COMPUTER AIDED DESIGN: COURSEWORK 2. HAIRDRYER

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INTRODUCTION

The aim of this project is to design a hair dryer using a variety of 3D CAD solid modelling techniques including 3D surface modelling and model analysis and simulation. The design must be functional, with easy grip, convenient operation and suitable for plastic injection moulding manufacturer.

The essential parts of the hair dryer that should be used are the following: motor, fan, switch, capacitor, standard (self-tapping) screws.

For the development of the design of this project, the computer-aided design software Creo Parametric 4.0 has been used. The renderings have been made in the same software

MAIN BODY

The Design Concept

For this design with variant sizes, it has been used a 30mm tip radius for the fan, as well as 16mm boss radius, 2mm diameter of the fan central hole and 7 number of blades. For the fan motor it has been used a 2mm diameter drive shaft and a 30mm diameter of the motor body. The fan stator has been modified to fit as well as the heating coil frame (HCF). The nozzle varies its design changing from a cylindrical shape to an elliptical one.

After this the assembly of the heating coil frame has been done, assembling the three different heating elements and the tapper shield (Modifying them to fit). The fan-motor-stator has also been assembled, by joining the fan with the fan motor and the fan stator, adapting them with each other.

After this, the sketches of the final product that is being sought were designed.

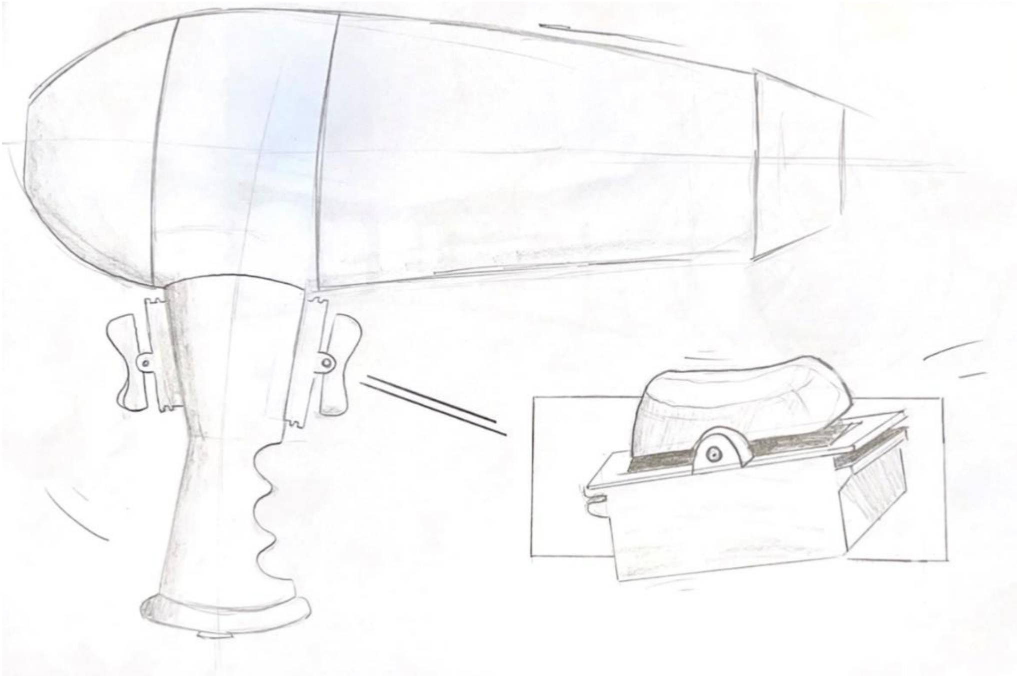


Figure 1: Sketch of the right view of the hair dryer and detail sketch of the switch

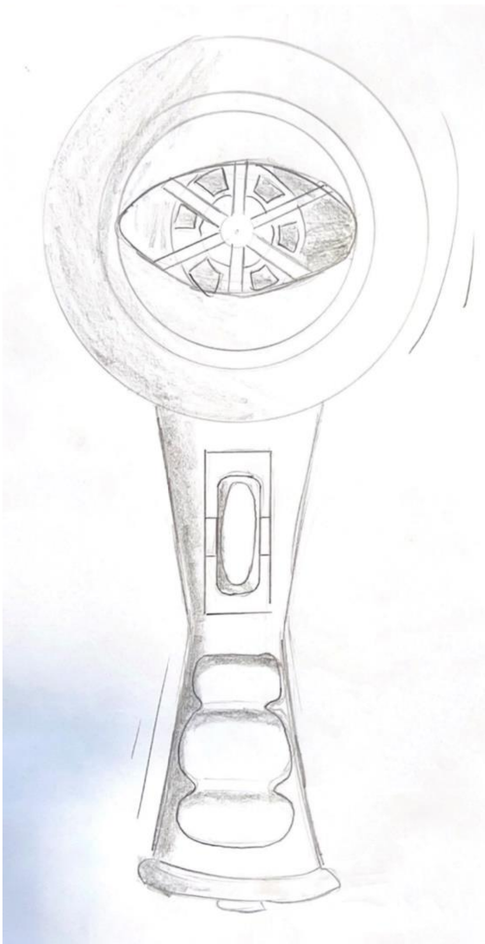


Figure 2: Sketch of the front view of the hair dryer

3D CAD Concept

Following these previous steps, the 3D design was done in Creo Parametric. Below you can see the assemblies and designs of some of the pieces necessary for the final construction of the product, in this case the hair dryer.

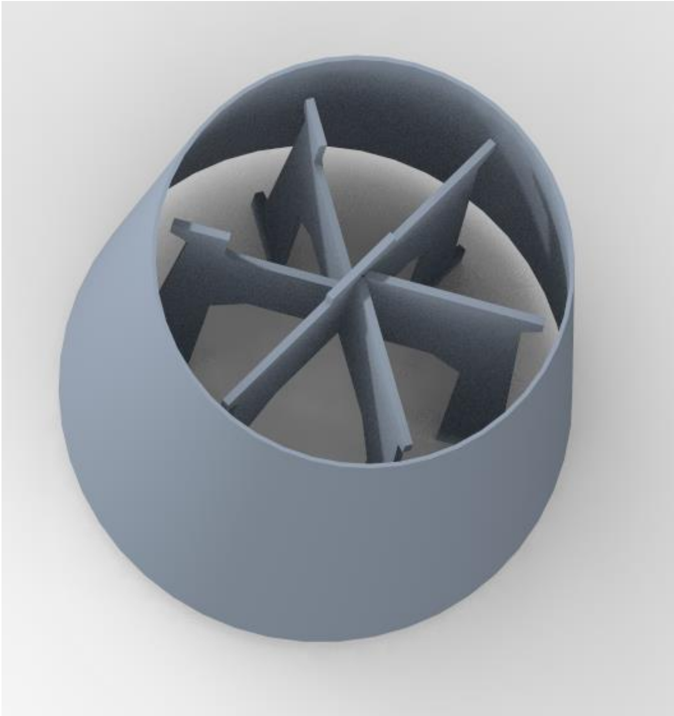


Figure 3: Render of the assembled heating coil frame

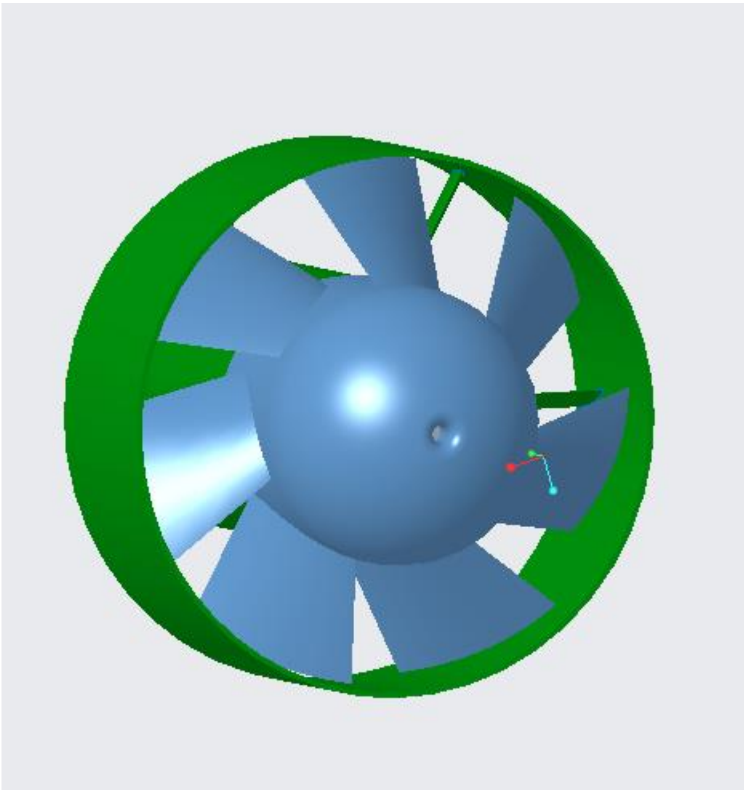


Figure 4: Fan, motor and stator assembly

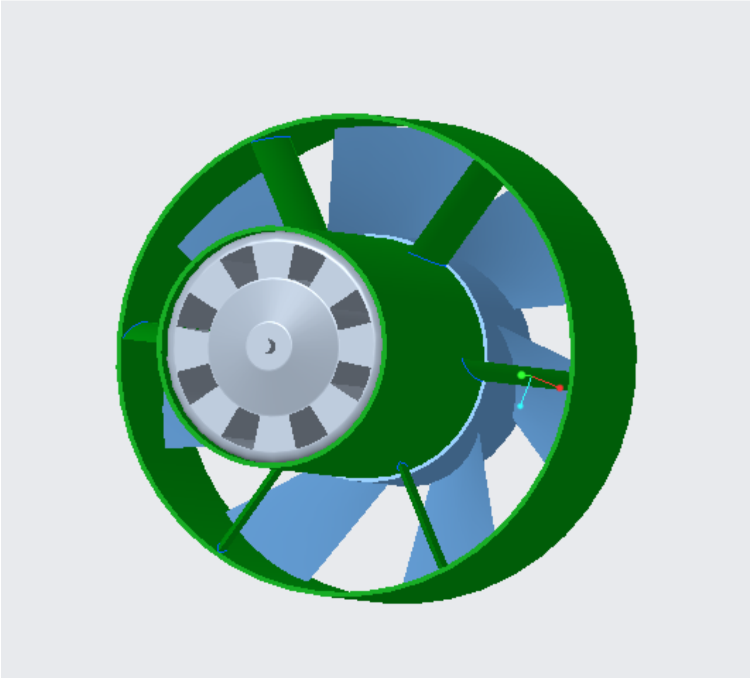


Figure 5: Fan, motor and stator assembly

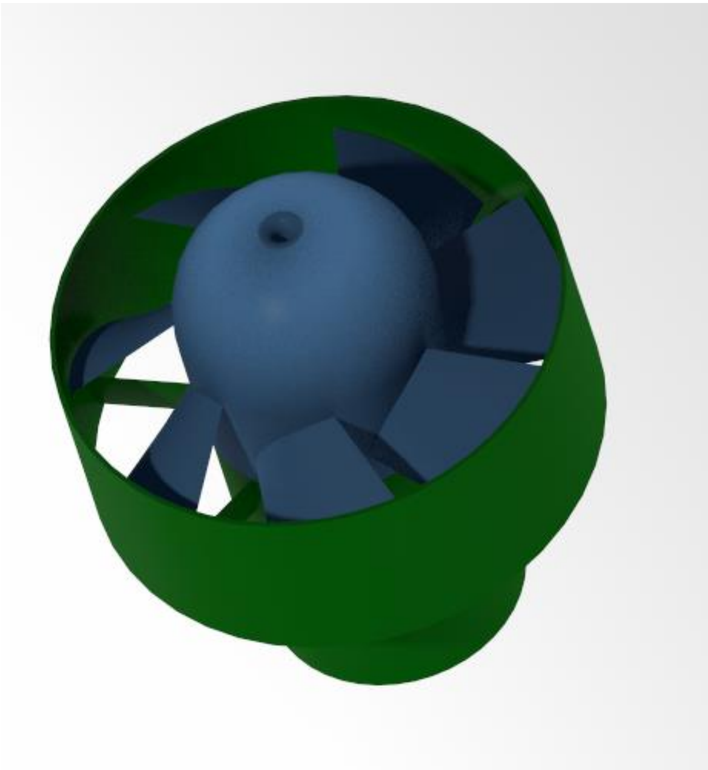


Figure 6: Rendered fan, motor and stator assembly

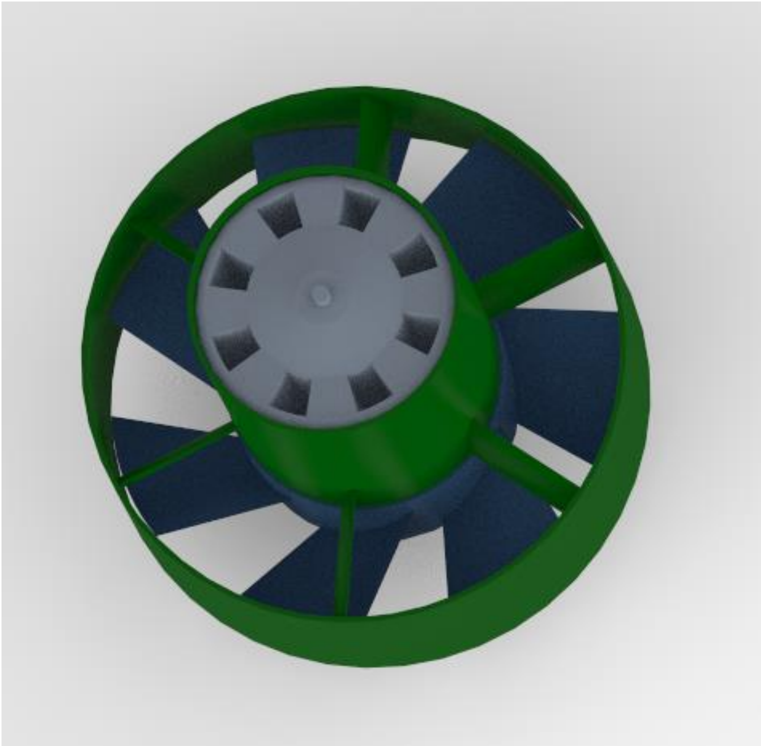


Figure 7: Rendered fan, motor and stator assembly

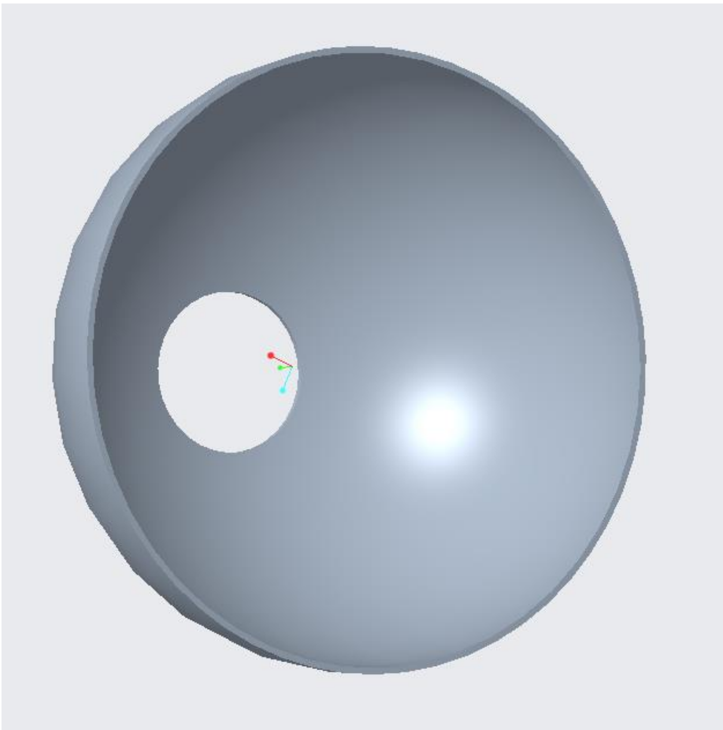


Figure 8: Back part of the hair dryer

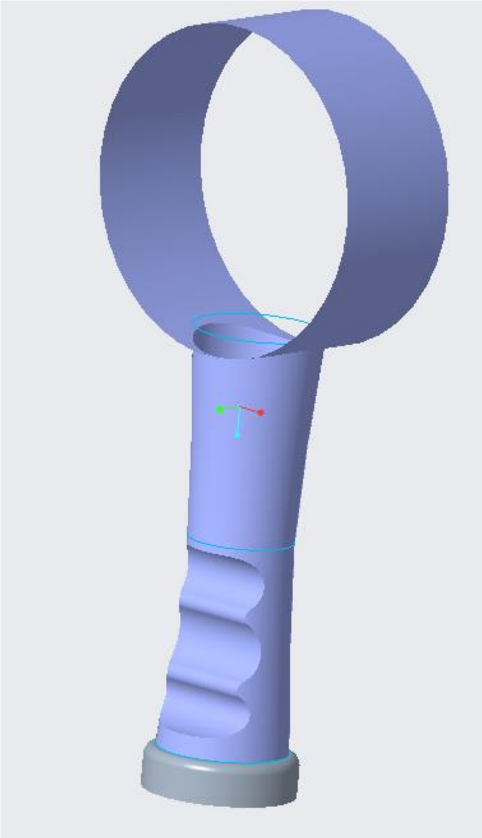


Figure 9: Handle of the hair dryer

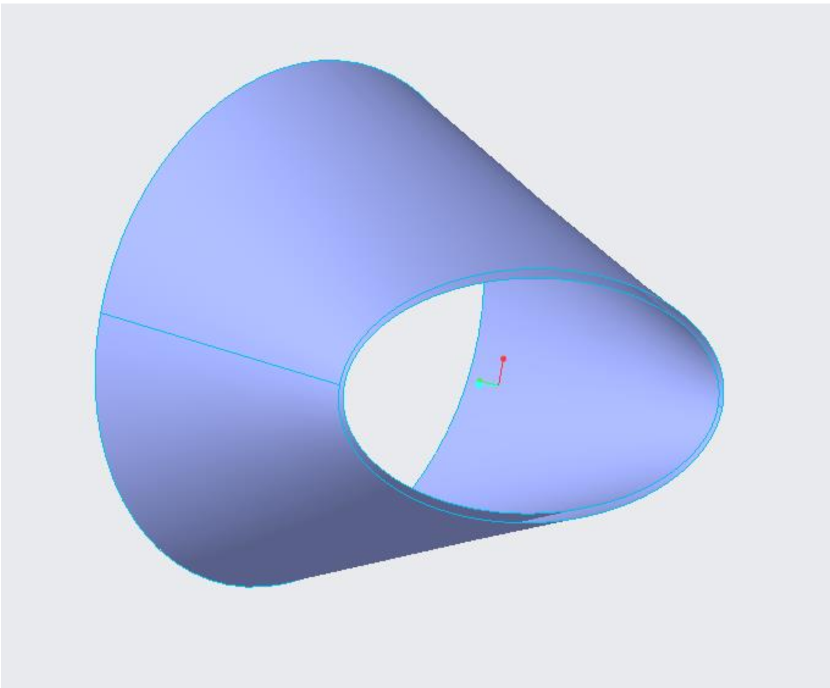


Figure 10: Stylish nozzle of the hair dryer

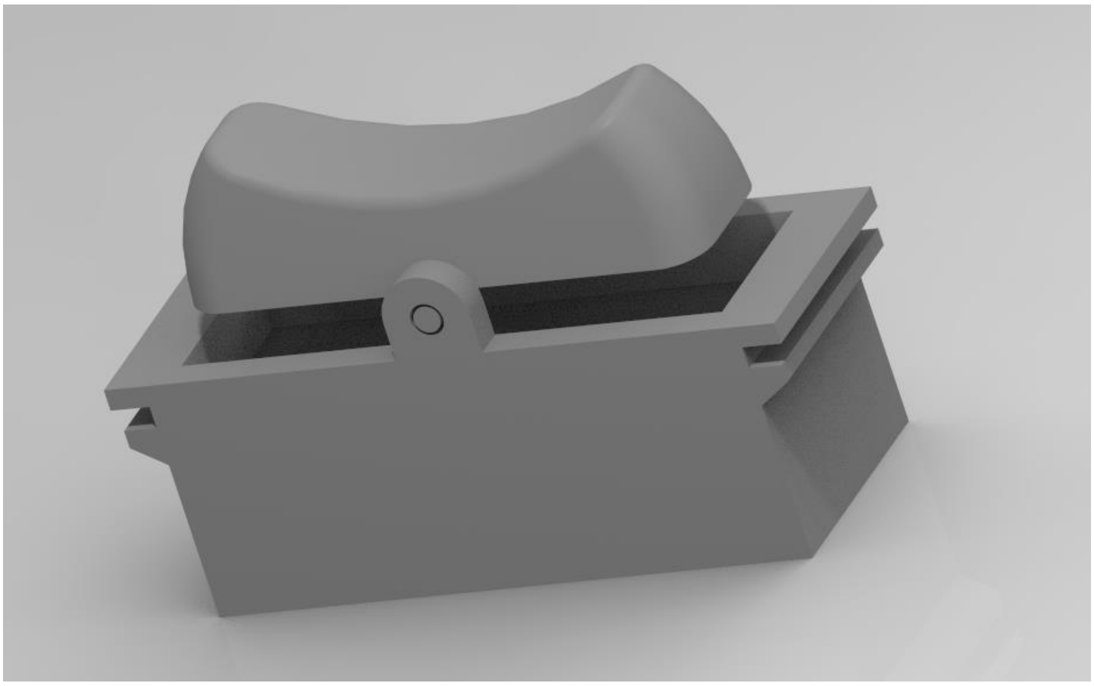


Figure 11:Rendered hair dryer switch

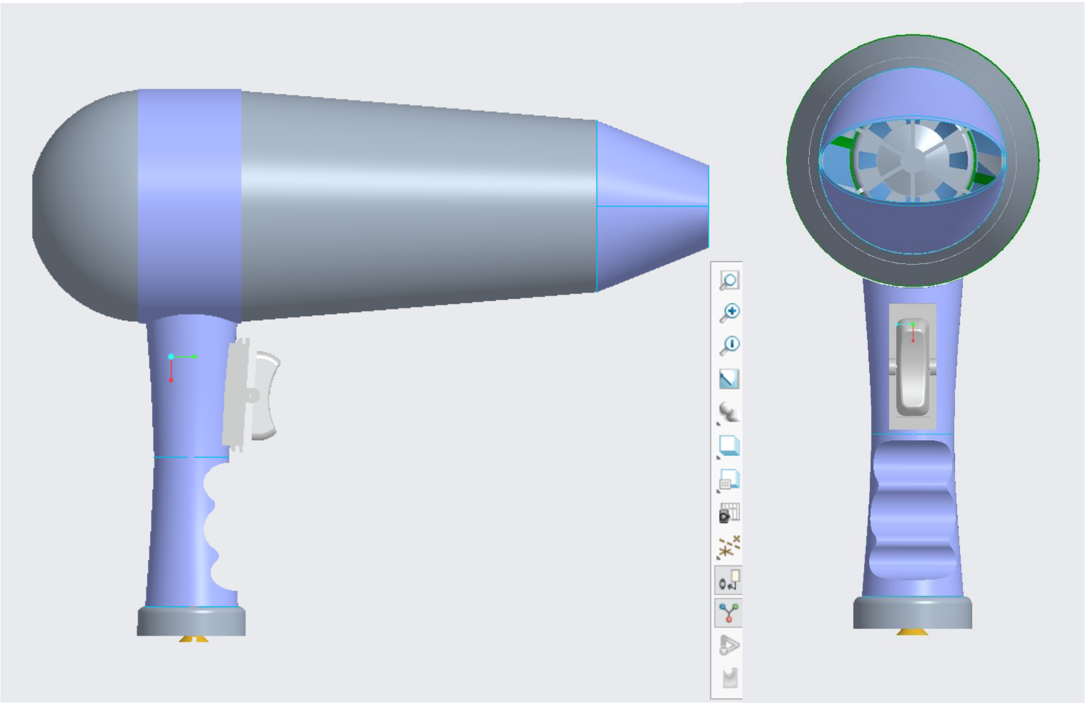


Figure 12: Assembled hair dryer

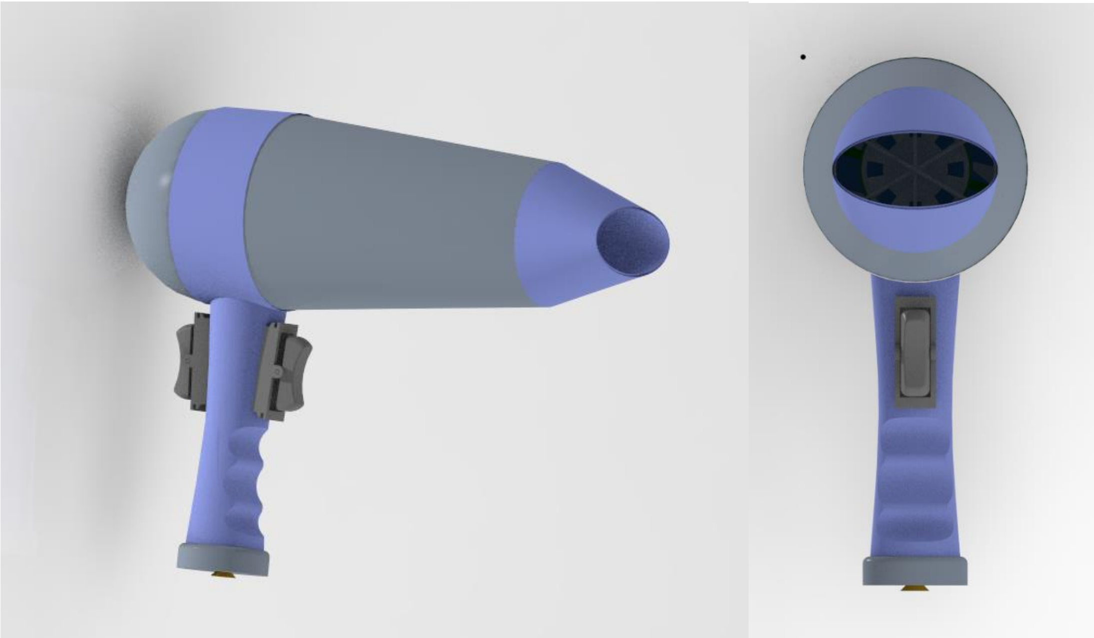


Figure 13: Rendered hair dryer

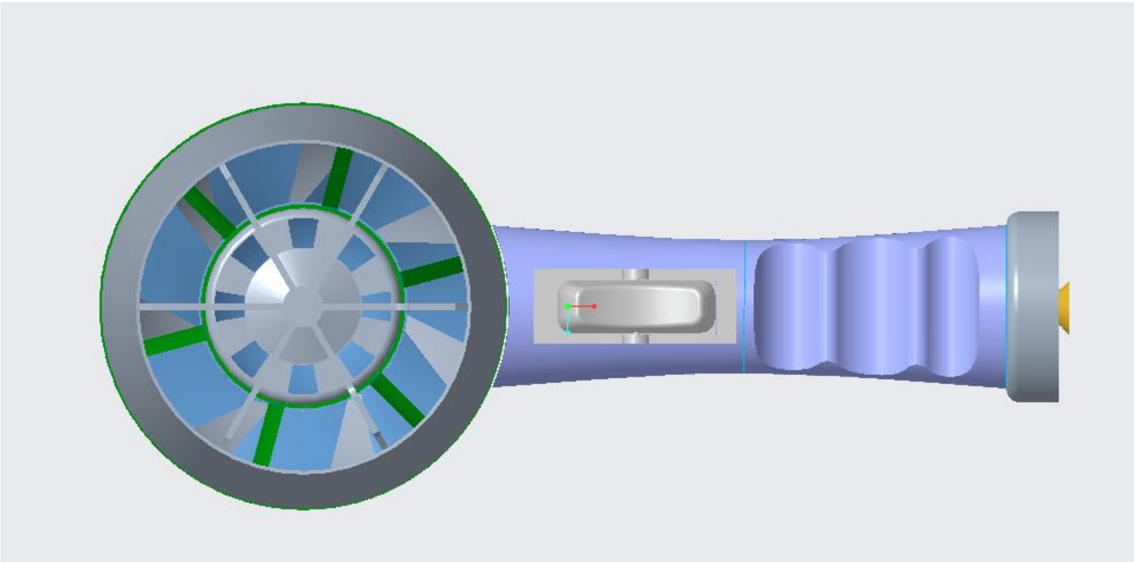


Figure 14: Hair dryer without nozzle and extension

Main Enclosers

Each part of the hair dryer has been designed with software techniques such as:

Surfaces (extrude, rotate, sweep, boundary merge, round, etc.). They have been used to create the main body, to help round the handle (position for the fingers) and in general to start the design of each part.

Surface manipulation techniques (merge, trim, offset commands). Thanks to these techniques, it has been possible to design the most fragile parts of the product, such as the union of the handle with the main body or the ventilation grille.

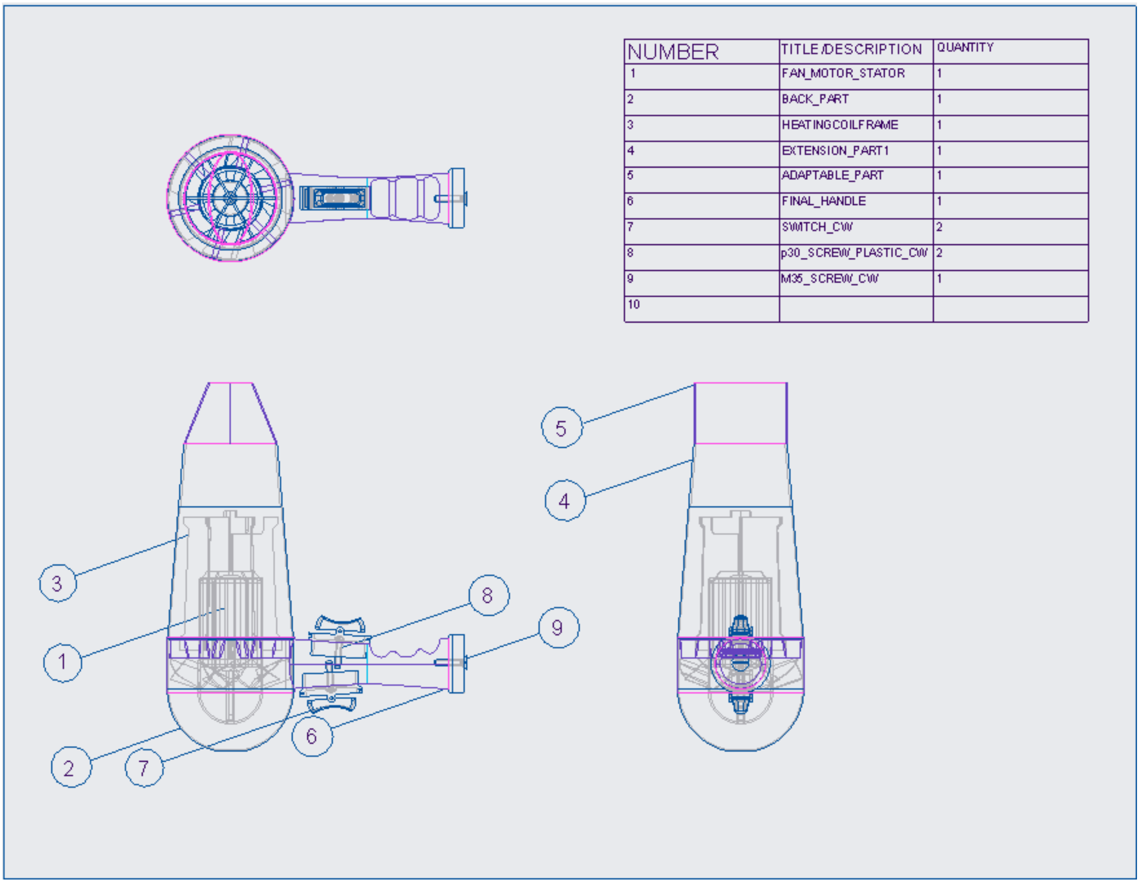
Design Improvements

After a detection analysis, a main conflict has been identified. The union of the handle with the main body is a very fragile area since the weight of the components is quite large when compared to a surface as small as the fist. Therefore, a new idea has been developed to carry out the union of both pieces. A handle has been designed which is directly manufactured together with a hollow cylinder. This cylinder has the same diameter as the outside diameter of the fan stator. In this way, both pieces can be joined much more easily. With a motor glue simply by dragging the cylinder into the main body it will be in the perfect position for the comfort of the user.

After all this we can identify an advantage in this new development. If the handle suffers some type of damage or simply breaks, you can easily remove the entire piece, remove the rest of the motor glue, add a little more and put a new piece that can be sold separately.

Assembly Drawing

An assembly drawing has been developed through the Creo Parametric software in which we can observe three different views: front, right side, top side. You can distinguish a table of elements with their respective numbers and quantities. The numbers of each element are defined by the balloons that stand out in the drawing



NUMBER	TITLE/DESCRIPTION	QUANTITY
1	FAN_MOTOR_STATOR	1
2	BACK_PART	1
3	HEATINGCOILFRAME	1
4	EXTENSION_PART1	1
5	ADAPTABLE_PART	1
6	FINAL_HANDLE	1
7	SWITCH_CW	2
8	p30_SCREW_PLASTIC_CW	2
9	M35_SCREW_CW	1
10		

Figure 15: Assembly drawing

Materials. Volume, mass, and costs calculations

Different materials have been used for the design of this product.

For the heating coil frame, stainless steel since it has greater resistance to corrosion, higher resistance to high temperatures, increased strength, and toughness, and requires less maintenance.

For the stator and the M35 screw, steel has been used since it has great thermal and acoustic insulation, optimizes materials and costs less labour.

Aluminium has been used for the fan motor and for the plastic parts, that is, the switches, the fan, the handle, the nozzle, the extension part and the back part of the hair dryer, a polymer has been used, PVC, which is a non-conductive electrical and thermal material, that is, a natural insulator. It does not conduct sound waves and due to its morphology, it is a good absorber of sound waves.

Calculations of volume, mass and costs.

After having calculated the properties of the plastic of each part, the following results have been obtained:

	SWITCH(x2)	**BACK PART**	**HANDLE**	**EXTENSION**	**FAN**	**SCREW(x2)**
VOLUME (mm^3)	1791.1943	3694.3885	5264.3323	5069.4152	4123.0127	118.46136
MASS (Tonnes)	2.48976E-6	5.1352001E-6	7.3174219E-6	7.0464871E-6	5.7309877E-6	1.646613E-7

The total volume of all the plastics parts is 21970.46002mm^3, and the total mass off al the plastic parts is 3.05389394E-5 Tonnes which has been converted to 3.05389394E-2 Kg.

Currently, PVC plastic is around 835 US dollars for each metric ton. We know that a metric ton is 1016260162 mm^3 so with a simple rule of thumb it is calculated that 21970.46002 mm^3 of PVC is about 0.01805180877 US dollars. After converting this amount to pounds, it results in 0.015, which when multiplied by the million we want to produce gives us a total of 15,000 pounds

FEA Analysis

To carry out the FEA strength analysis, the most fragile parts of the product have been analysed, reaching the conclusion that they were the small holes to which the switches are anchored. The study has been carried out by applying a pressure of 0.68 atm to the surface of the switch, obtaining the following results:

Results Summary		
QUANTITY	MAXIMUM VALUE	MINIMUM VALUE
Von Mises Stress	2.94804 [MPa]	0 [MPa]
Deformation, SUM	0.0211312 [mm]	0 [mm]
X Normal Stress	2.36479 [MPa]	-2.6544 [MPa]
Y Normal Stress	0.36357 [MPa]	-1.04328 [MPa]
Z Normal Stress	0.434372 [MPa]	-0.706446 [MPa]
XY Shear Stress	0.883884 [MPa]	-0.765443 [MPa]
YZ Shear Stress	0.655136 [MPa]	-0.652691 [MPa]
XZ Shear Stress	0.354231 [MPa]	-0.362157 [MPa]
Maximum Principal Stress	2.50203 [MPa]	-0.218263 [MPa]
Middle Principal Stress	0.439736 [MPa]	-0.639926 [MPa]
Minimum Principal Stress	0.120158 [MPa]	-3.06119 [MPa]
Local Reaction Force, SUM	0.861474 [N]	0 [N]
Reaction Resultant, SUM	4.16679 [N]	0 [N]

Figure 16: Table of results of the FEA

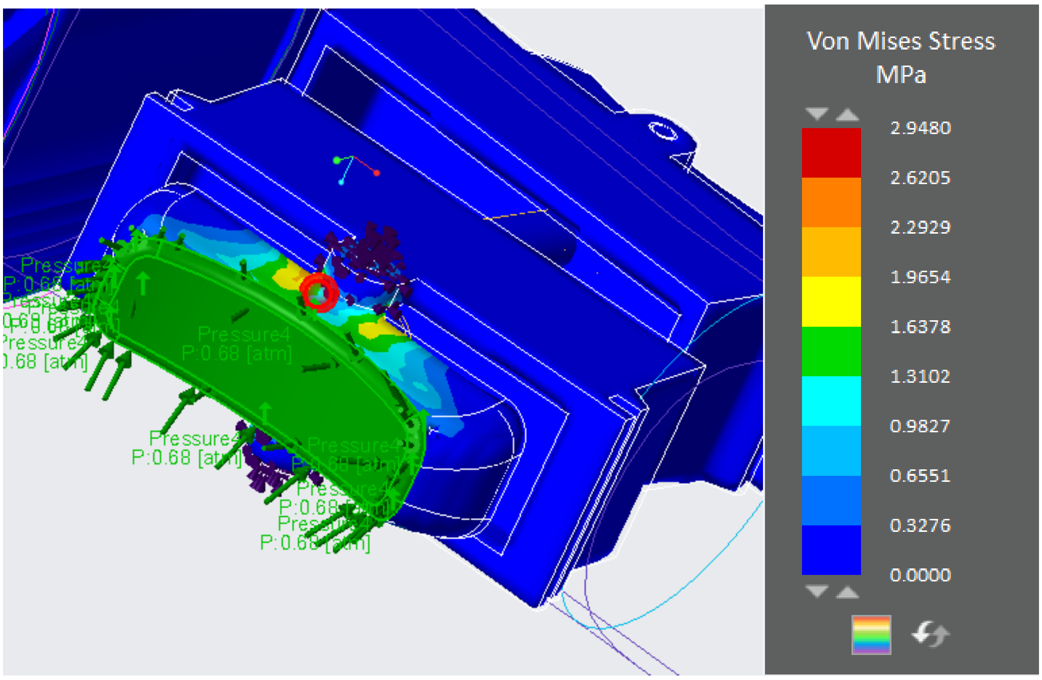


Figure 17: Detail of the test zone and values of the VMS

A maximum Von Mises Stress value of 2.94804 MPa has been obtained by applying a pressure of 0.68 atm. The yield strength of PVC plastic is between 37.9 and 54.8 MPa. After some basic calculations, it can be concluded that the maximum pressure that can be applied to the most fragile area (the switch) is approximately 8,742 atm.

CONCLUSION

To conclude, it is worth highlighting the importance of the development of technology in these times. In half a century, society has achieved unimaginable things, and the most important has been the advancement of the Internet and computers. Who would have thought 50 years ago that you could take a computer and simply design a product until you could mass-produce it? CAD software is undoubtedly a great help for modern design. They are very precise programs which avoid all kinds of errors in measurements or units, they are relatively easy to use with a keyboard and a mouse, they can be rendered and printed in 3D, and, above all, real simulations of forces exerted on fragile zones can be done to calculate the VMS, the deformation or many more things. As a disadvantage, relatively “few” people nowadays know how to use CAD perfectly, this means that finding help for difficult problems is still difficult to get easily, unlike in other sectors, unless you study design in university or college. There is still a lot to improve, and it will get better, but for now CAD software is a huge help to designers.