



Engineer Portfolio

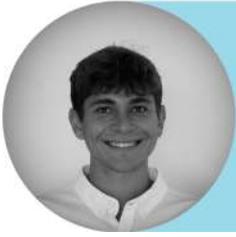
Miquel Altadill Llasat





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1. Who am I?

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I am a second-year MSc student in Aeronautic Engineering at the Universität Stuttgart strongly committed to solve new technological challenges that society brings to us. My aspiration is to be involved in projects that require the most of me and the cooperation of extraordinary teams of people to push the limits of technology and science, especially in CFD related projects that involves programming and designing. My primary research interests are flow field analysis, sustainable aviation and data treatment and its visualization.

February 14, 2021



2. Next Generation Hydrogen Powered Aircraft



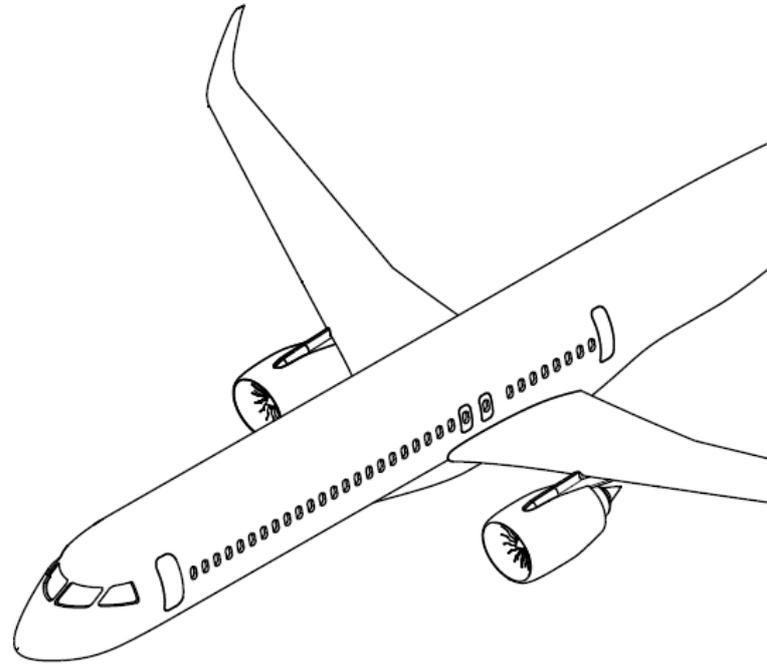
This year 2020/2021 I started a new academic stage at the University of Stuttgart where I had the opportunity to be involved in the Aircraft Design Seminar lectured by Herr Ingmar Geiß in collaboration with Airbus. Thanks to that I could work on a group project related to the next generation Hydrogen propelled aircraft. Together with my teammates Felix, Kostantin and Andreas we developed the H-Craft project.



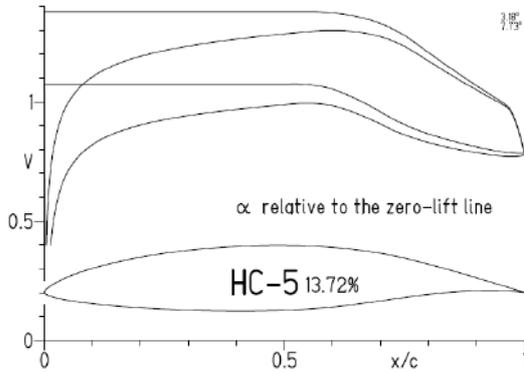
The main objective of this project is to propose a reliable commercial aircraft based on Hydrogen propulsion systems. The use of that element would allow to completely reduce the CO₂ emissions and also go a step forward on the future clean aircraft technology. Unfortunately, there are some drawbacks that difficult the use of LH₂ as propellant but with the nowadays technological advances it is believed that most of them would be solved in a 30 years gap. With this goal in our mind the H-Craft project has developed the future Hydrogen based aircraft that would define a new base for the fight against the climate change.

2.1 Airfoil design for the H-Craft Project

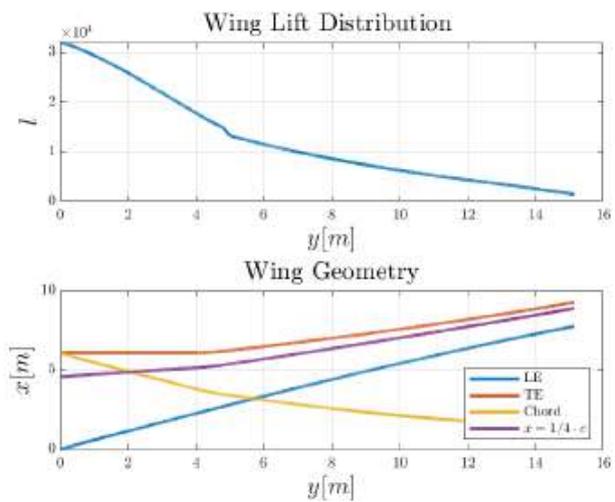
The main objective of this project is to propose a suitable airfoil for a reliable commercial aircraft based on Hydrogen propulsion systems. My Airfoil Design was a project developed in the IAG department of the University of Stuttgart for the Airfoil Design Seminar. Working together with the help of Dr. Lutz and the specific airfoil design software provided by the emeritus Dr. Richard Eppler I could gain a better insight about airfoil aerodynamics. The HC-5 Airfoil has been designed using an inverse engineering method that consisted on assessing and modifying the AF performance from the variation of its velocity profile.¹



AIRFOIL DESIGN MODEL - HERAFT



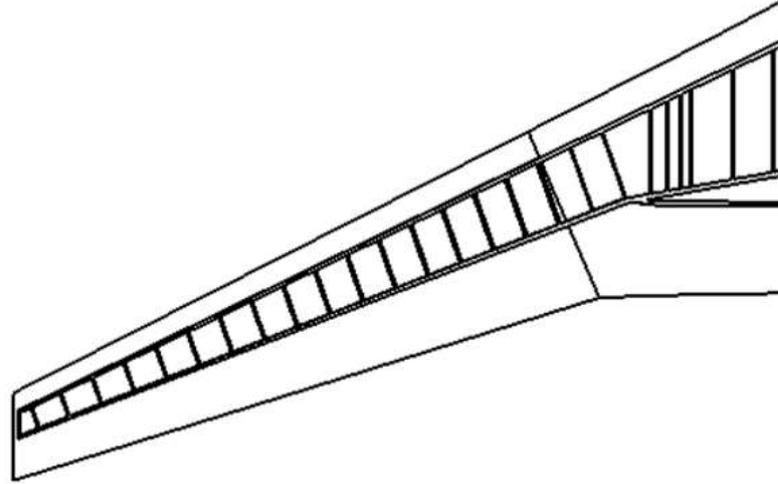
| Main Wing Parameters | |
|-----------------------------------|-------------|
| Geometry | |
| Wingspan b [m] | 36 |
| Wing Area S_w [m ²] | 124.5 |
| Aspect Ratio A_W | 10.41 |
| Incidence Angle i_W [°] | 3.5 |
| Dihedral Γ [°] | 5 |
| Sweep Λ [°] | 23.33 |
| Section 1 | |
| Airfoil | Airbus TA11 |
| Twist | -0.5 |
| Root Chord c_{root} [m] | 6.094 |
| Tip Chord c_{tip} [m] | 3.564 |
| Tapper Ratio λ_1 | 0.5848 |
| Section 2 | |
| Airfoil | Airbus TA11 |
| Root Chord c_{root} [m] | 3.564 |
| Tip Chord c_{tip} [m] | 1.5 |
| Twist [°] | -3 |
| Tapper Ratio λ_2 | 0.4208 |



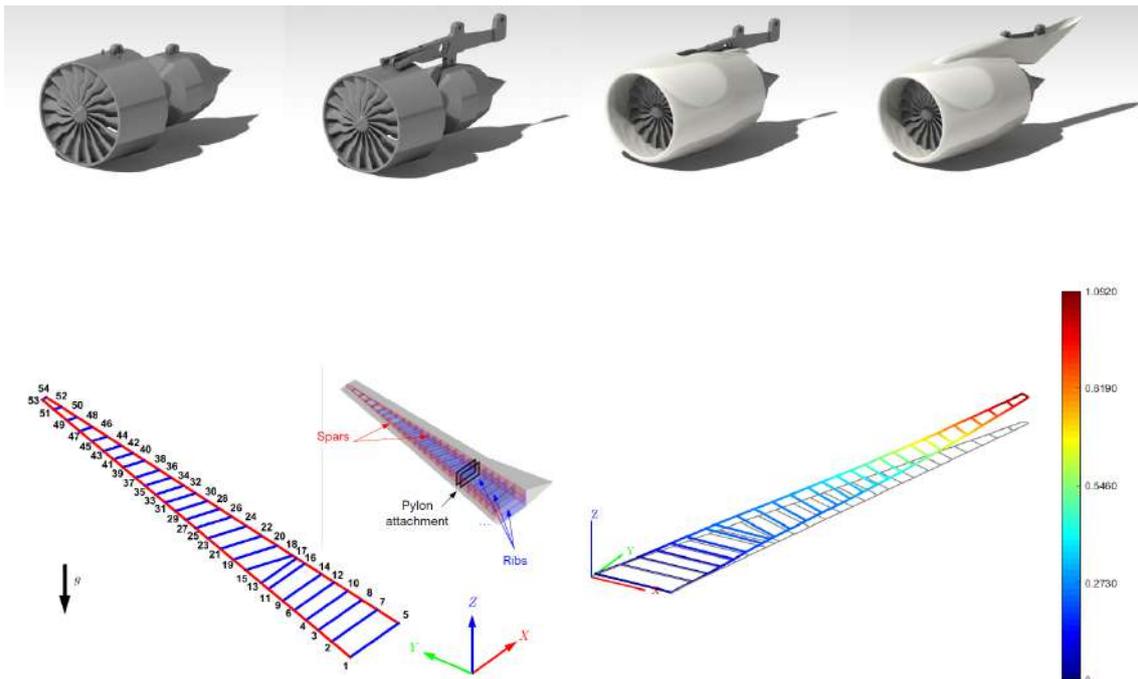
¹The complete FE analysis Matlab code can be found in a Github repository by clicking here [here](#) .

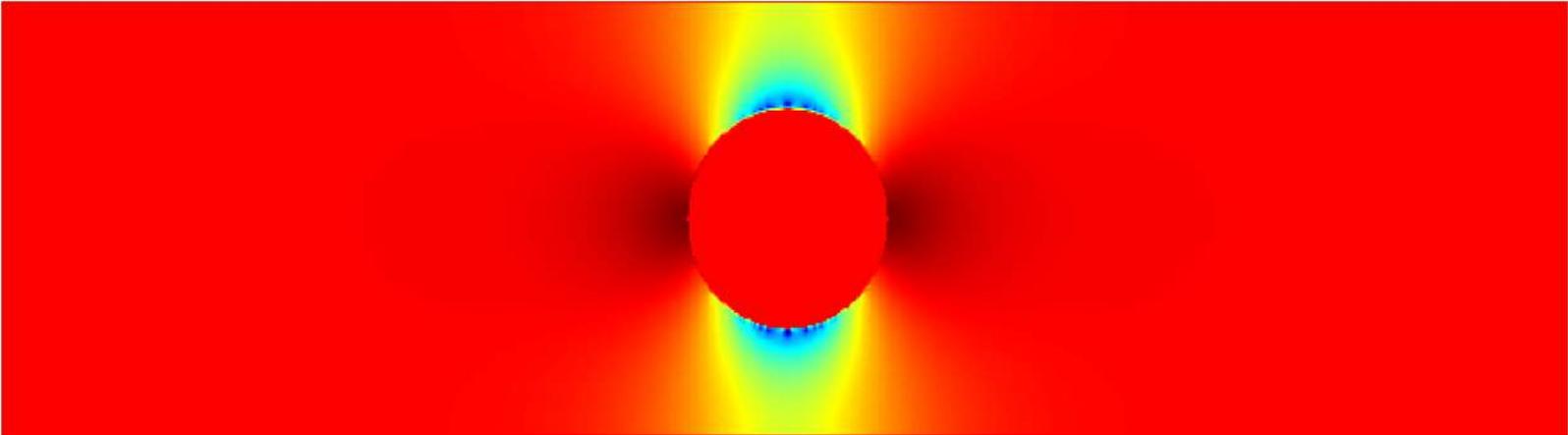
2.2 Wing Structure Analysis

As it is well known an aircraft wing structure purpose is to keep the wing skin fixed at the same time that it holds the weight of the engines and the fuel tanks in some cases. The main idea is to develop an inner lightweight structure capable of holding the bending moment in the most critical cases. These cases are while taking off and landing but also while the aircraft does not fly. At the same time the wing as to be elastic enough to hold the deformation that it suffers while flying. For the H-Craft Project, a complete structural analysis including the engine pylon attachment has been developed for studying the wing behaviour over the different flight stages. The FE structural analysis code can be found in an old LinkedIn article by clicking here [here](#) 



For the computational FE analysis of the wing it was necessary to develop a preliminary design of the wing structure using a CAD Software. In our case it has been used Catia V5 for building the ribs and spars inside the wing in order to get a structure similar to a real one but with a lot of simplifications. The approximation is shown in the following scheme. In order to extract the structure from the CAD software for introducing it into a self developed Matlab code it was necessary to save the points in a table following the same node order as shown in the figure below.

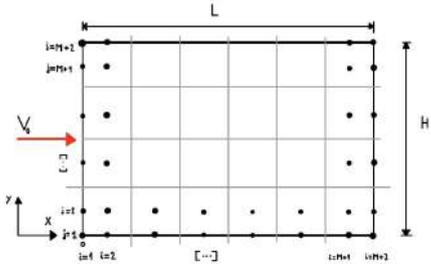




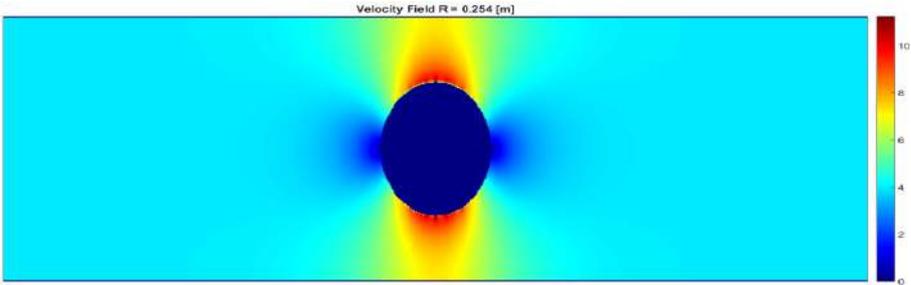
3. Numerical Analysis Non-Viscous Potential Flows

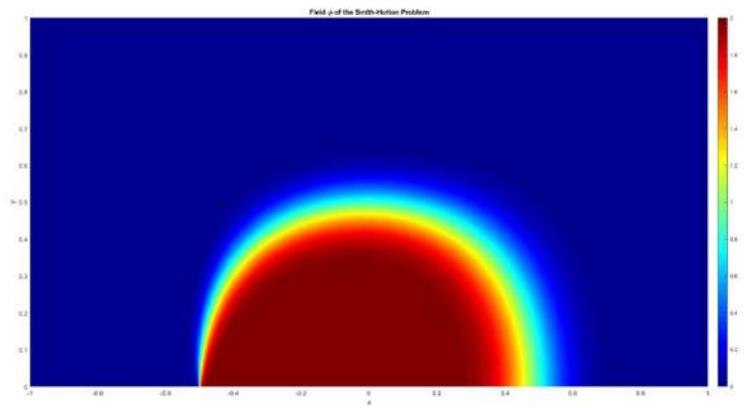
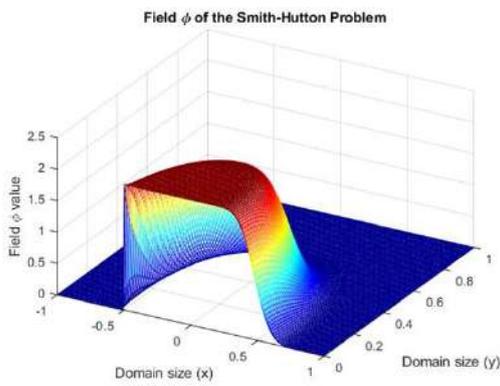
This project was developed in the Computational Engineering subject taken during my MSc in Aeronautic Engineering at the UPC - ESEIAAT. It was developed under the supervision of the Dr. Carlos David Perez Segarra in the CTTC department. The project consisted on the application of the **Potential Flow** theory for two simple case of study. The objective is the understanding of the theory and how it is applied for developing a numerical analysis on simple cases. The code can be downloaded by clicking [here](#) .

The **first case** of study consists in solving a simple flow in a channel. Here it is shown a graphical representation of the real problem, which would consists in two flat plates with an air flow in between them. As it is one of the most simple cases for studying the Potential Flow this case is a suitable first approach for modelling the fluid field for given initial boundary conditions.



The second case of study consists in solving a simple flow in a channel for the study of how it interacts with simple objects such as a cylinder. The problem would consists in two flat plates with an air flow in between them with a cylinder placed in between. This case is an extension from the first one and it only presents few modifications related to placing objects in the middle of the domain. The image at the top of the page shows the pressure field around a specific cylinder. The following image shows the velocity field.

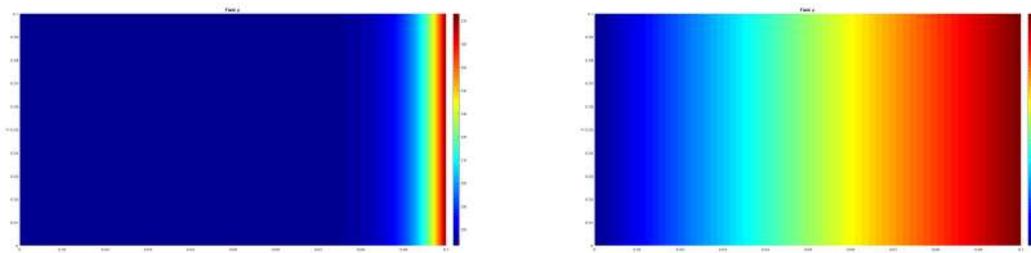




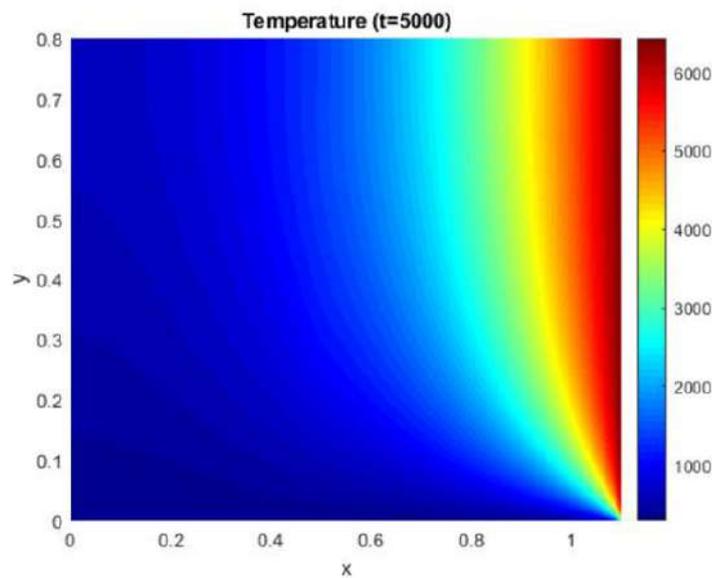
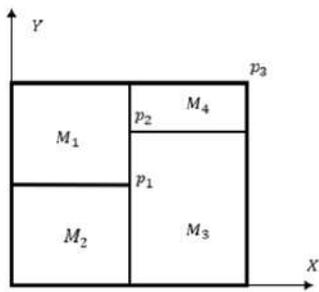
4. Convection-Diffusion Phenomena Modelling

This project was developed in the Computational Engineering subject taken during my MSc in Aeronautic Engineering at the UPC - ESEIAAT. It was developed under the supervision of the Dr. Carlos David Perez Segarra in the CTTC department.. The numerical solution of heat transfer, fluid flow, and other related processes can begin when the laws governing these processes have been expressed in mathematical form, generally in terms of differential equations. In this project it was to developed the mathematical formulation and complete derivation of the convection-diffusion equation as an initial step for developing the code for modelling these phenomenon.

The first case consists in the study of a one-dimensional flow with a one-dimensional variation of the variable solved in the same direction of the flow. The second one is the same but solved in the perpendicular direction. The results obtained are shown below.



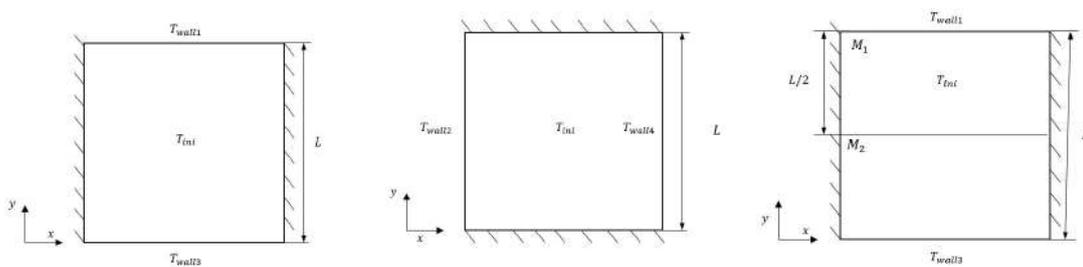
With the concept of the previous case it is possible to solve the solenoidal flow case also know as the Smith-Hutton Problem. By controlling the convection-diffusion term ρ/Γ it was possible to observe the results for full convective or full diffusive situations. Giving thus a better insight about the understanding of this phenomena and its modelling. The results are shown in the upper part of the page but a complete report and the OOP Matlab code can be found by clicking [here](#) 



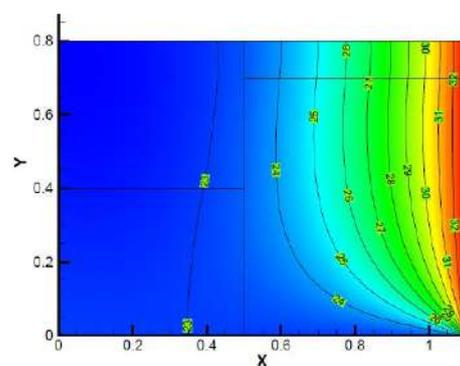
5. Unsteady 2D Heat Conduction Modelling

This project was developed in the Computational Engineering subject taken during my MSc in Aeronautic Engineering at the UPC - ESEIAAT. The objective of this section is the application of the heat conduction formulation to a two-dimensional HT conduction problem proposed by the CTTC.

It is required to solve a two-dimensional transient heat conduction problem which consists in a very long rod composed of four different materials (M1 to M4) for some given boundary conditions. For different validation cases a plot with the temperature field of the rod will be presented in order to check the validity of the results and the code. The code was developed using a self developed C code which validity was tested comparing the validation cases shown below with its analytical solution.



The images shown in the top side shows the final results for the proposed case of study. At right we can see that the obtained result corresponds more or less to the one given by the CTTC for the final validation. A complete report and the C code can be found by clicking [here](#)





6. Design for the new Geneva Airport

During my MSc in Aeronautic Engineering studies in the UPC - ESEIAAT I took the Airport Design and Construction. Together with a group of 7 people we had to develop a complete project that consisted on designing and planning the construction of an airport based on some previous requirements. In our case, we finally decided to place our designed airport in the city of Geneva.

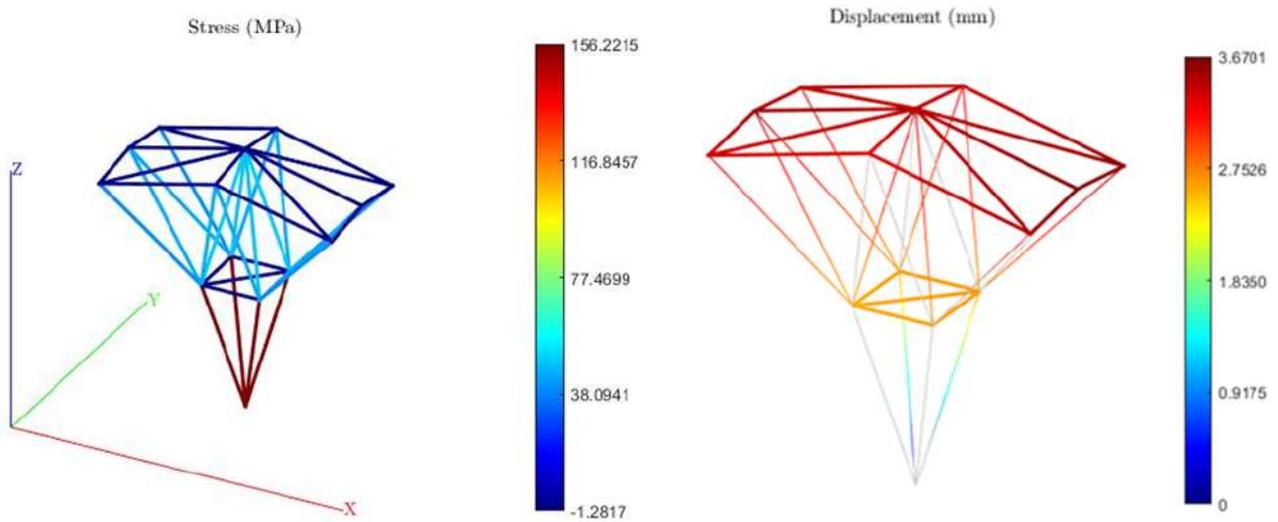
Switzerland is a country that has a great tourist attraction. On the one hand, it is a cultural destination, since it presents a wide range of activities of this type, led by the Grand Théâtre or Musée International de l'Horlogerie. In addition, it is a destination usually chosen by people who seek activities in nature, especially by those who want to practice winter sports. Currently there is an airport in the city of Switzerland, which has two terminals: one in Switzerland and another in France. This causes logistical problems and does not allow it to grow above the values achieved in recent years. This fact justifies the construction of a new airport in the city.

The location chosen for the airport that is the subject of this report is on the outskirts of the Swiss city of Geneva at 20km from it. It is necessary to highlight the proximity of Lake Léman, which provides a large space for landings and take-offs. There is a mountainous formation to the southeast of the airport, at a height of about 1000m, but it does not pose any problem since it would not be necessary for airplanes to pass over it.



During the development of this project I had the opportunity to be involved in all the main aspects for its planning and design. From the air traffic forecasting to the terminal design. In this case I had the opportunity to work using SketchUp for developing the terminal spaces and merging the results with the landing field and runway system.



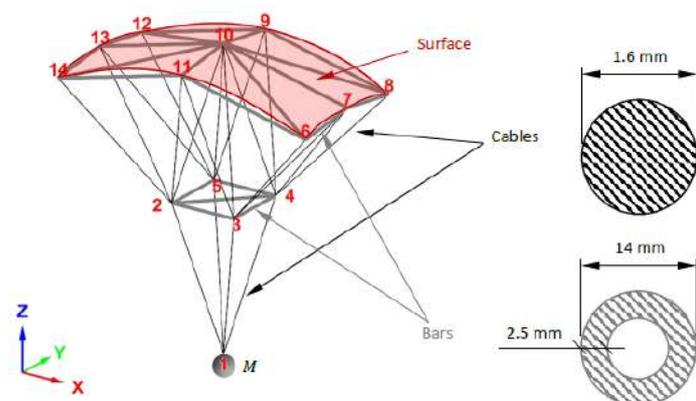


7. Parachute Structure Analysis

This project was developed in the Computational Engineering subject taken during my MSc in Aeronautic Engineering at the UPC - ESEIAAT. It was developed under the supervision of the Mr. Juan Carlos Cante Teran in the aerospace structures department. In order to analyse the an engineering system, for this case a parachute structure, a mathematical model is developed to describe the system. These model consists on some assumptions made for simplification. Finally, the governing mathematical expressions is developed to describe the behaviour of the system. The mathematical expression usually consists of differential equation and given conditions.

These differential equation are usually very difficult to obtain solutions which explain the behaviour of the given engineering system. One of its major advantages is that a general purpose computer program can be developed easily to analyse various kinds of problems. In particular, any complex shape of problem domain with prescribed conditions can be handled with ease using Finite Element Method.

For this project it was asked to solve the parachute structure composed of a surface attached to an upper bar structure from which a second bar structure hangs through a set of cables. The system is designed to be dropped with null velocity from a certain height. There is a mass $M = 122\text{kg}$ hanging from its lower structure that would land with a relatively low velocity thanks to the drag produced by the upper surface. The complete static analysis was solved using a self developed Matlab code that can be downloaded by clicking [here](#) 





8. Activities and Free Time



FOOTBALL CLUB JESUS CATALONIA - FCF

I always enjoyed playing football with my teammates. I think that when you are playing an sport like football you not only learn how to play, you also gain strong cooperative spirit interpersonal and teamwork skills. There is no day that I do not miss playing.



WINSURFER - LEVEL 2 ISSA

During the summers that I did not worked I used my free time doing activities that I loved such as fishing and hiking but I also tried new ones like windsurf. It turned out that i loved this sport and all the physics surrounding it.