. For one, with the newly discovered function, I managed to get a 3D model but it resembled something closer to a frustum than a cockpit. It lacked the distinctive curved shape of the cockpit. I had to understand the nuances of the "loft" function and understood the role of the "rails" suboption which allowed me to restrict my model within the distinct curved shape. In the end, I felt partly relieved and very satisfied with the work that I had put in and the result I got.

Fuselages

by Adit Rambhia



After brainstorming and hard work, I finally completed our model. Since I had the fuselage, I had to find the dimensions of a real plane. I looked up the actual Boeing dimensions and allotted them accordingly to everyone. There were a few dimensions that we could not find as they were not disclosed. Hence we had to approximate the dimensions. Overall it wasn't that a difficult task as immense training in tutorials had improved our estimation skills.

One thing that I didn't know and challenged me was making a frustum figure. I tried various methods like drawing a 2D figure and rotating it about its central axis. Another technique that I tried was

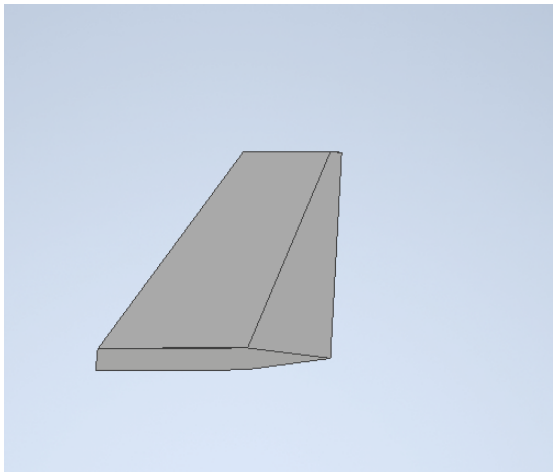
making a cylinder and a cone separately and then integrating the two, but that also wasn't a feasible method, as the cone didn't have a curved surface but a straight one. After a lot of surfing the internet and watching a couple of youtube videos, I came across the LOFT FUNCTION. I drew an offset plane and then drew a small circle away from the end of the main body a little above the cylinder's axis. Then I connected the two circles, and for continuity I had to apply the fillet function in the joint of the fuselage and main cone. I made a few changes in the end, after part of the assembly i added windows to the fuselage. I made the fuselage hollow and cut out small squares and used the **RECTANGULAR FUNCTION**. This added detail to the airplane.

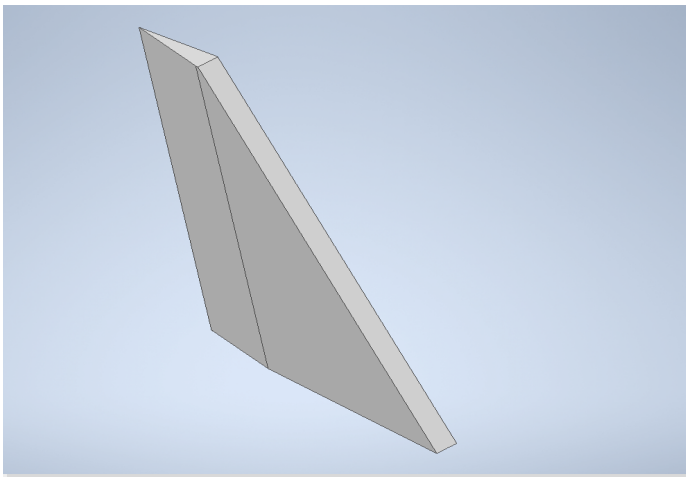
Another challenge that I faced was compiling the whole model, but with the support of my team, I could do it without a lot of problems.

Overall this project taught me a few things other than just modelling and interpreting drawings, it taught me teamwork. As a leader, it taught me how to work between deadlines, motivate my team and manage the logistics that go into it.

Stabilisers (Horizontal and Vertical)

by Aashu Singhal





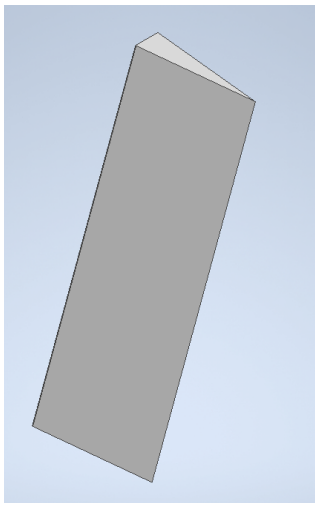
In this project, we are making the Boeing 777 our model. It consists of different components like stabilisers, wings, etc. So after spending so much hard work on this project, we finally completed it. I was given stabilisers as my subpart. So the main problem in constructing a model is its dimensions. So at first, we tried to find the dimensions of the plane because according to that, only we will get to know the dimensions of the individual part. So we first searched for them, and then we started working on them. In this project, we learned to design completely different models from the real world, which helped us improve our technical and judging skills.

The challenge I faced in developing the model of stabilisers was to extrude it. The extrusion required to make my part is different at different distances, so I have to wisely choose a suitable length until I have to extrude it. So I got to know about a new option called “Chamfer”.This option asks till which distance we have to extrude it and how much, and it linearly decreases the model's height. The next challenge I faced was to specify the dimensions of the slant distances because as the size varies, the slant distance will also change, so I had to be a little careful while dimensioning it.

The main challenge arose when we were compiling the whole project as we got to know that the stabilisers I made are relatively very small compared to the entire model. So I had to change the dimensions again and design the model again to minimise the mistakes I made while making the first model. This project teaches us how to design a model and work with different people, coordinate with them, deal with the hectic schedule, and manage things well.

Rudder

by Abhinav Anand



The rudder is a tiny part of the plane but plays a significant role. The rudder is used to change the direction of the aircraft.

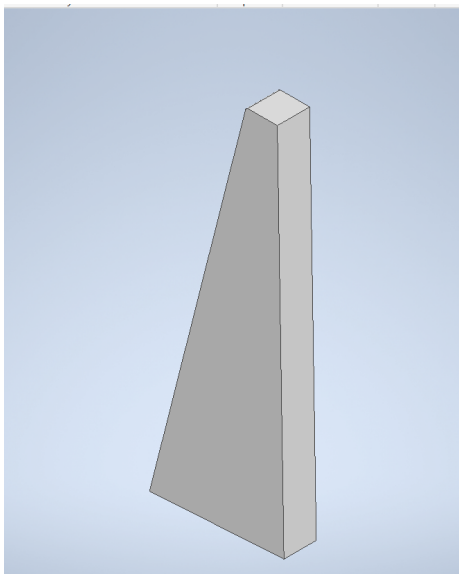
It was hard to get the dimensions of it. After searching many documents on the internet and the official page of the Boeing 777, we concluded that the sizes of the rudder could be confirmed only by referencing it with the plane body. The first proposed model we submitted by creating freehand had a comparatively small dimension. While assembling the Vertical stabiliser with the main body, we observed that it is too small for the desired size.

While constructing the rudder, the main challenge was to extrude it through both sides while having some inclination to the top. After watching some videos on youtube, I did it. This project was fascinating for me as I am interested in creating 3d designs. I learned a lot doing all the things.

The main thing that I learned doing this project was the value of coordination with the group while doing the project. It would have been more interesting for me if I had got a big part, though it was the best experience.

Tailcone and Elevator

by Abhay Upparwal



We're using the Boeing 777 as our basis for this endeavour. So, after a lot of hard effort, we were finally able to finish this project. Elevator was assigned to me as a sub-component under the Tail subsection. The most challenging aspect of building a model is determining its dimensions so that it can be fixed with other parts of the tail. So we began by attempting to determine the dimensions of the plane because only by doing so we will be able to decide on the size of each element. While doing this project, we learned how the designing process of each part is linked with others and needed to be made in order.

While making this part, I was mainly worried about the dimension and size of my part as it is going to be fixed in a stabiliser in which a particular space is being made for it. The dimension of my part should exactly fill that space, so I could not start making my part until the stabiliser was made. I had to work with the one designing this part of Autodesk's design process. Initially, the one making the stabiliser had not considered making space for fitting my part, so we finally created both the parts together as a single part. Well, the designing process on my part is easy. I didn't face any severe problems with it.

This project taught us how we need to work together in designing all the parts and developed judgemental, logical, and designing skills.