I. How this idea come to our mind :

We started by thinking about what kind of project we wanted to do. We're both interested in design and programming, but not so much in electronics, so we came up with the idea of an articulated arm, and more specifically a robotic arm. This would combine the areas that we enjoy, with a large design part and a large programming part that would enable us to control the arm. We are well aware that in this type of project, electronics are essential, given the installation of the motors and the connections between our arm and the arduino board.

II. Conception part :

We all started by creating a prototype on fusion 360, but then we realised that starting by designing our first prototype directly could cause us problems during final.

We drew the various parts of our robotic arm in 2D so that we could analyse how well our project worked as imagined in our heads. This is called a cardboard and it allows you to visualise a prototype before printing or manufacturing it for the first time. Thanks to the cardboard, you can see the different constraints that need to be met and avoid encountering them when assembling the first prototype. This method enabled us to highlight a number of points for reflection, such as :

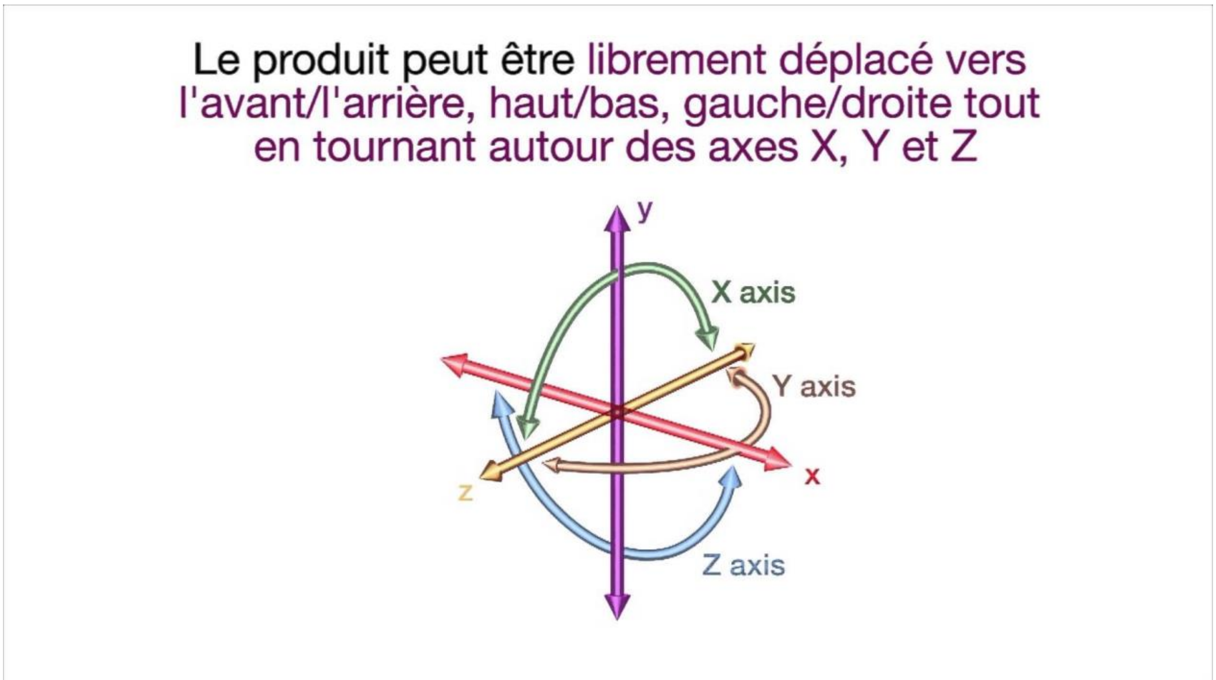
1) The number of freedom degree :

We will start by explain to you what that is in the context of a robotic arm, it's refering to the ability of a mechanical arm or robotic system to move independently in a specific direction. It represents the number of movements or axes of rotation that the arm is capable of performing.

More precisely, a degree of freedom corresponds to a direction or movement in three-dimensional space. This may be linear translation along an axis (for example, the X, Y or Z axis), or rotation about a specific axis (for example, the yaw, pitch or roll axis).

A typical robotic arm has several degrees of freedom, allowing it to perform a variety of movements and positions in space. For example, a robotic arm with three degrees of freedom might be able to move in three different directions: forward/backward (X axis), left/right (Y axis) and up/down (Z axis). Each degree of freedom is controlled by a specific motor or actuator.

The number of degrees of freedom of a robotic arm determines its flexibility and its ability to achieve different positions and orientations.



We have chosen to manufacture a robotic arm with two degrees of freedom along the x and y axes. We didn't want to add a third because it would be too complicated to code and adapt to our application, which will control the arm on our telephone.

2) The angle of heel :

The different positions that our robotic arm can have is made possible by the ability to make different angles to these different parts. We have two two-part junctions to which this applies:

- The first junction is between the base of the arm, which holds the arm to the ground, and the first part of the arm.

- The second junction is between the first part of the arm and the second part of the arm. This will give greater precision and make it easier to grab objects.

We've chosen an angle of 180 degrees for the first junction, which will give our arm greater capacity for movement, so that it can catch objects both in front of it and behind it. For the second junction, we realised that it needed to be reworked because with our first idea, it wasn't big enough to be able to pick up all the objects depending on the first angle.

The card board also highlighted some very important points about the connection between the different engines and their junctions. Indeed, the first junction being at ground level is easy to make.

The carboard method also allowed us to start asking ourselves more technical questions. Design is an important part of the project, but it's also important to think about how our robotic arm is going to work.
The choice of components was therefore an important step in our project.

<u>Choice of components :</u>

1. Servomotors: We need a servomotor to provide the movement of the arm. For our project, a standard medium-sized servo motor will be sufficient.

2. Mechanical arm: For the mechanical arm itself, we can use carbon rods or aluminum rods to build the structure. there are several options available in the market that are suitable for our project, such as the SunFounder mechanical arm kit. But we decided to go through the 3D printer.

3. Control card: A control card is needed to manage the movement of the arm. The Arduino Uno board is a great option for this.

4. Cables: We need cables to connect the servo to the control board. You can use 30cm servo cables.

5. Power supply: A power supply is required to power the control board and the servo motor. So, a 9V battery or a 5V power supply.

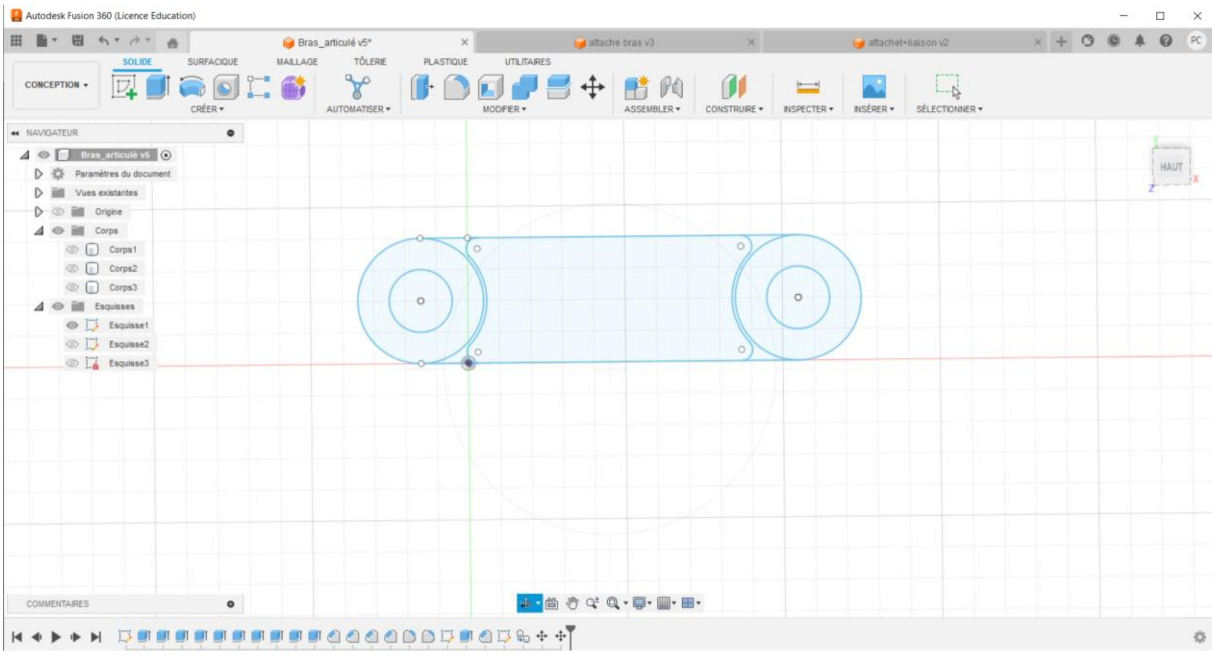
6. Connectors: We will also need connectors to connect the various components together.

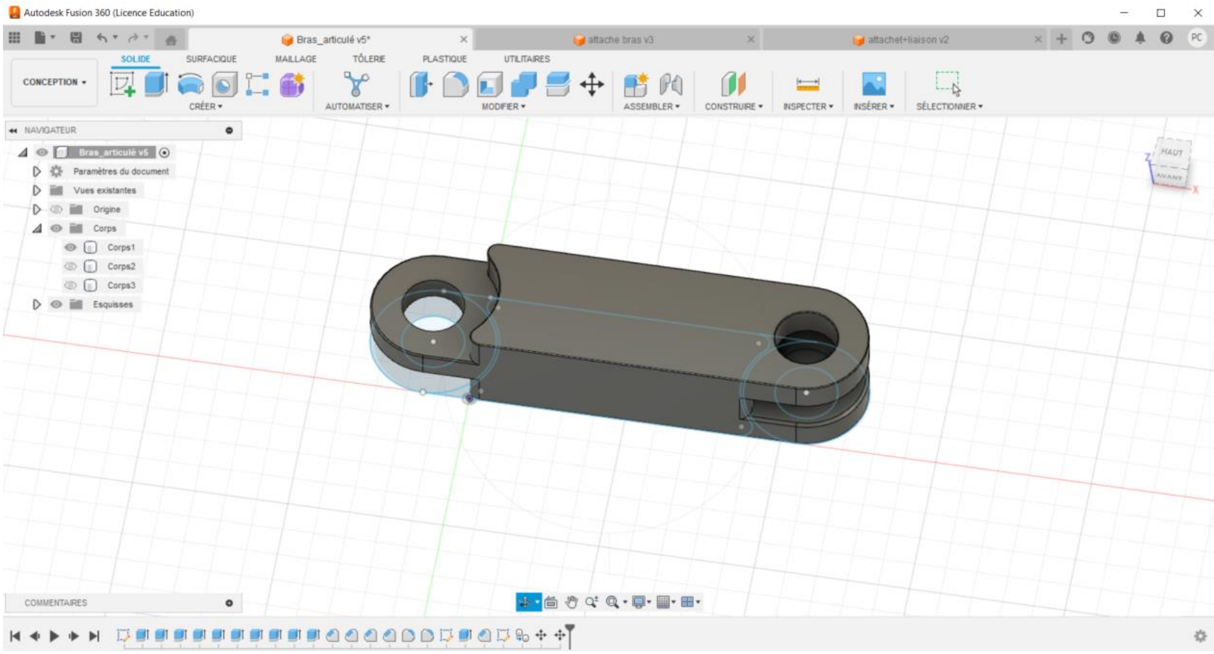
Once all the components had been chosen, we had to start thinking about how we could integrate each of them into our robotic arm. This question mainly arose for the motor linking the first part of the arm and the second part of the arm, but also for the motor linking the second part of the arm to the gripper operated by an infinite screw. The first motor linking the base and the first part of the arm is quite easy to position because it is at ground level, but this is not the case for the other two. We therefore had to find a solution to offset the other two motors, and came up with the following solution:

- The first was to create a shaft parallel to the first part of the arm, which would operate on the same principle as a piston and which could therefore trigger the second rotation of our robotic arm.
For the third motor, the solution was simpler: as it was a very small motor whose sole purpose was to turn an infinite screw, we placed this motor on the second part of the arm.

<u>Design on fusion 360 :</u>

Once we had analysed and sorted out all the major faults we had encountered using the Card Board method, we started the design on Fusion 360 software. This was the longest period, as it was the first time we'd created a part assembly, so there were a lot of constraints.
We started by creating the first part of the arm:

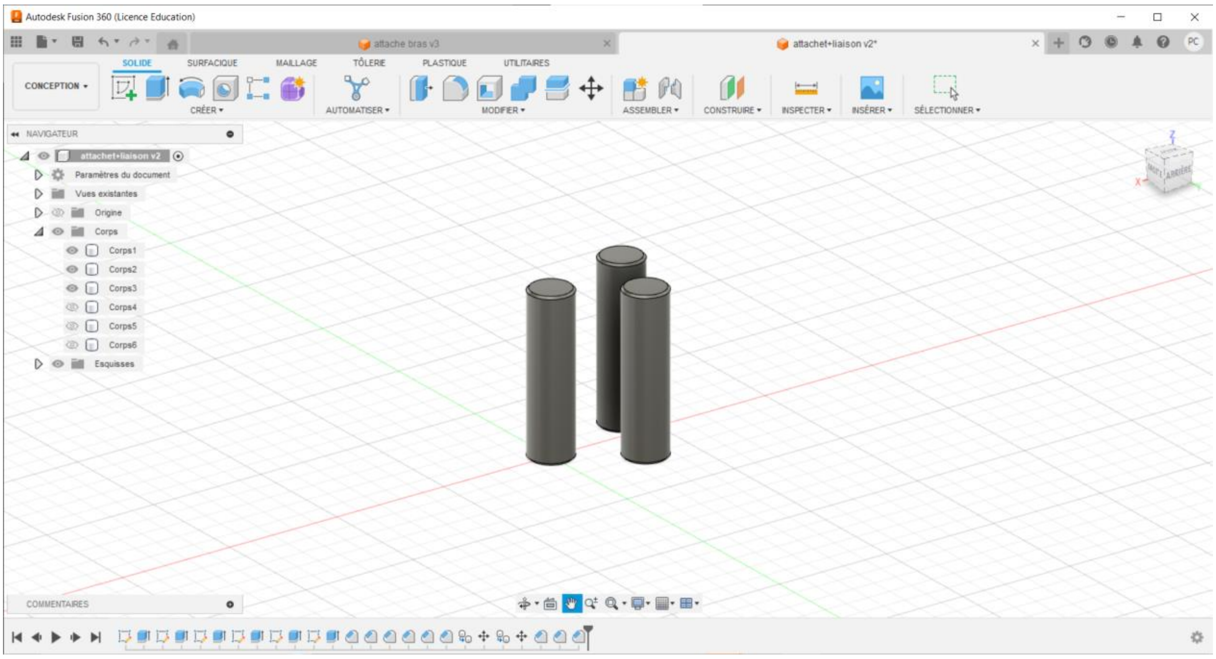




It's important to note that the first part of the arm and the second part of the arm are two identical parts, so that their assembly is as precise as possible. Adding a chamfer makes for better assembly during printing, and also prevents the part from breaking when it's removed from the 3D printer tray.

Once these different parts had been finalised, we exported them in .stl 360 fusion format so that we could open them on the software (Cura) which would allow us to choose the different options we wanted for our print (filling, size etc...). Our part was too big for the printer, so we reduced its size.

We then created the support to attach the first part of the articulated arm to the floor, as well as a place to put our rotor. The creation of this part required a lot more thought than the first part, because we had to be precise enough to be able to place our motor in it, but also to ensure that the first part of the arm would fit into our part.



We tried to create a clamp that would be located at the end of our second part of the arm but despite many attempts we didn't manage to create one that could be controlled using an infinite screw. So we looked on the internet to find another type of gripper that we could design, but they were all more complex than the others, with the creation of gears for example.

We're now going to move on to the programming part, which involves developing the interface for controlling the robotic arm using the smartphone, as well as the various programs for controlling the different motors within the constraints we've given them.

III. Programmation part :

One of the primary purposes of the sample code is educational. It serves as an entry point for beginners to grasp the principles of robotic control. By initializing and manipulating servo motors, newcomers to robotics can begin to understand how movements and positions are controlled programmatically. Through the code, users can see the direct impact of their instructions on the physical movements of the robotic arm.

The code is instrumental in testing and calibrating the robotic arm. When assembling a robotic arm, it's important to ensure that the motors and joints are functioning as expected. By using a simple code that moves the servos to specific positions, users can verify if the motors are responding accurately to the instructions and if the arm's range of motion is within the expected parameters. This phase is crucial before embarking on more complex programming.

While the code is basic, it serves as inspiration for further development and experimentation. Users who have implemented this foundational code can start to imagine the vast possibilities and applications of robotic arms. They can begin to add sensors, create more complex movements, or even integrate machine learning algorithms for advanced tasks such as object recognition and autonomous manipulation.

While wanting to delve deeper into programming, we thought about combining our Arduino codes to enable our arm to be controlled via our phone. We thus created a code and an app through an app builder. This allowed us to control the arm with our phone using different instructions. However, the idea came to us a bit too late, and we realized that we needed a Bluetooth module for the program to work completely. Nevertheless, from a theoretical standpoint, the combination of our codes worked very well and would have functioned with the Bluetooth module.

IV. Personnal Behavior

After completing the first semester within the same academic track, Paul and I found ourselves inspired and full of ambition. We had a shared vision that we could push the boundaries of what we had learned thus far and create something even more innovative and impactful than our first-semester project. With a mixture of enthusiasm and a sense of purpose, we decided to embark on this journey together.

We carefully evaluated several ideas and eventually settled on developing a project centered around an articulated robotic arm. At first glance, this seemed to be an ideal choice. It presented us with an opportunity to apply the skills we had acquired, and on the surface, it seemed less complex than some of the other options we had considered. Little did we know that this endeavor would prove to be much more challenging than we had anticipated.

As we delved deeper into the project, we began to unravel the intricacies involved, particularly in coding the robotic arm. The motors, which we believed to be straightforward to control, were anything but. We found ourselves revisiting the drawing board multiple times, altering and reworking the code in an attempt to breathe life into the motors. It was a rollercoaster of emotions, with small victories followed by setbacks.

When we did manage to get the motors running, they seemed to have a mind of their own. The arm's movements were not aligning with our intentions, which led us to realize the complexities in calibrating and fine-tuning the mechanical components and the code that governed them.

Our progress was painstakingly slow, and the clock was not on our side. We had envisioned a fully functional and sophisticated robotic arm, but the breadth and depth of the challenges we encountered were overwhelming for just the two of us. We found ourselves wishing for more hands on deck and more hours in the day to explore the myriad possibilities before us.

Reflecting on our journey, we recognized that our ambition, though commendable, had perhaps outpaced our resources and timeframe. While we did not achieve the lofty goals we had set for ourselves, the experience was invaluable. It taught us about the importance of thorough planning, the challenges of translating theory into practice, and the humbling nature of engineering challenges.

Even though the final product was not what we had dreamt of, we gained insights, skills, and a deeper appreciation for the complexities of robotics. This experience, punctuated by both triumphs and tribulations, was an important stepping stone in our educational journey.