VlaTech Designs

Innovation Through Design & Technology

Robotic Arm - Concepts & Design:

Ingham & Vlachos

VlaTech Designs

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1

Design Brief

The Design Brief describes the required task and all the limitations and expectancies.

2

Research

Engineering builds upons the minds of previous inventors. The Research Phase examines successful designs as well as designs to avoid.

3

Concepts

Engineering involves exploring many different ideas, and evaluating each design's pros and cons. Not looking beyond the first idea can often destine the project to failure.

4

Design

Design is the key to a good engineering product. No amount of precision and strength of a material can make up for a weak design.

Design Brief

The Engineering Task assigned to VlaTech Designs is to develop a **robotic arm** for the **Roberta** platform through combining **programming arduinos**, **mechanical design**, and **electrical fundamentals**.

1

Stage 1: Sketch

Develop a sketch

2

Stage 2: Draw it up in AutoCAD

Draw it up in Autocad

3

Stage 3: Produce a Prototype

Produce a working prototype using the 3-d printer and workshop facilities

4

Stage 4: Develop the Electronics

Develop the electronics needed to drive the servos

5

Stage 5: Develop the Software

Develop the software to make the robotic arm do something useful.

6

Stage 6: Write a Report

Write a report and present your project to industry professionals

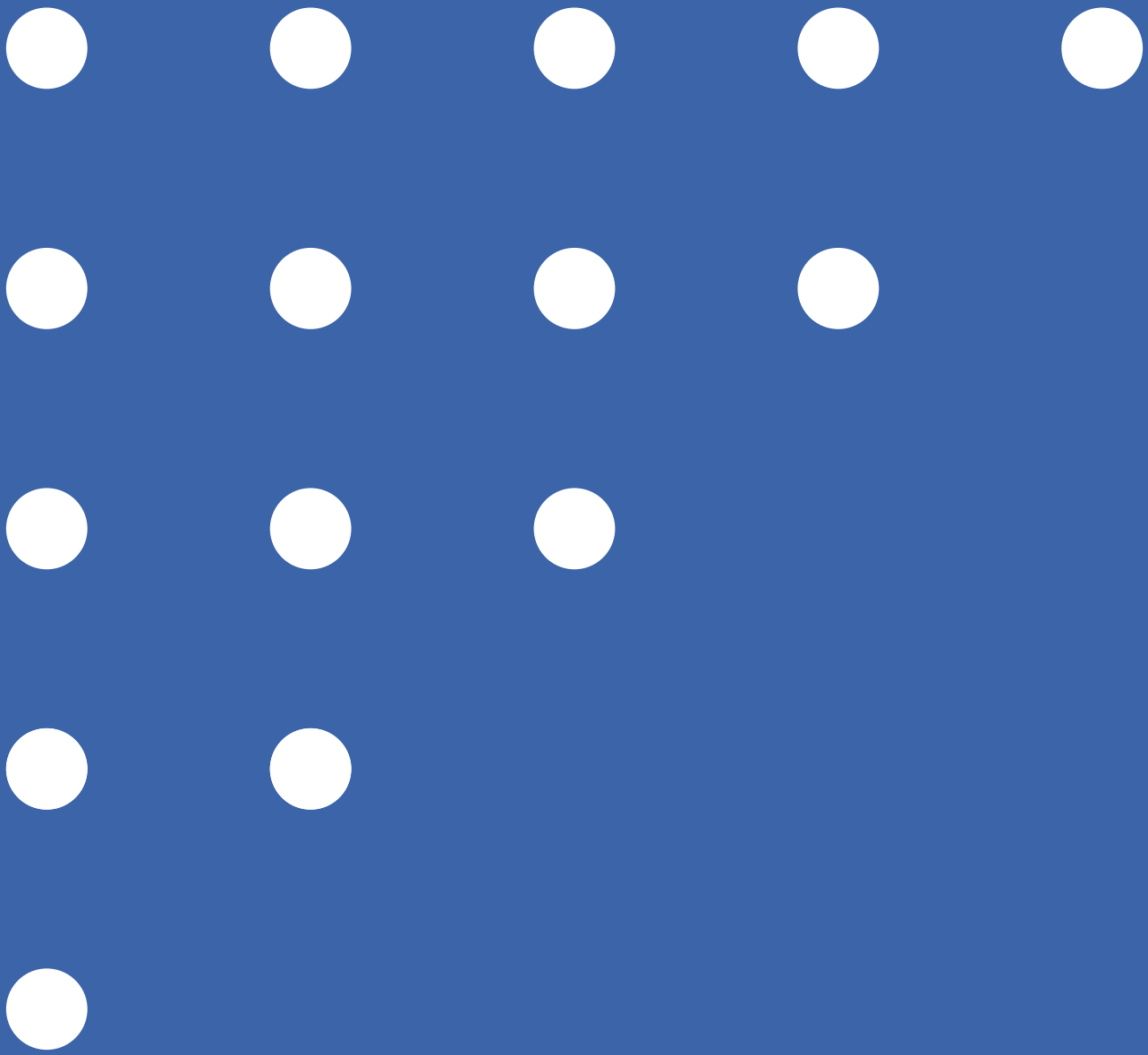
TECHNICAL SPECIFICATIONS

- The robot arm is to have 6 degrees of freedom. The base of the robot will be bolted to a large piece of wood or a table with three bolts. The mounting surface will be rigid and heavy enough to support the arm in any position. The diagram for this mounting will follow.

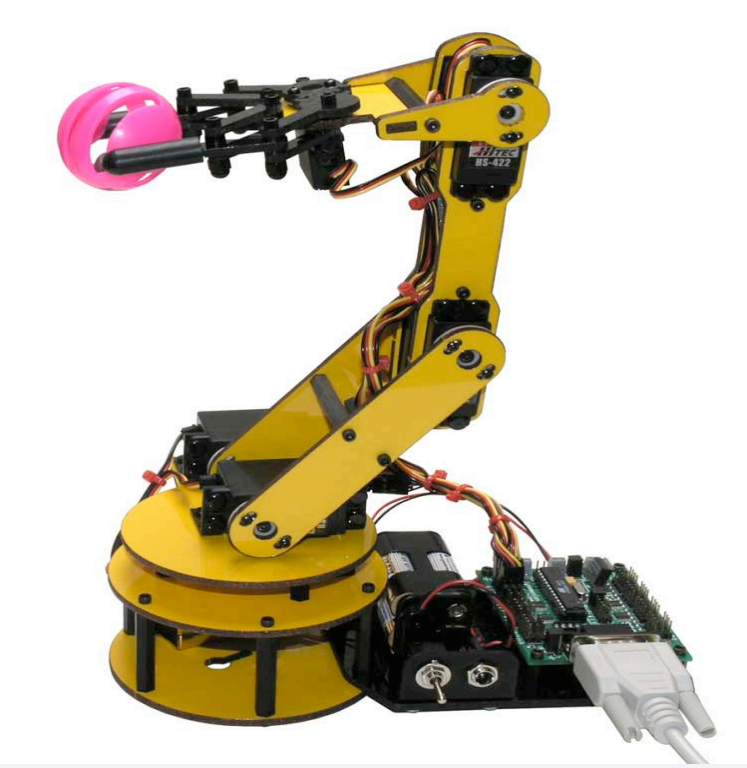
- The size of the robot arm is to be less than 30 cm x 30 cm x 30 cm when fully collapsed. The reach of the arm needs to be more than 40 cm when measured from the base of the mount. You can make the structure out of any material you like. You will be responsible for supplying the material for the robotic arm. Extra points will be given by using recycled/inexpensive materials

- The robot arm need to life a 500ml bottle of water (500grams) without breaking the bottle. The arm should be able to move this bottle from one position within it's reach to any other position. It should do this gracefully and be able to keep the bottle upright.

- The robot arm will be controlled from a microcontroller board (UDOO, Arduino, etc). The user interface can be a series of button switches, a game controller or a radio control transmitter. As an extension task, you can make the robotic arm autonomous or semi autonomous by connecting various sensors to it. There will be bonus points given for this.



RESEARCH



A robot arm is often designed for very general fuctions. Rather than a specific task, it is often planned to be able to adapt to different tasks with ease. While our robot will be required to move a 500m bottle of water, we will design and test it for various other tasks. To do this, we have first researched other general robotic arms, and examined their pros and cons. We have studied some of the common themes in each of them.

The most basic trends, besides the yellow/orange colour, start in the shape of the arms. The arms tend towards three options: all

flat arms (Image 1), combination of flat and round (Image 2), and all round arms (image 3). The requirements of the project require the arm to have 6 DOF (degrees of freedom). To achieve this and to fit into the limit, the arm will have 6 servos built into.

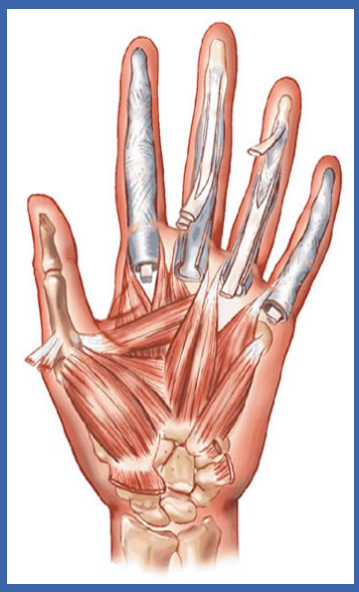
Arm Design

BAXTER

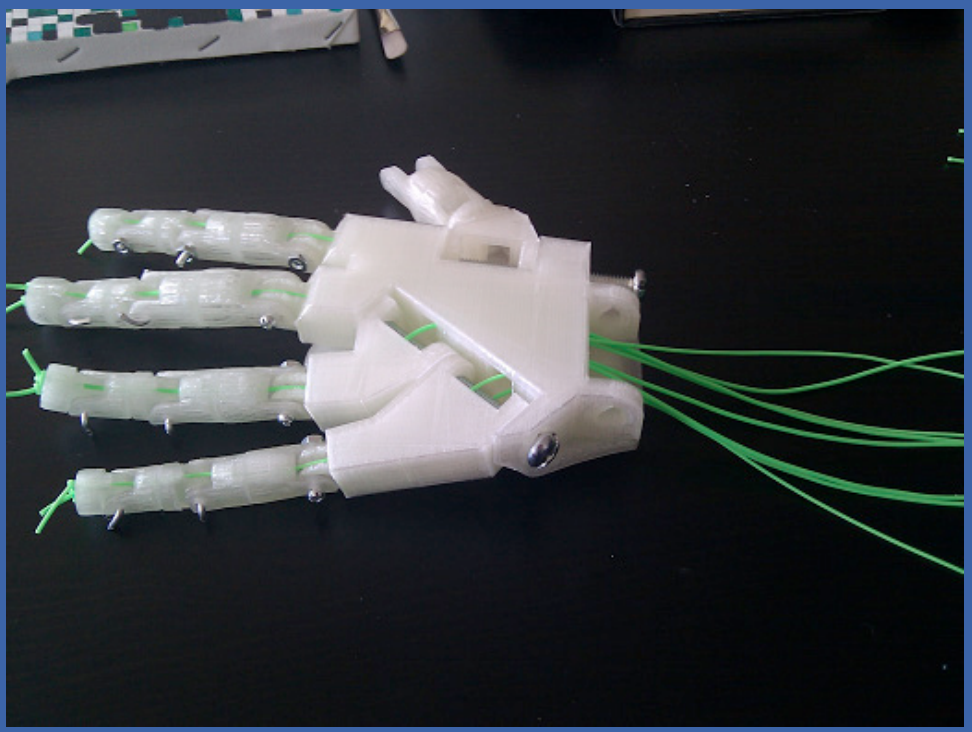
Baxter is an industrial robot designed to learn from humans around it. It is a 3-foot tall, two-armed robot with a face. Its face is an animated screen that allows Baxter to express itself by making several facial expressions. Its face can show what it is focused on, its current status and its confusion when something isn't right. Baxter has sensors surrounding its head that allow him to sense people nearby. The sensors also give Baxter the ability to adapt to its environment, alowing it to adjust to changes in its workspace.

Workers can teach Baxter how to perform a task by moving its hands in the desired motion and having Baxter memorize them. **VlaTech** aims to incorporate a learning capability similar to Baxters, by memorizing movement using wheel encoders.

Claw Design



The hand of the robot will be designed to lift a 0.5L bottle. VlaTech also aims to use adaptive servo control to be able to manuvre an empty bottle without breaking it. Various sources of inspiration involve 3D-printable hands, which use strings to move the fingers, and the Vex robotics claw, which uses two gears.



CONCEPTS

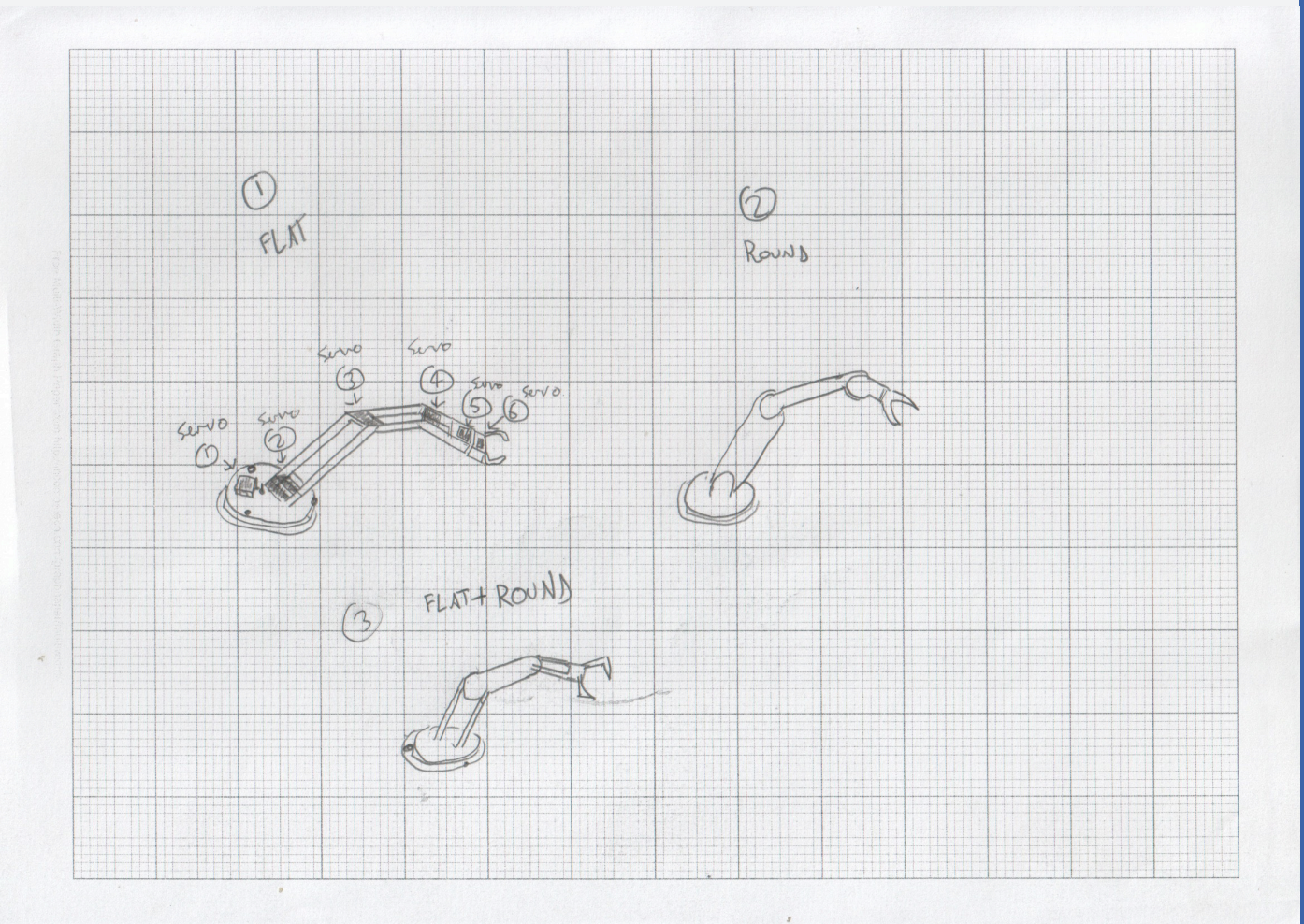
OverView

Having experimented with and researched many types of robot arms and shapes, we have come up with our design that will be easy to make out of recyled materials, while remaining solid and stable.

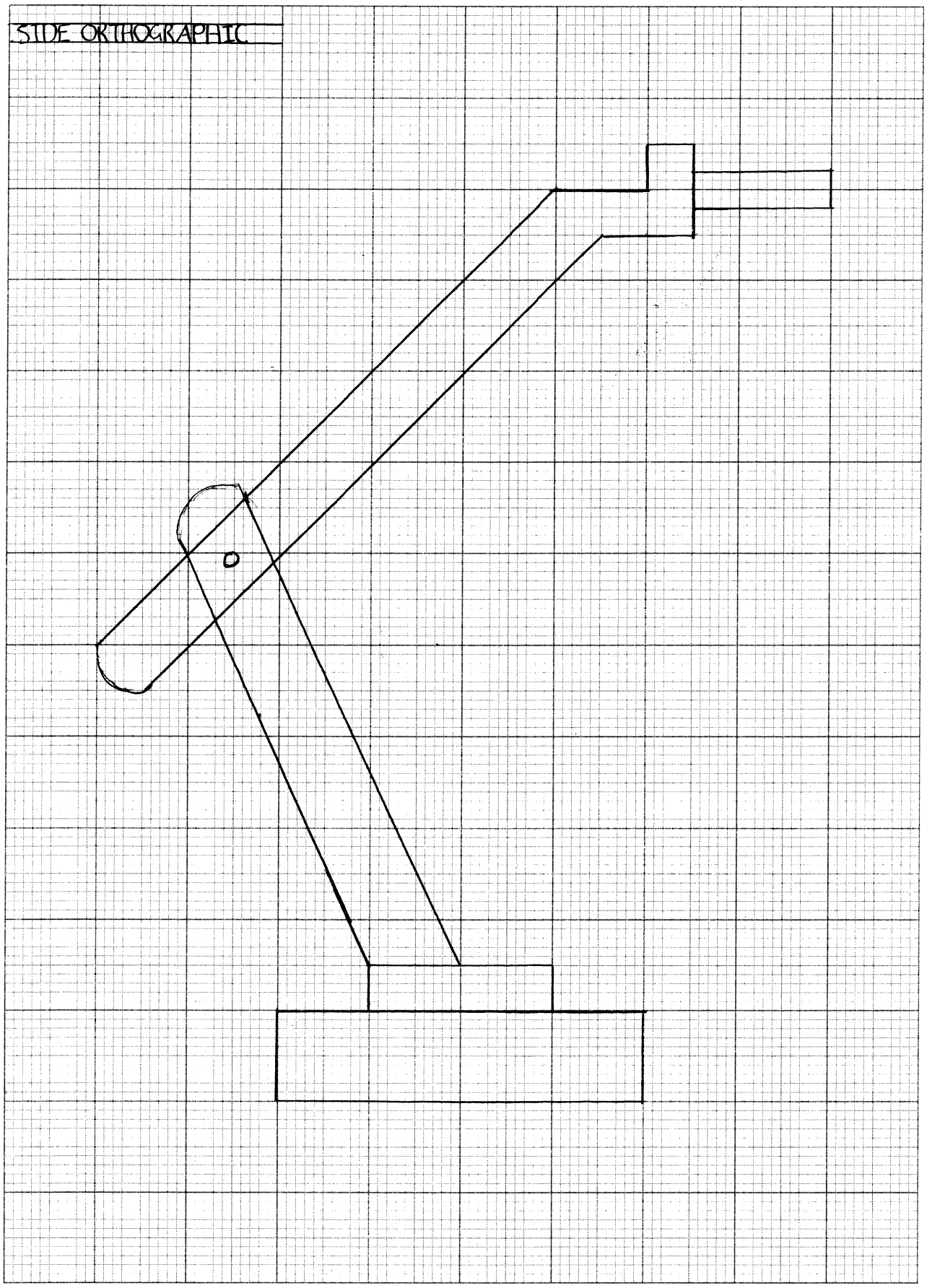
The drawings display the different style of arms and shapes considered, including rount, flat, and mixed arms. After evaluating each (see Arms and Joins section), Vlatech decided on an arm based on parallel straight arms.

The design features strong parallel arms, supported by servos between them.

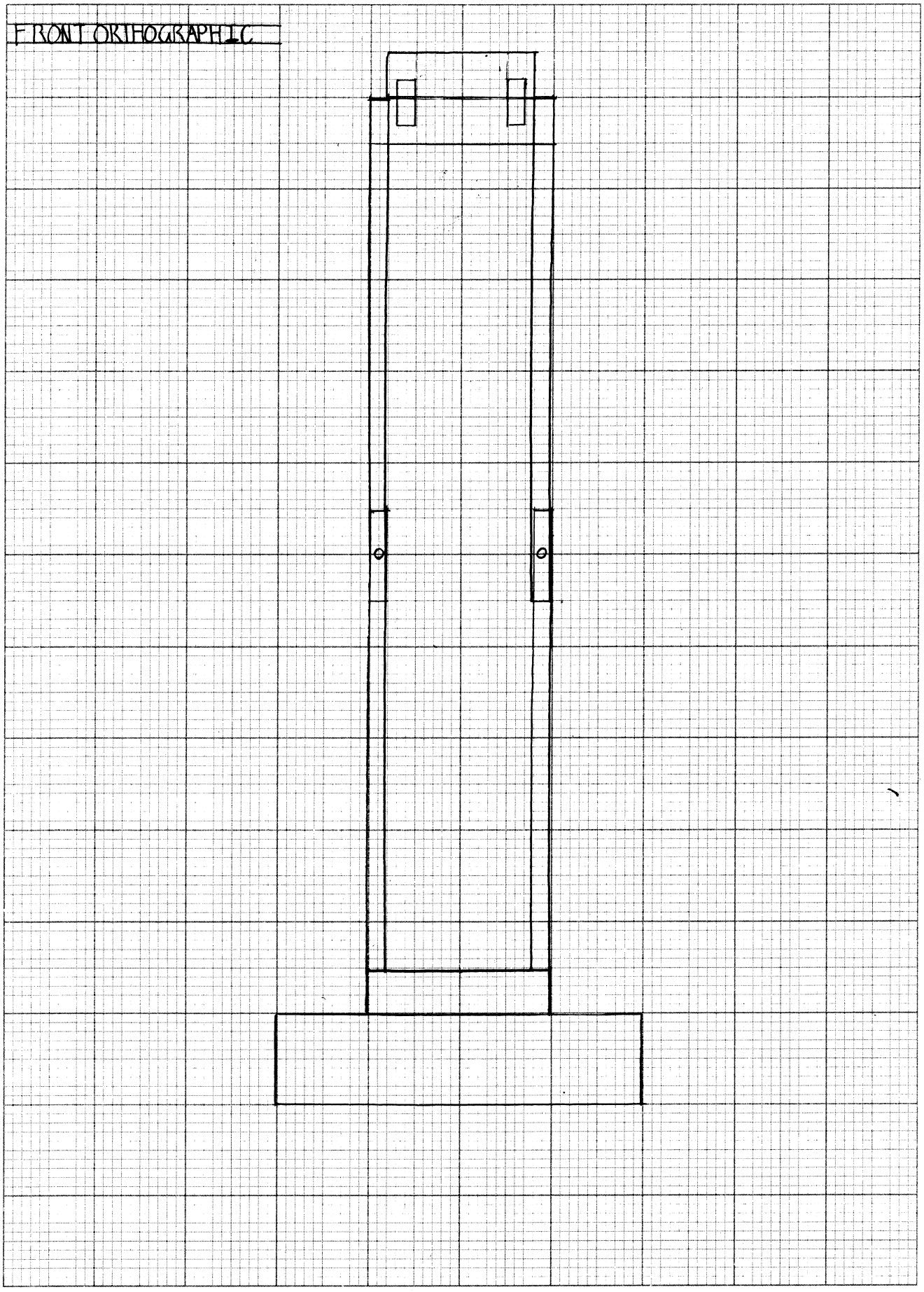
Drawing 1



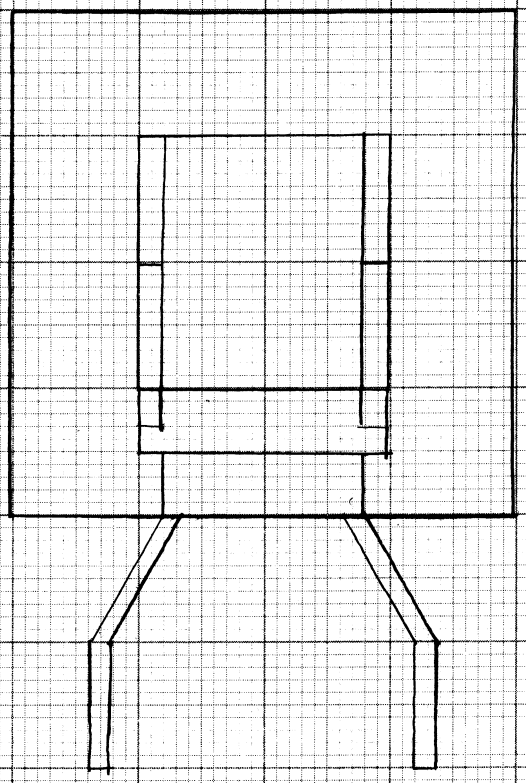
SIDE ORTHOGRAPHIC



FRONT ORTHOGRAPHIC



TOP ORTHOGRAPHIC

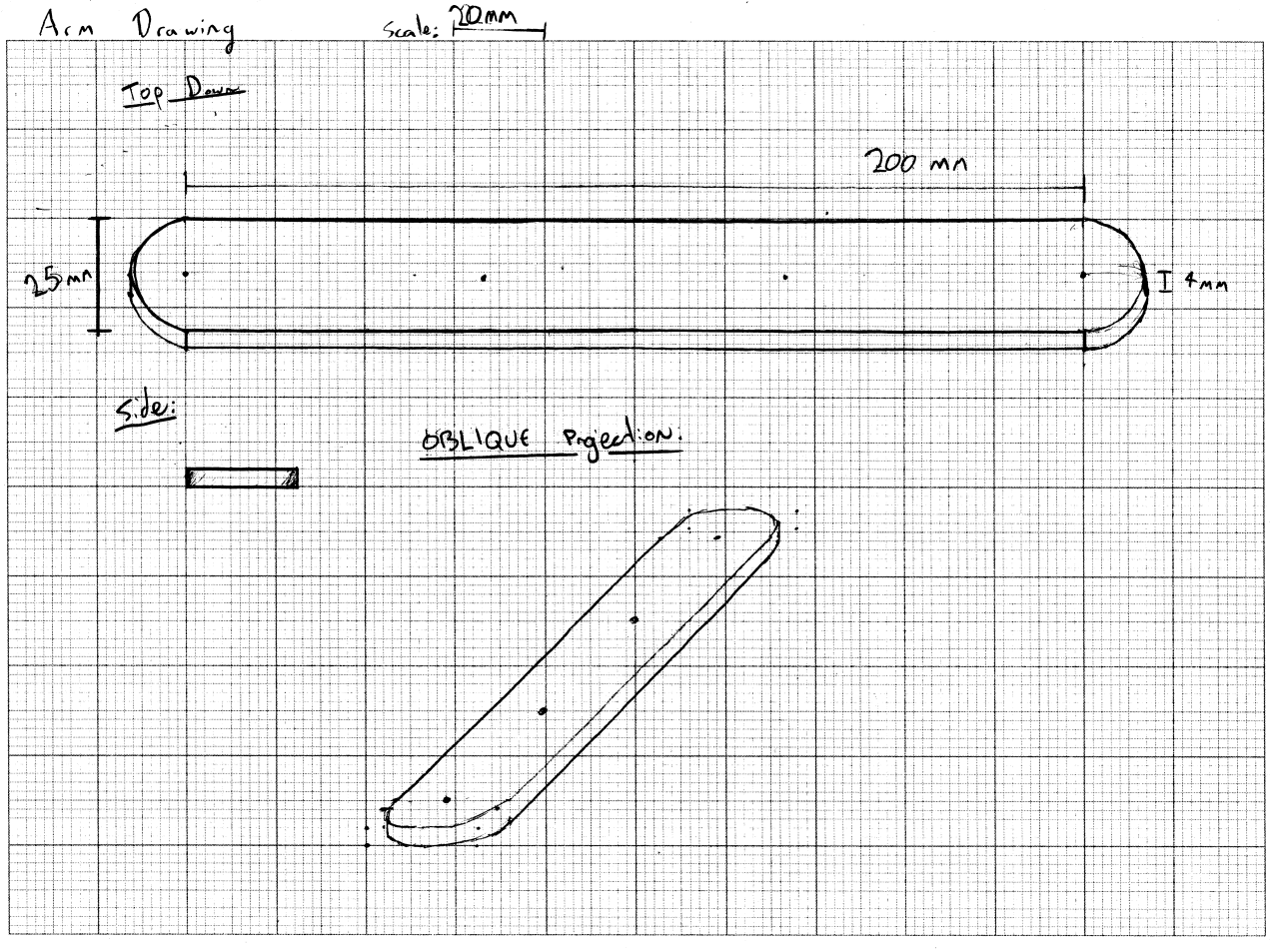


Subsytem: ARMS and Joints

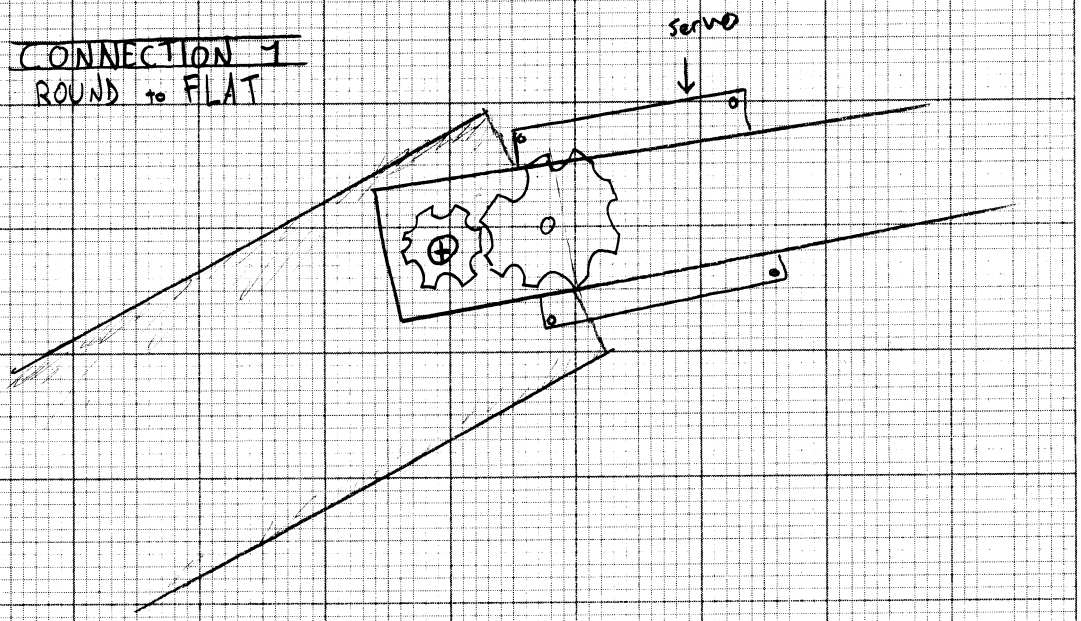
The joins are the most fragile part of an arm. To overcome this, we take advantage of the strength of the servos rotating them by spacing the two parallel arms at each elbow using the casing of the servo. We experimented with different arm and joint shapes, alternating between a single round pipe and two parallel bars to form the arms. We determined that while the round shape provided a more stable structure, the parallel arms were more convinient to mount to a base and to the servos.

Arm Type	Flat + Round	Flat + Flat	Round + Round
Flexible Materials Choice	0	1	0.5
Structural Strength	1	0.5	0.6
Total	1	1.5	1.1

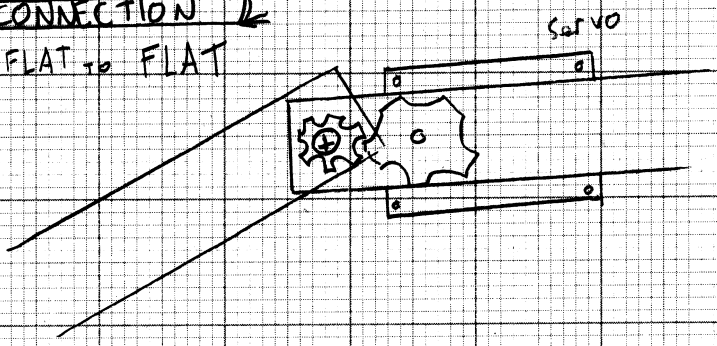
Drawing 5



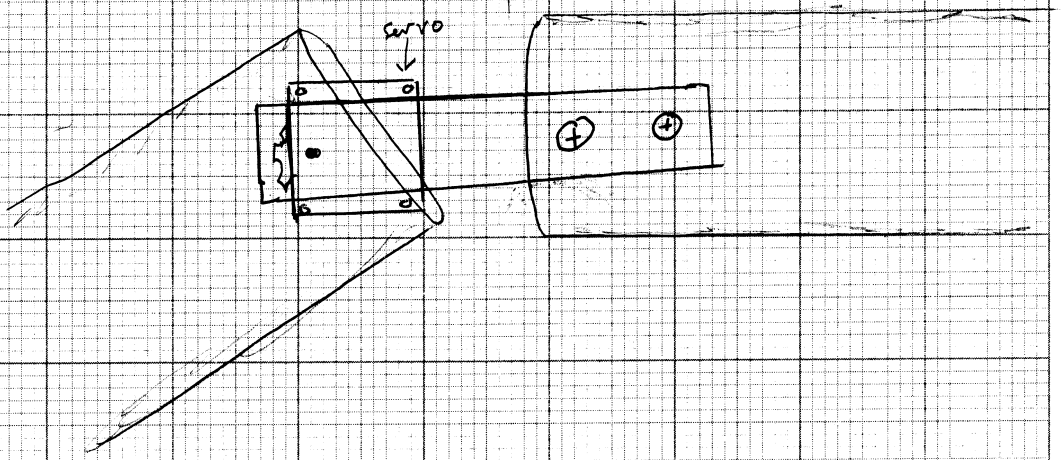
CONNECTION 1
ROUND to FLAT



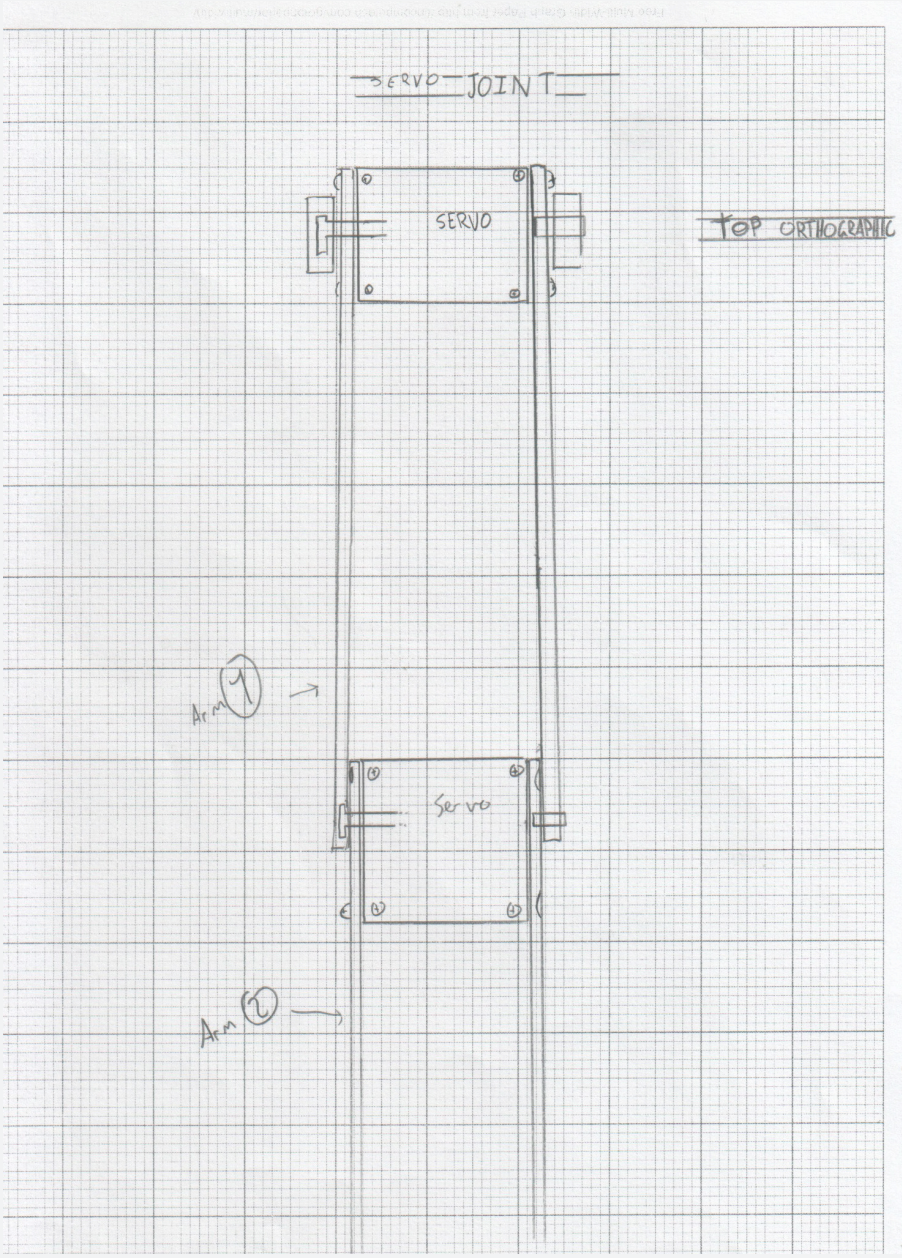
CONNECTION 2
FLAT to FLAT



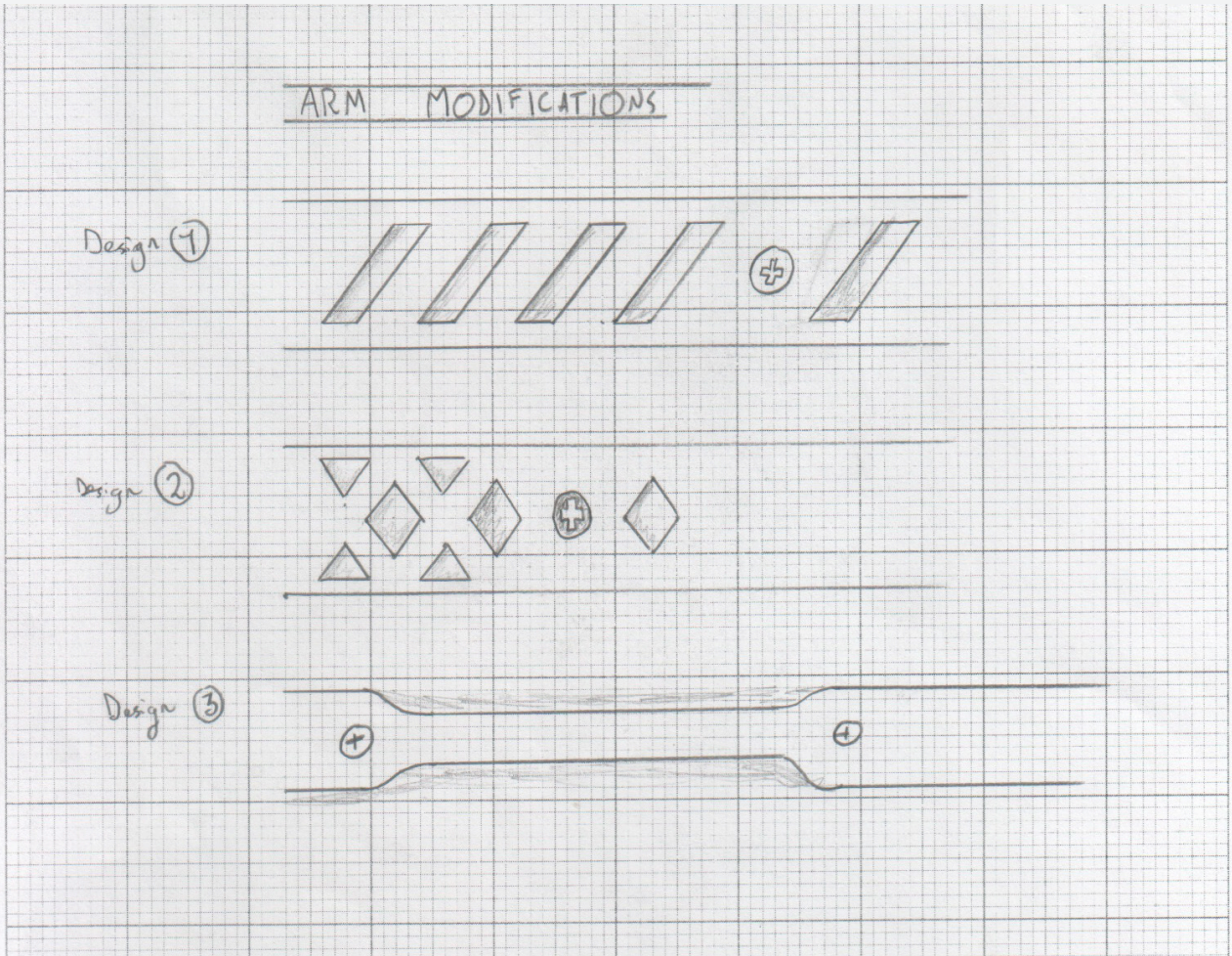
CONNECTION 3
ROUND to ROUND

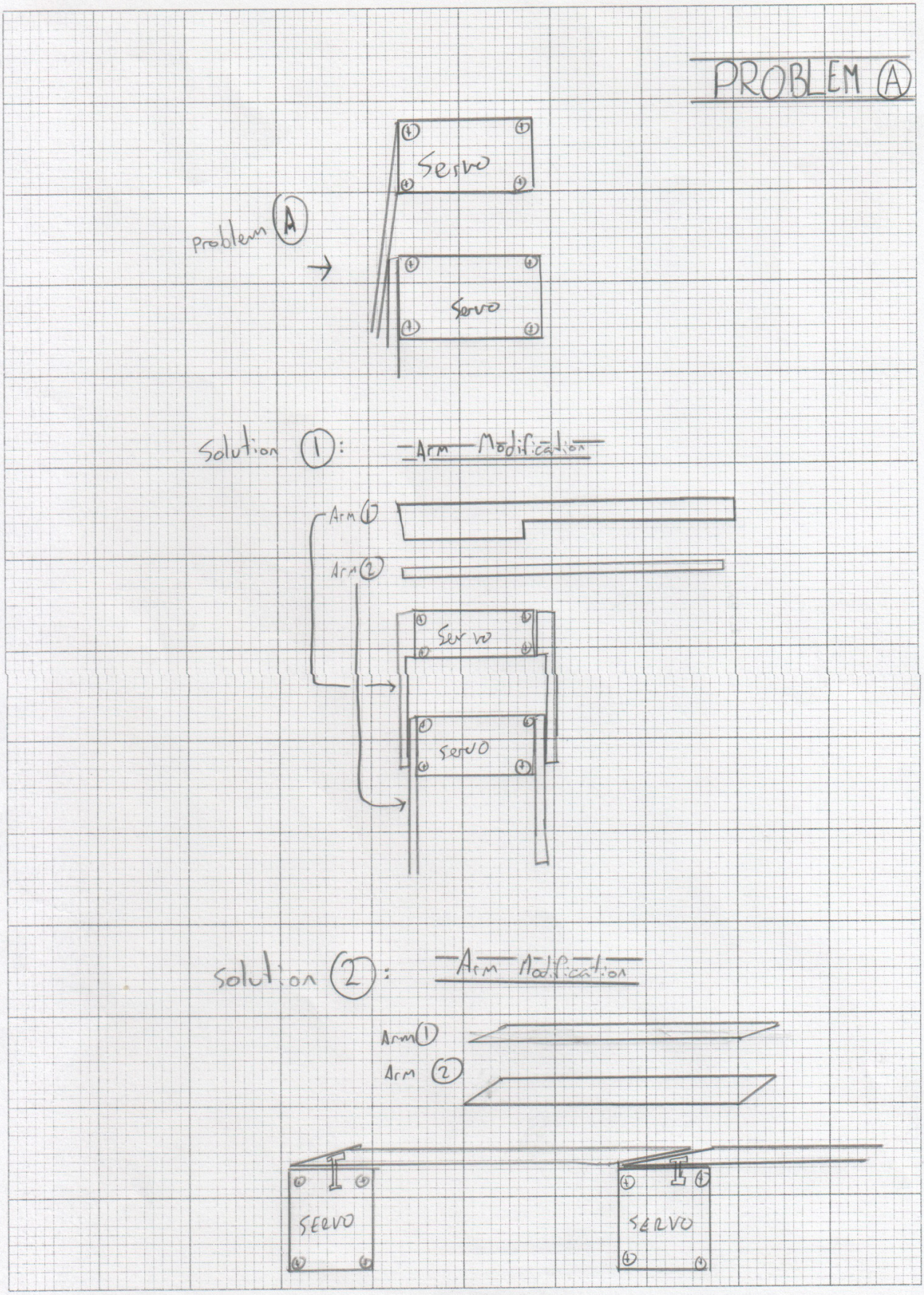


Drawing 7



Drawing 8



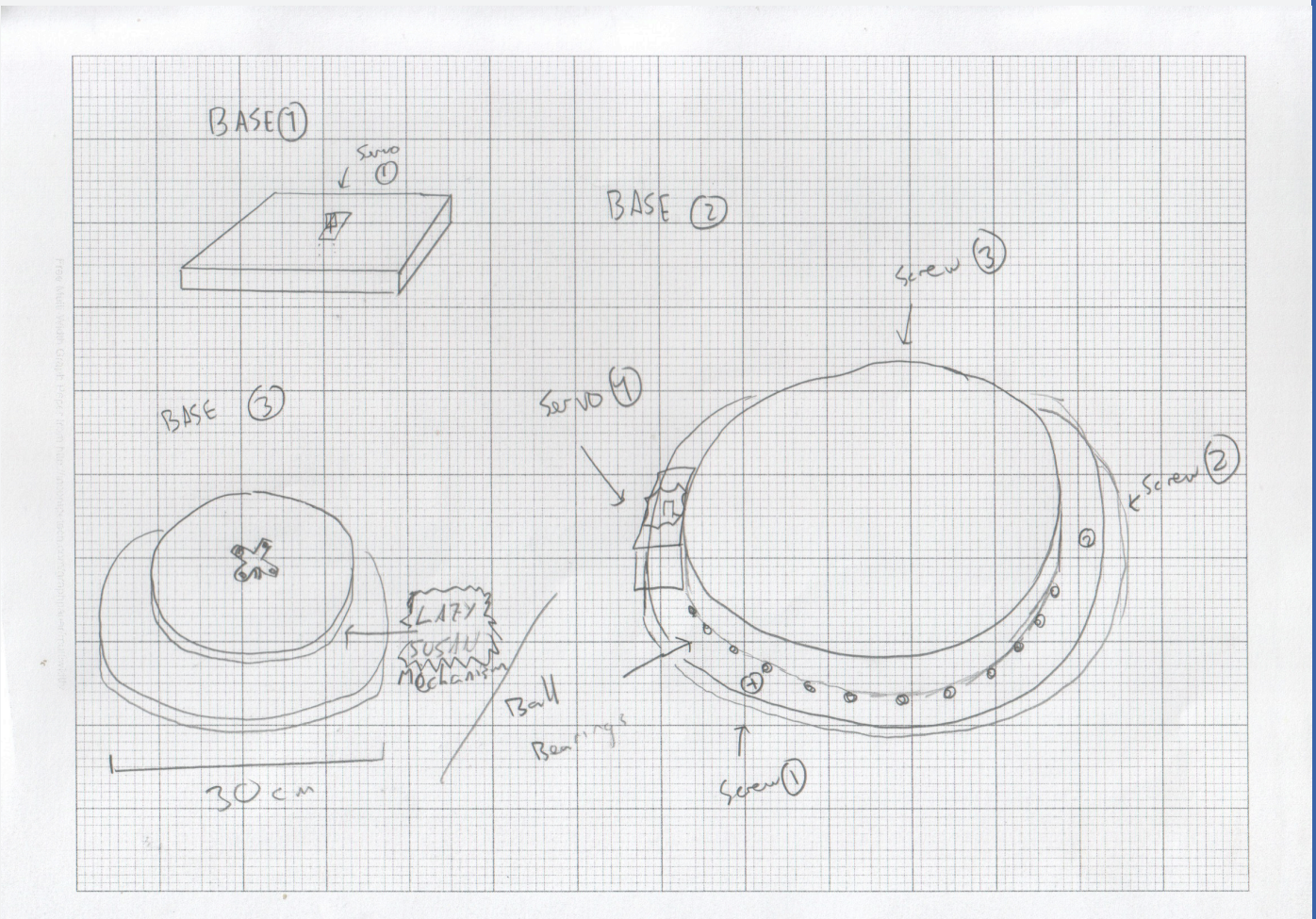

PROBLEM (A)
Problem (A)
Servo
Servo
Solution (1): Arm Modification
Arm (1)
Arm (2)
Servo
Servo
Solution (2): Arm Modification
Arm (1)
Arm (2)
SERVO
SERVO

Base

The base of the arm is required to support the weight of the arm and of the bottle, while being able to rotate. Instead of using a design that places all the upper weight on the shaft of one servo, Vlatech decided to use ball bearings to hold the weight. However, because of the high precision required for ball bearings to be effective, the final design will incoporate a Lazy Susanne (turntable) mechanism (the metal interior, pre-assembled). The servo can then spin the top without suporting any weight.

Base Design	No Bearings	Ball Bearings	Laxy Susan
Smoothness	0	0.8	1
Strength	1	0.6	0.8
Total	1	1.4	1.8

Drawing 10



Claw

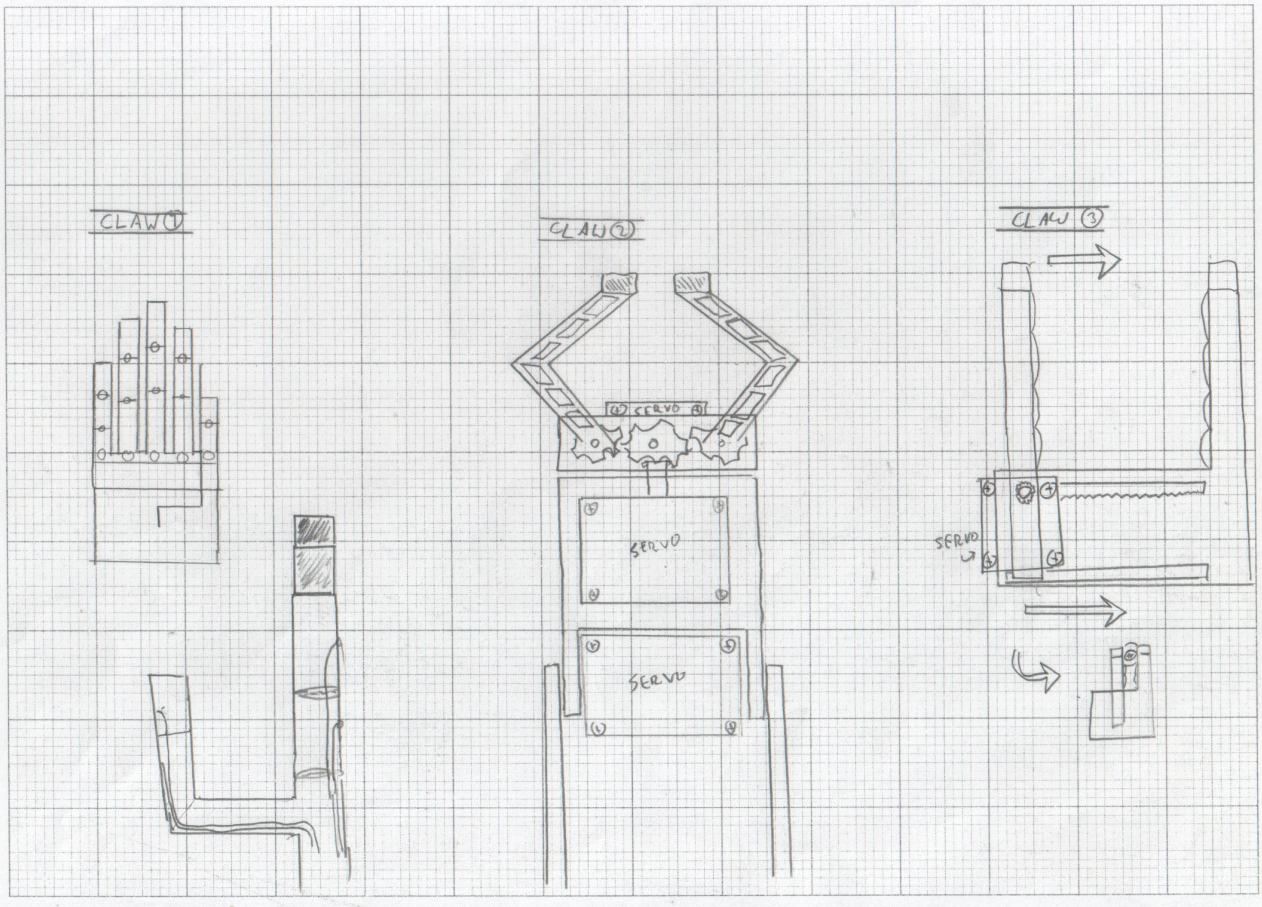
The claw of the arm will be designed according to general-purpose claws popular in Vex and similar robots, using a double bar (see Image 10) to keep the claw fingers straight. The hand will be composed of three servos, offering roll and pitch, as well as being able to close the claw.

The hand will be designed to easily come off the hand, to be replaced by another hand for a different purpose.

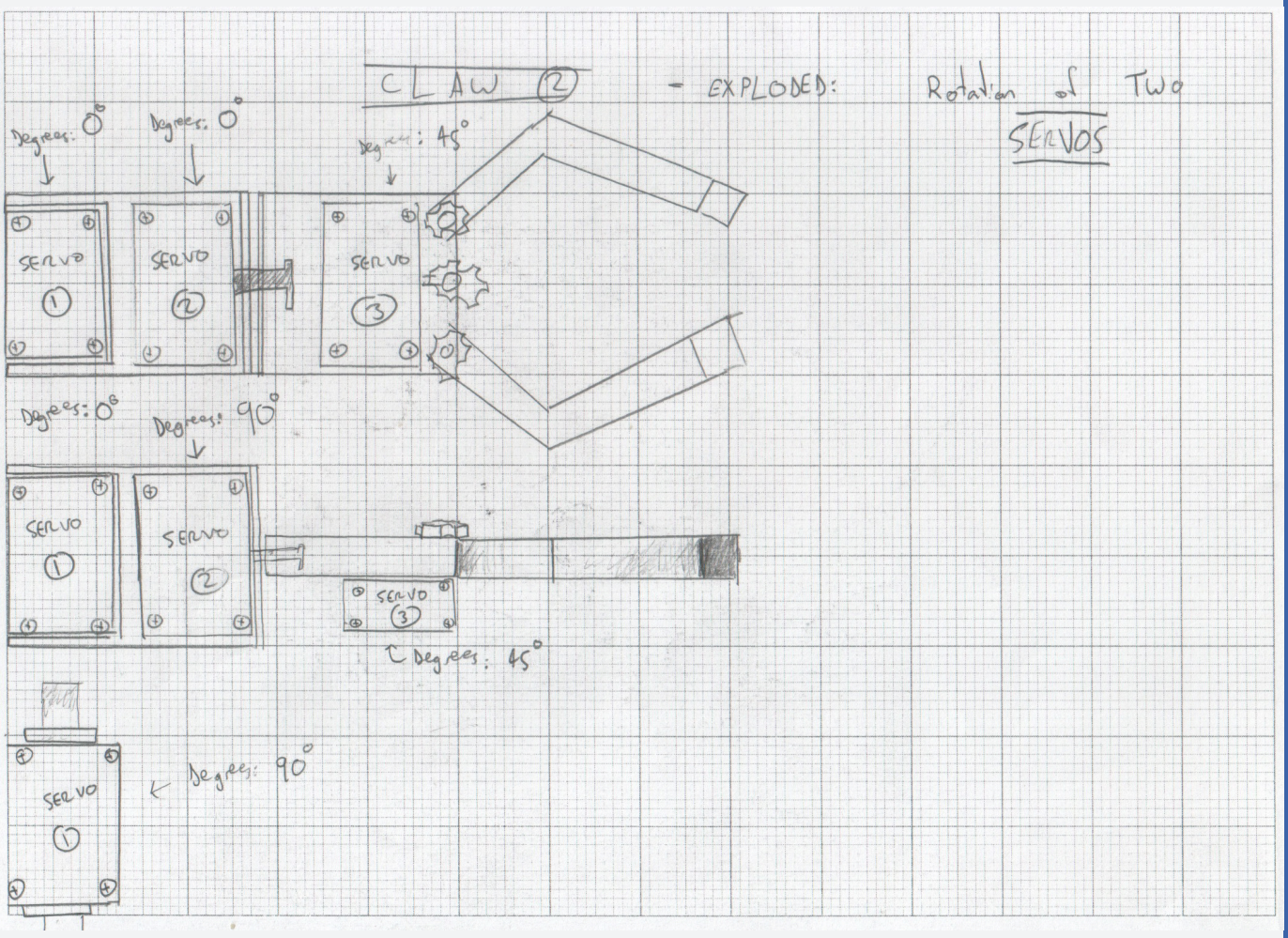
Other potential hands are small table platforms, and ping-pong racket hands.

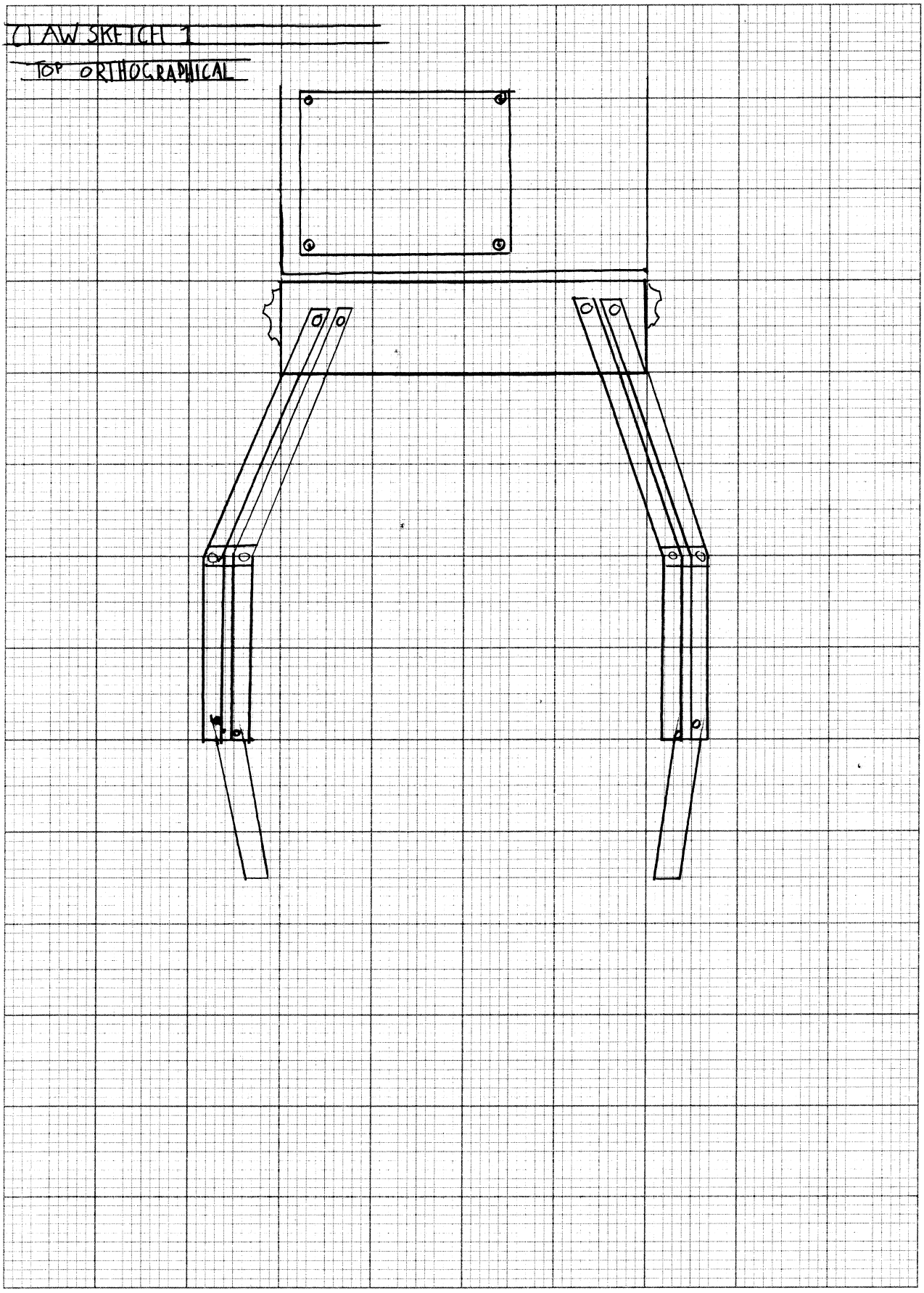
Arm Type	Hand	Single-Claw	Double-Bar Claw
Construction Easiness	0.2	0.8	0.4
Grip / Strength	0.9	0.5	1
Total	1.1	1.3	1.4

Drawing 11



Drawing 12


CLAW (2)
- EXPLODED:
Rotation of Two SERVOS
Degrees: 0°
Degrees: 0°
Degrees: 45°
SERVO (1)
SERVO (2)
SERVO (3)
Degrees: 0°
Degrees: 90°
SERVO (1)
SERVO (2)
SERVO (3)
Degrees: 45°
SERVO (1)
Degrees: 90°


CAW SKETCH 1
TOP ORTHOGRAPHICAL

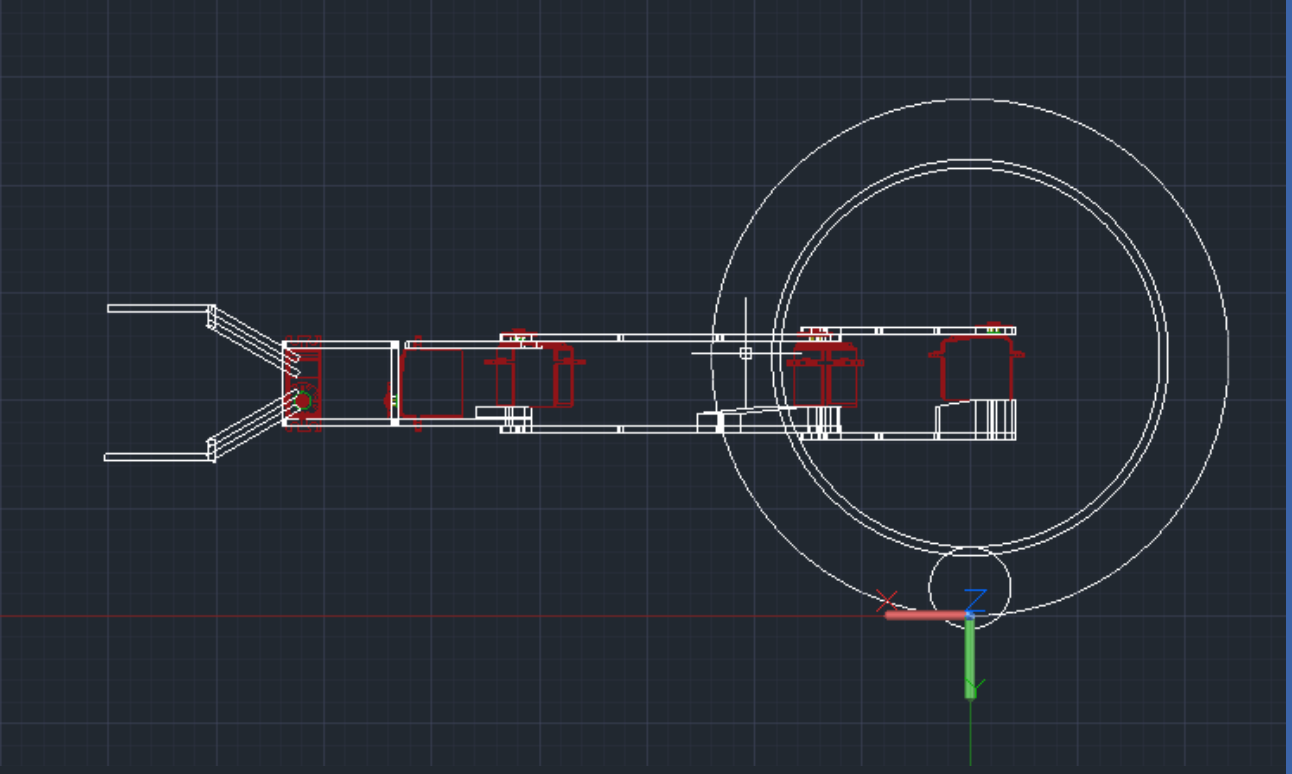
Development

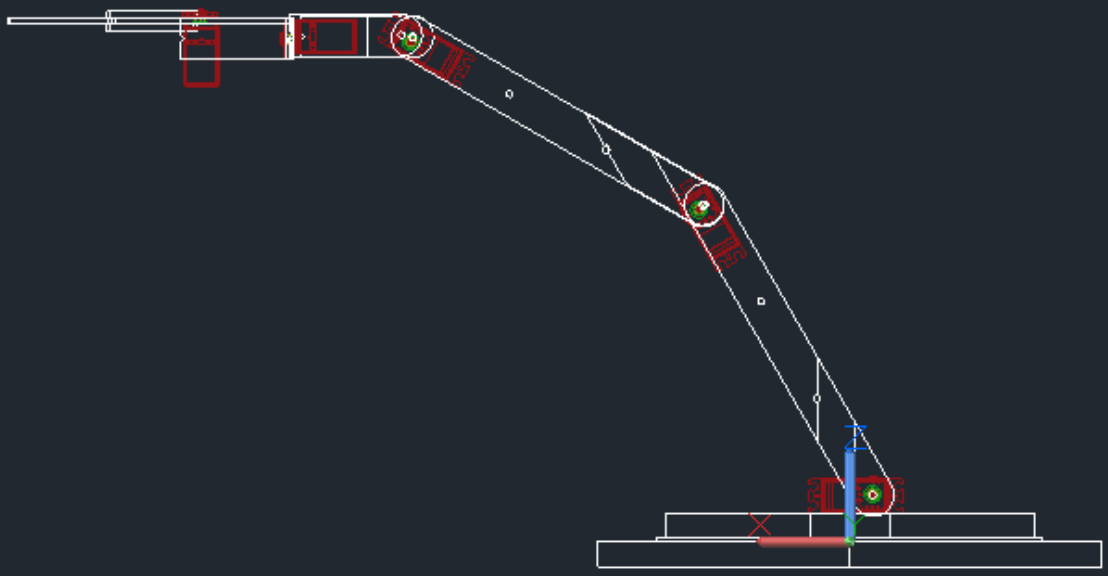
Development

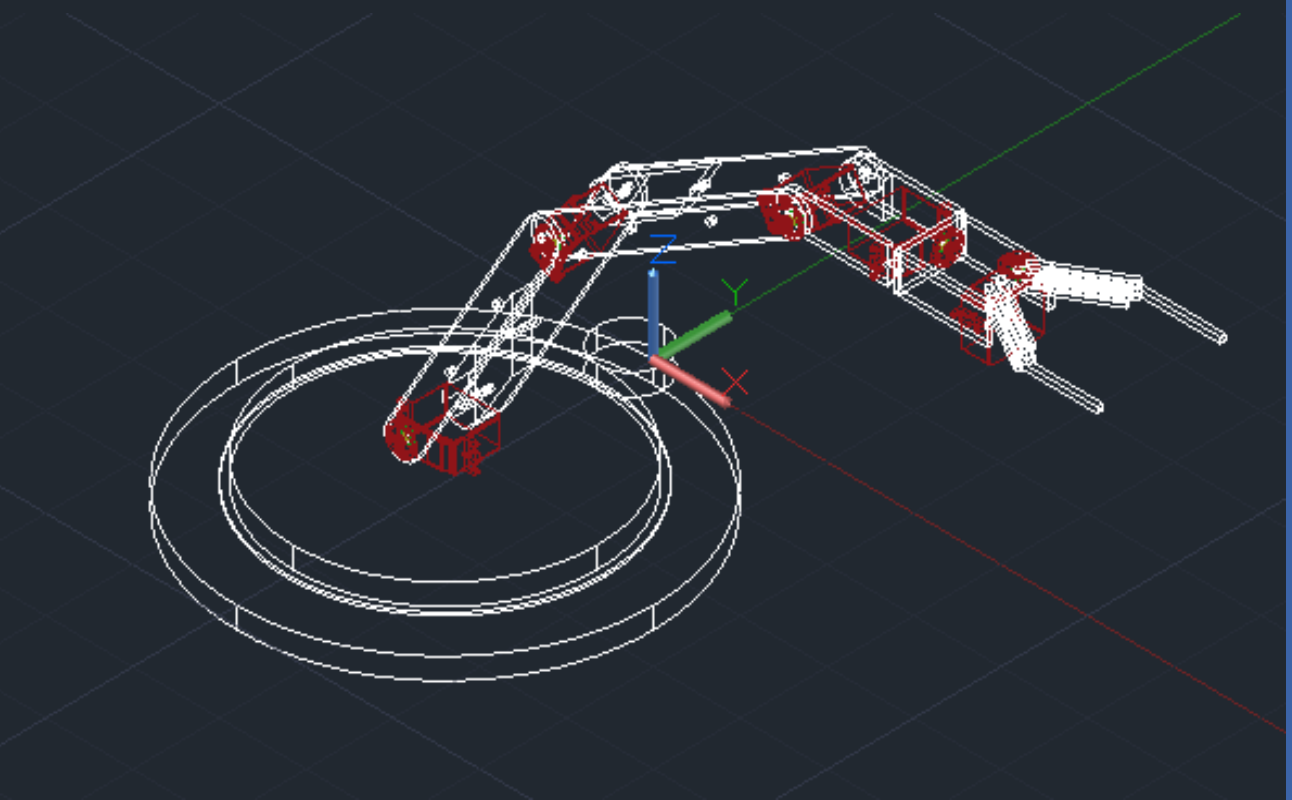
Development

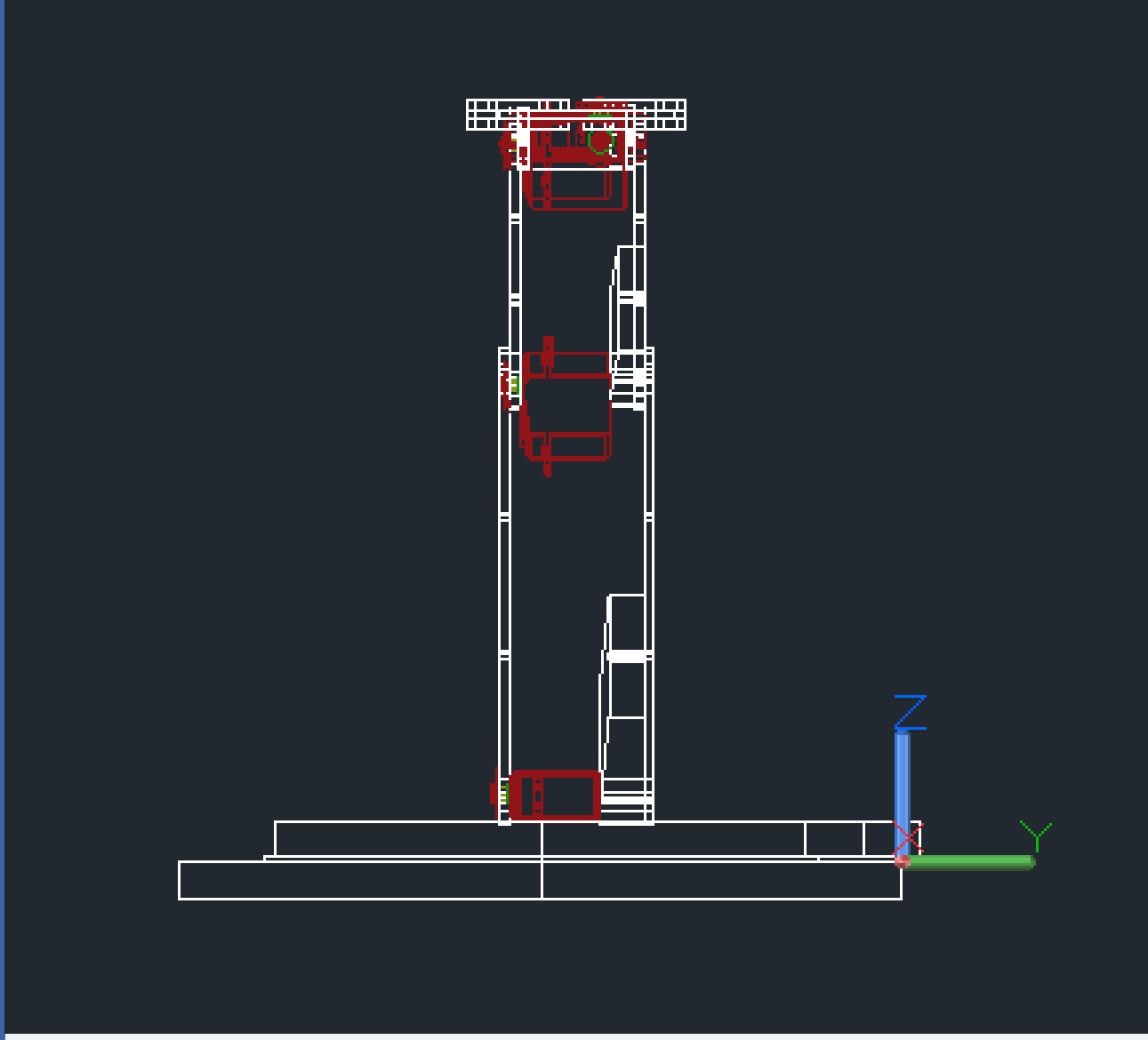
Development

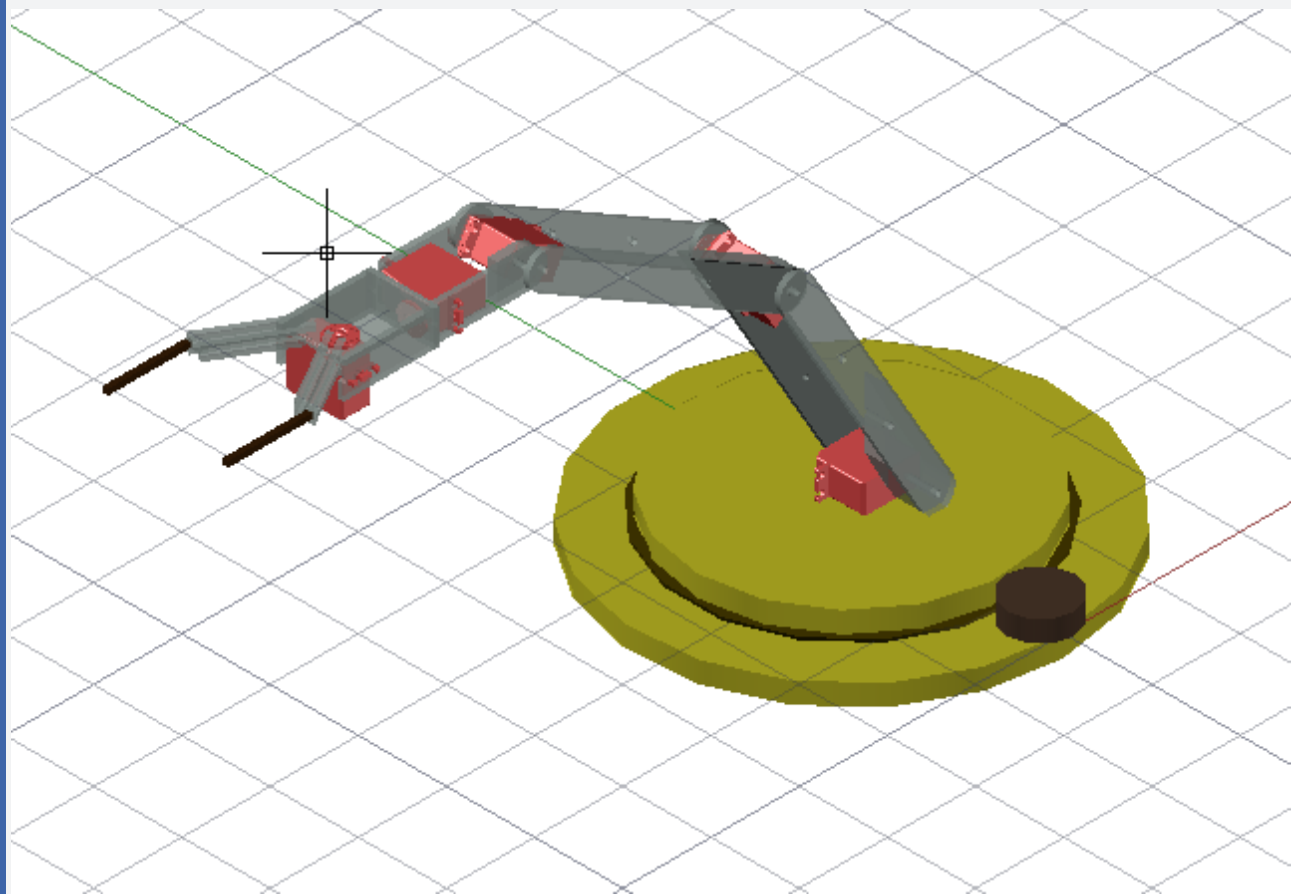
Development

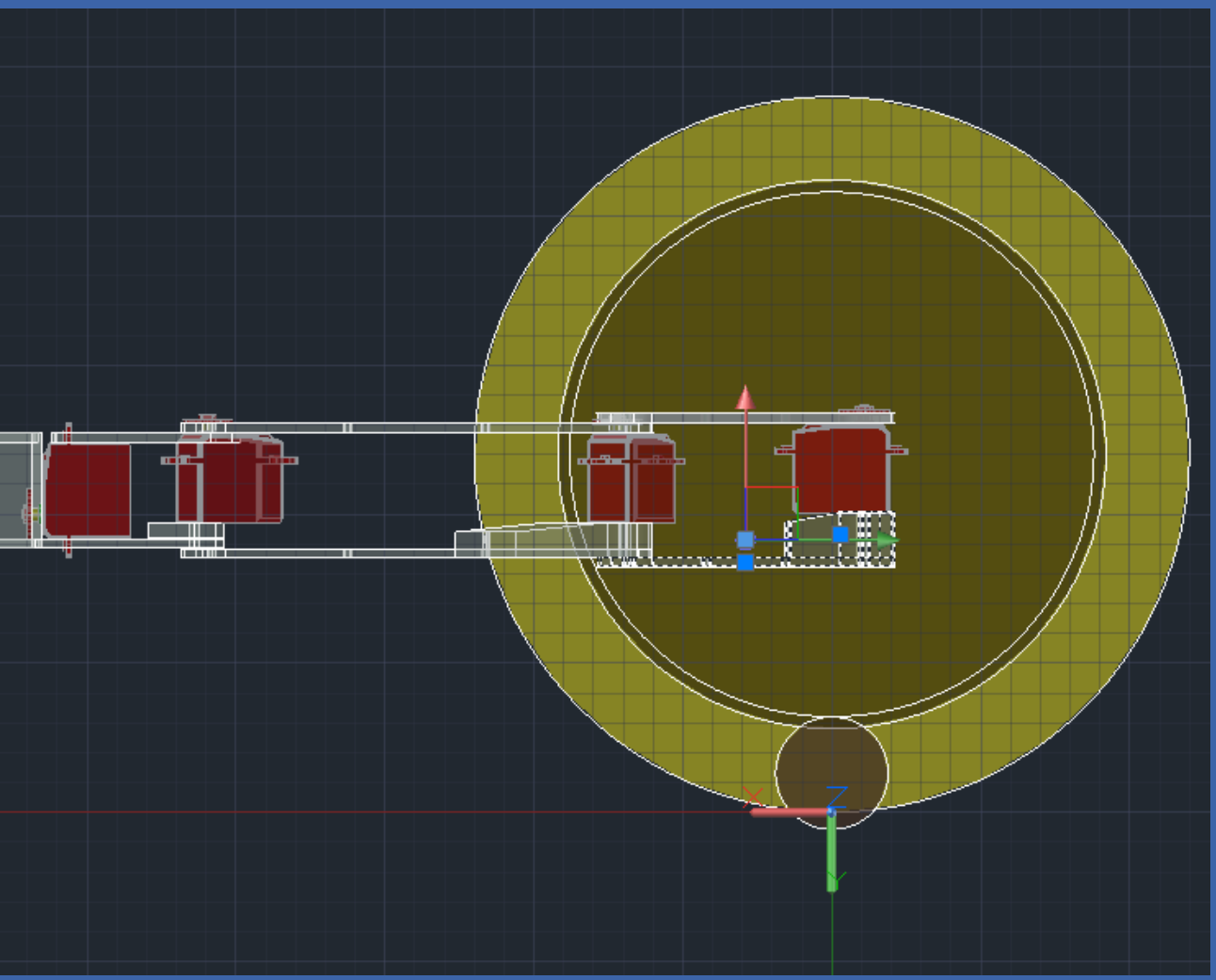


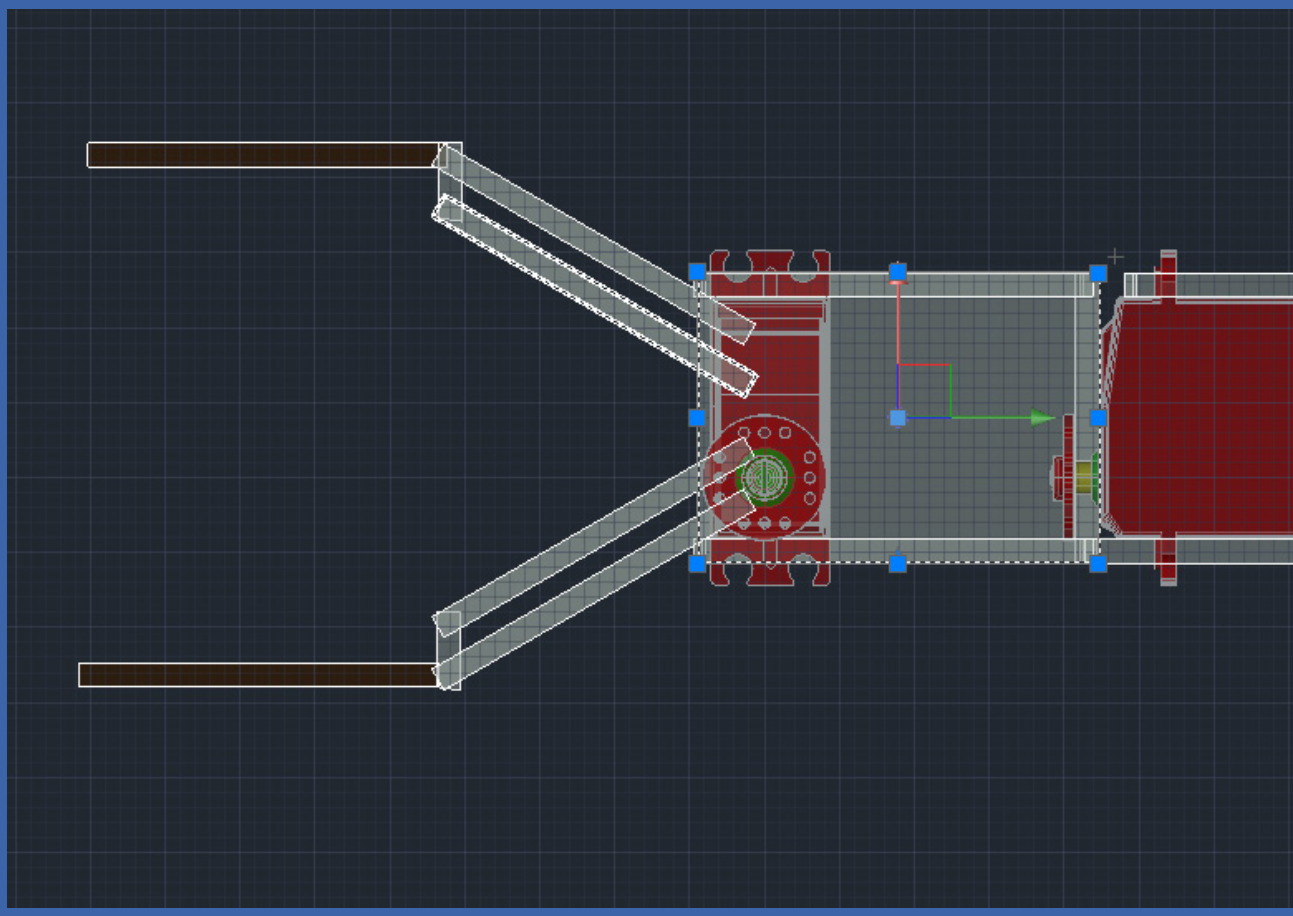


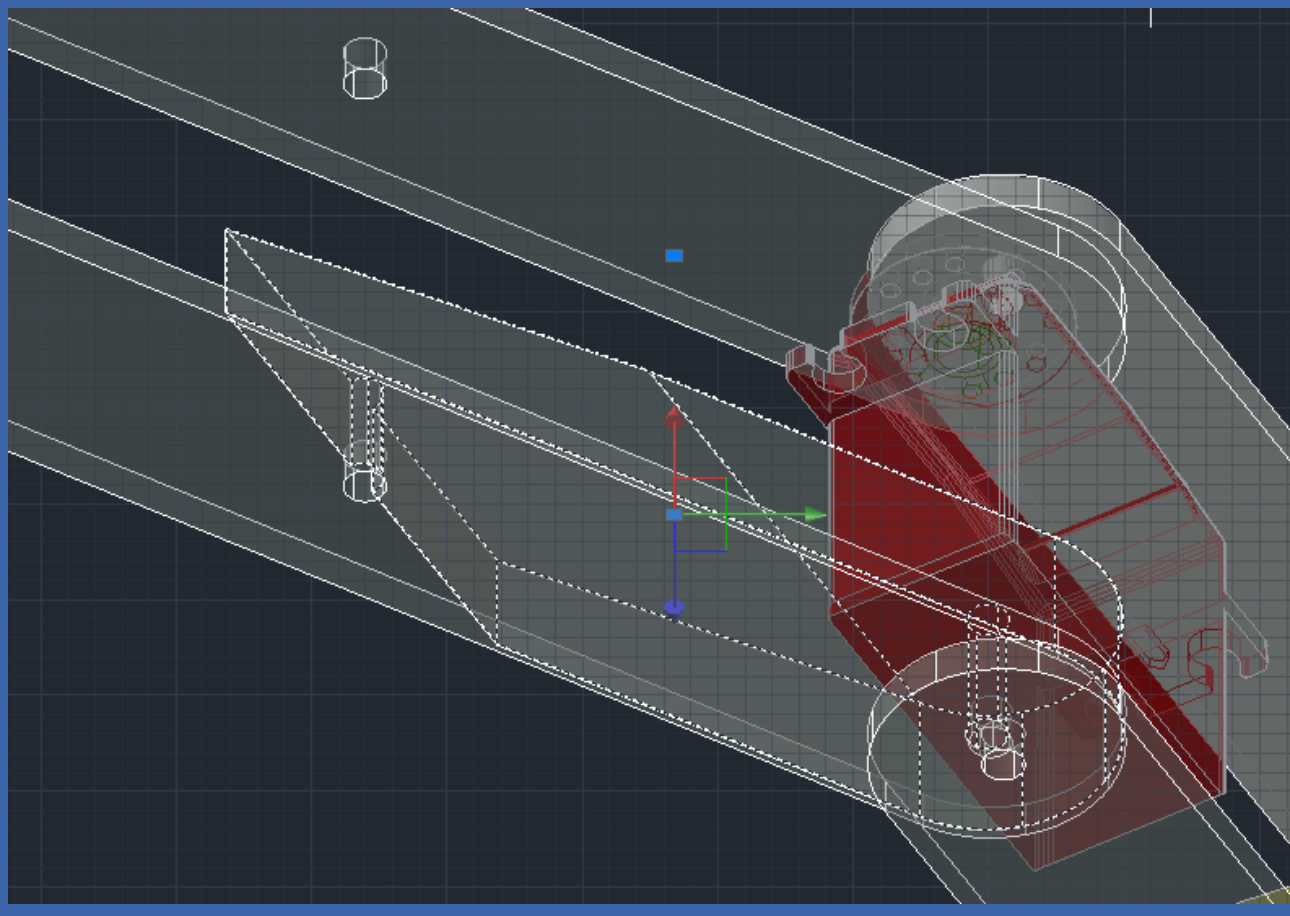



Z
Y









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