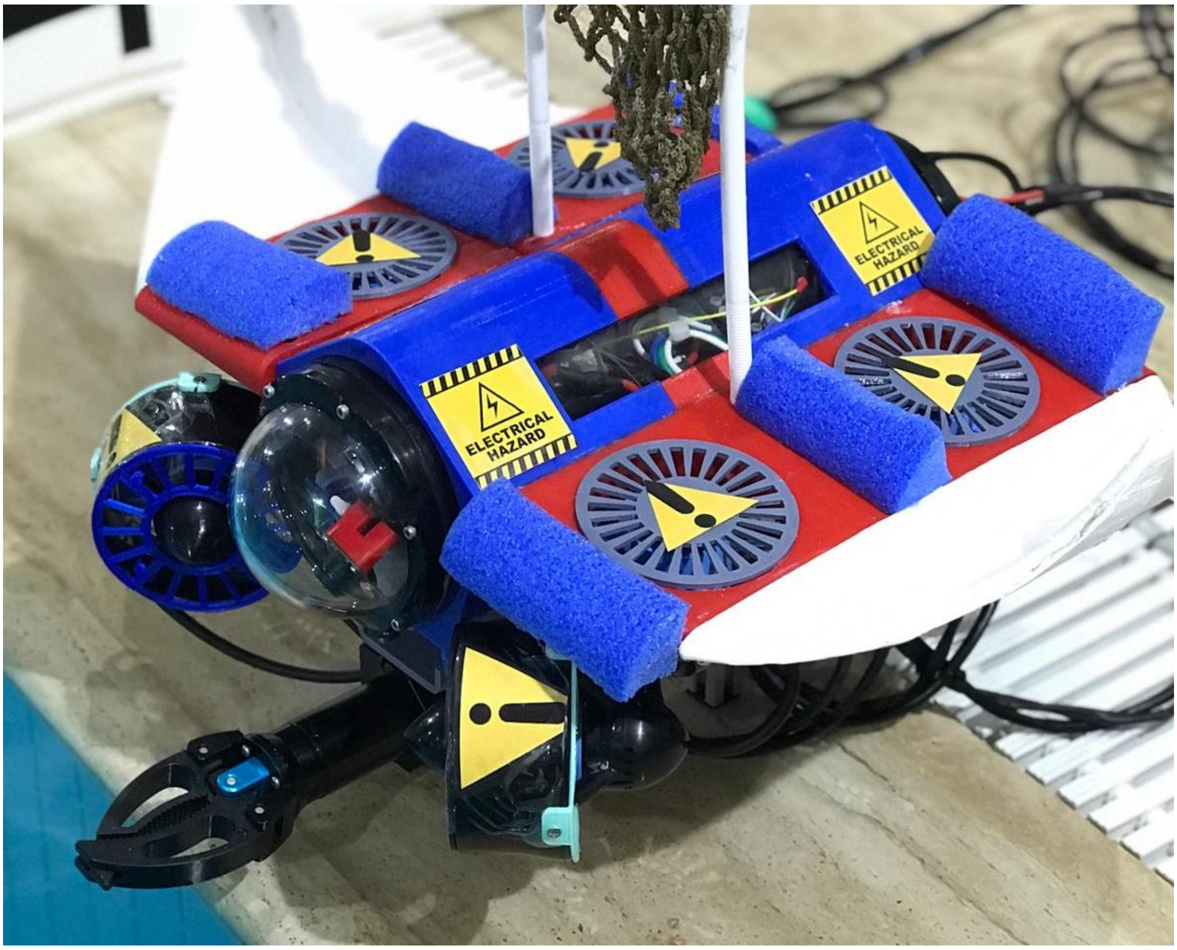


# 2021 MATE ROV WORLD CHAMPIONSHIP

by the Mentoring of Batuhan Ekin Akbulut
Aslı Gönül Ansel– CEO
Koray Koca – Software & Driver
Kaan Kozaklı – Software
Zeynep Keskiner – Mechanics Leader
Cemil Barut– Mechanics
Bora Baysal – Mechanics
Rozem Dila Aydoğdu – Electronics Leader
Alp Ethem Öcal – Electronics
Ali Trenova – PR Leader and Safety

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## Abstract

Cosmos Gravity is a team that includes nine students from 9th to 11th grade with a mentor from Bahcesehir College Nakkastepe 50th year Campus Science and Technology High School. Cosmos Gravity was found in 2019, since than the team has been working on how to make a robot that benefits the nature and humanity's future. The robot that we choose for the competition is the newest creation of Cosmos Gravity. The multidirectional abilities of the robot are due to its technological advanced construction that includes eight brushless motors which are control by eight ESCs. While focusing on constructing the most versatile and powerful ROV, the result is Stingraybot. Stingraybot is the result of the passion and acknowlegments about Marine technology.  The motivation that we gained to help our future in real-life problems such as climate change is the best motivation source for us. As a team, we have participated in many competitions such as TEKNOFEST 2019 and TEKNOFEST 2020, we crowned our hard work with the successful outcomes. Our goal is to take part in such real-life events that will crown our work and save our future. By this, we would be happy to help the field of science and techology

## Team History

As a result of our researches on underwater systems in 2019, we realized that this field is a new type of a development in our country. That’s why we have decided to direct our projects to work on underwater robotics. In order to gain experience in this field, we firstly applied to the TEKNOFEST 2019 competition on Unmanned Underwater Systems. We have tried to learn and generate ideas until the final stage. In the final, we became the only team that was able to complete all the tasks and got the highest score, and we came first. By participating in the TEKNOFEST competition again in 2020, we came third this time. Our dream is not limited to participating in competitions, but we also want to use the robots we have produced for underwater researches and finding solutions to climate change in water. For this reason, we aim to make our robots, that we use in the competitions that we participate in, utilizable in real life situations.

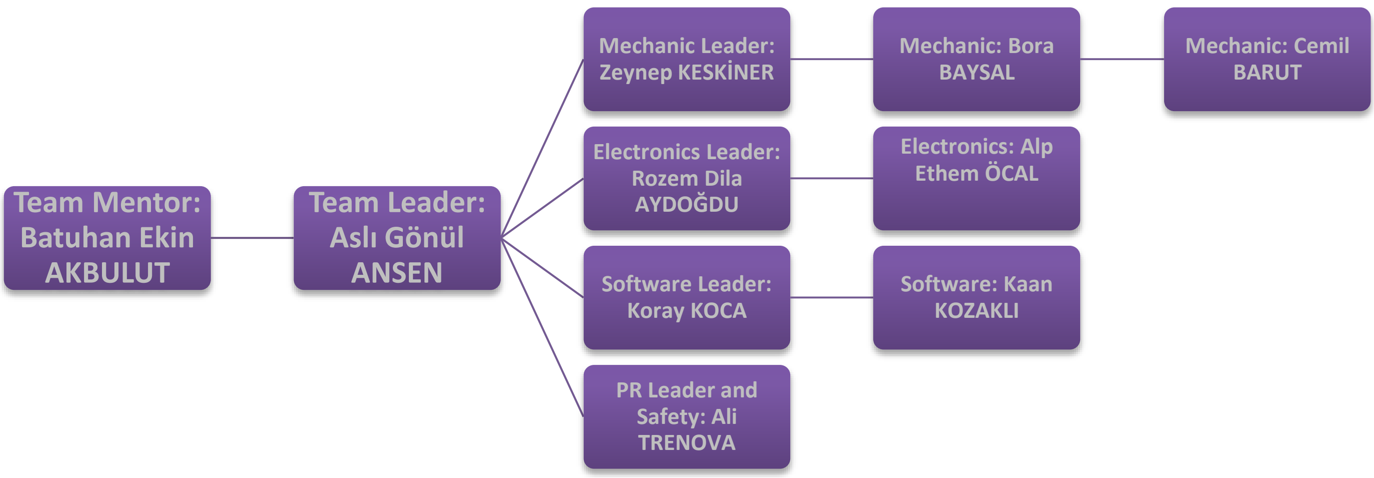

**Our Team Members From Left to Right: Aslı Gönül Ansen, Rozem Dila Aydoğdu, Koray Koca,**

**Ali Trenova, Cemil Barut, Kaan Kozaklı**

# Team Formation

Organization and right distribution of tasks, fulfilling the responsibilities of the members facilitates teamwork and prevents chaos. Our members participation in the tasks they choose and demand in the team will increase the efficiency of the team. We held a meeting for team roles at the beginning of the year and made adjustments to the roles in line with the requests of the members who are not satisfied with their roles and wanted a change. We have identified leaders for sub-units (electronics, mechanical, software, public relations, security officer). Thus, business tracking and organization became easier during the year. Down below, you can see the schema of the roles and responsibilities of our team members, which we revised at the beginning of the year.

| Mentor | Team Leader | Elektronic Leader | Mechanic Leader | Software Leader | PR and Safety Leader |
|---|---|---|---|---|---|
| • Paperwork of the team<br>• Controlling the written reports | • Writing Rapor<br>• Following the deadlines<br>• Controlling other team members | • Installing the electronics<br>• Writing the electronic based parts on the reports | • Making the robot's drawing<br>• Writing the mechanic based parts on the reports | • Coding the robot<br>• Writing the code based parts on the reports | • Responsible for public relations<br>• Social media and event managing<br>• Ensuring the team safety |



# PLANNING ORGANIZING, AND SHEDULING


At the beginning of the each week, we hold a team meeting from the application called "Discord" at the time we have planned in earlier, and we create the program of the week together. The Discord program is actually a chat program. With this application, it is possible to communicate with people over the internet by voice or in writing. Discord is especially preferred by people who play online games. It is also possible to make video calls with this application. In the meetings we hold through this application, we determine the members who will come to the work area during the week, and if there are members who cannot come to the work area, they continue to work from home and for a different branch (such as social media management, reporting from home for the members who cannot come to work). In addition, we hold monthly meetings with our sponsors, which we mentioned in the acknowledgments, and talk about our needs and the current status of the team.

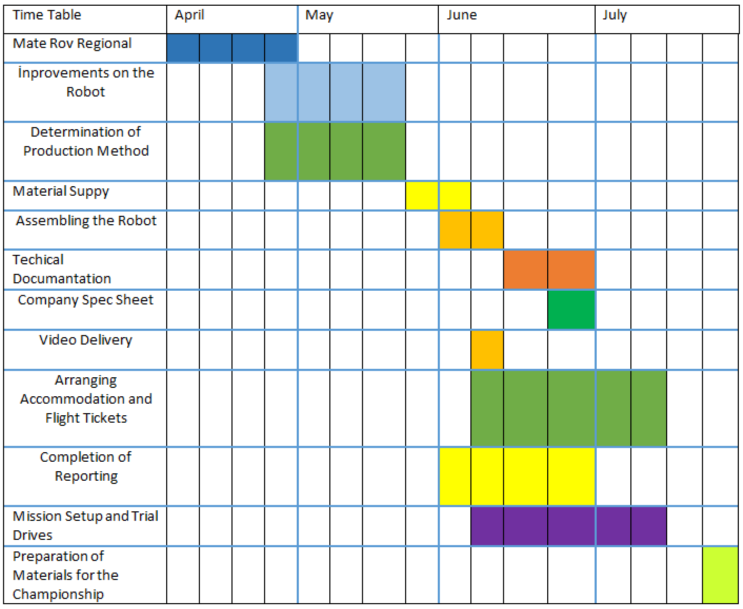
In order to increase the efficiency in our workshop in the robot production process, we have organized our workshop and our own plan as follows: In the workshop where we work for an average of 6 hours, the units will work among themselves for 4 hours; All members will work together for 2 hours. Thus, ideas and prototypes produced in 4 hours; It gets combined in the last 2 hours, which prevent members from doing business without knowing each other's work.

In addition, we made a "Risk Matrix" in order to be predictive about the problems we will encounter during the production phase and how to deal with them. Risk Matrix, visualizes risks in a diagram. In the diagram, risks are divided according to their probability and impact, or degree of damage, so that the worst-case scenario can be identified at a glance. This planning prepared us for the situations we encountered during the production phase and enabled the problems to be solved in a short notice.

| Importance | | | | Possibility |
|---|---|---|---|---|
| VERY HIGH | HIGH | MEDIUM | LOW | |
| Robot's aotonomus software is faulty | Leakage of water into the robot's electronic circuits | Insufficent protective materials | Incorrect printing of 3D Parts of the robot | LOW |
| Injury to team members | Damage to the robot during driving test | Deterioation of robotic arm | Failure of production machines during the Production of robot parts | MEDIUM |
| Team members getting Corona | One of ESC's wire broke | Controller is not working | | HIGH |

As you can see in the table on the side, we have divided the risks we may encounter during the robot production process as low, average, high and very high based on our experience.

| Description of Risk Ranking | | |
|---|---|---|
| LOW | MEDIUM | If the results of this Event/Activity are Low/Medium, our team may continue to work. |
| HIGH | | If the results of this Event/Activity is High, It is recommended to get help before continuing your work |
| VERY HIGH | | If the results of this Event/Activity is Very High, It is recommended not to start work before the problem is resolved. |




In addition to these, we have also created a time schedule at the beginning of the year in order not to miss the tasks to be completed during the year and to maintain order.

# Safety

Ensuring the safety of our team members and the environment has always been our top priority. In Robot production proceses, we take our security measures during the testing phase and we warn each other in a case of a security violation. We have also made a new decision to ensure complete safety within the team: If any team member violates the predetermined safety rules more than 3 times during the day, they cannot participate in the next day's work, that team member has to carry out his work from home and from a different area. Since we have realized that we were more distracted, especially since we got tired during the robot production phase, and we found such a solution method. With this rule, we saw that security breaches decreased and members repeated the security rules more frequently.

We are aware of the fact that, the robot we produce in order to ensure environmental safety must also be planned in a safe and non-threatening manner. That's why we ensured the safety of our robot with the following items:

1.Engine propellers are secured by the engine guards that our team members have designed.

2. Sharp ends were not included in the drawing of the robot chassis, machine-welded protrusions were smoothed with sandpaper when the chassis was produced.

3. Two different warning signs were placed on the robot, one for the electronics and one for the engines.

4.The long cables are fastened up to the chassis, so that the robot cables will not be tangled in the motors and will not be cause us any trouble.

5. "Emergency Stop Button" has been added to be used in situations that will threaten security. Attention was paid to the location of the button especially near the driver station.

6. For emergencies, the numbers of emergency services, such as the police, ambulance and fire brigade is engraved on the edge of the robot chassis.

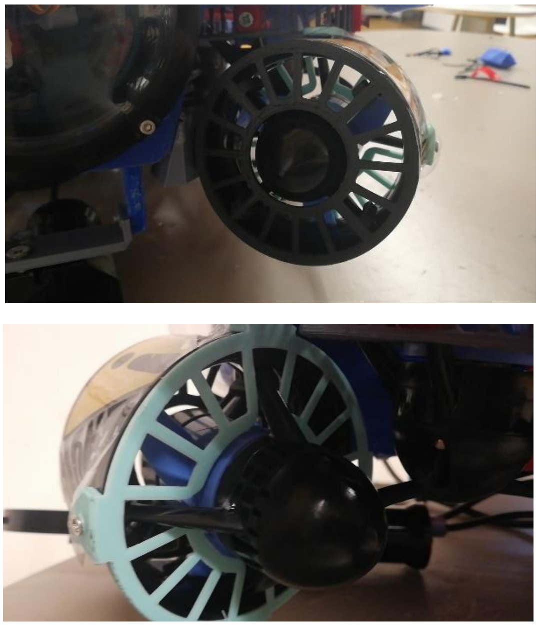
7. While taking the robot out of the pool, a section of the power and ethernet cable is tied up to the chassis to use the cables in a case of a power fail.

8. Anderson Power Connectors was used to securely connect the power cable from the robot chassis to the power supply.

9. The chassis design has been drawn in such a way that the robot cannot risk us about a safety manner when exiting and entering the water.

**Emergency Stop Button**

**The connector where we connect the cables to the chassis**



**Protectors that we use for the engines**


**Warning signs that we hang on our workshop's door**

In addition to these, at the beginning of each year, we remind the team members of our safety rules, which we have stated below, at our meetings.

**Working Safety Precautions:**

- There should not be more than enough people in the working environment.
- A mask should be worn when 3D printings are getting taken (especially with Petroleum Based Filaments).
- Eatting and driking in the working area is not allowed.
- Before starting work, necessary safety equipment (Glasses, Gloves, etc.) should be worn and members with long hair should tie up their hair.
- Liquids should not be allowed near the robot.

- Before working on equipment or parts that could fall or "break loose," properly secure the equipment or part. (Handbook, Chapter 9)
- Pocket knives and multi-purpose tools (e.g., Leatherman & Gerber Multi-Plier, etc.) are not permitted in the workplace. (Handbook Chapter 17)

**Security measures in the Test Phase:**

- Before the robot is put into the water, it should be checked whether the acrylic tube is leaking with a help of an air pump.
- There should not be more than enough people in the test area.
- During the test, if a different kind of a problem is observed in the robot, the emergency stop button should be pressed.
- Before starting the test, the electronic connections of the robot should be checked.
- In an event of a fire, team members must know the evacuation rules.
- All members of the team should know the location of the fire extinguisher, to respond immediately in a case of a fire in the vehicle.

**Safety precautions while driving:**

- The driver and those by the pool should be informed about what to do in case of trouble.
- Those by the pool should not take their eyes off the robot while driving.
- Understand the site's HSE(Health, Safety & Environmental) policies and PPE(Personal Protective Equipment) requirements. (Handbook, Chapter 37)

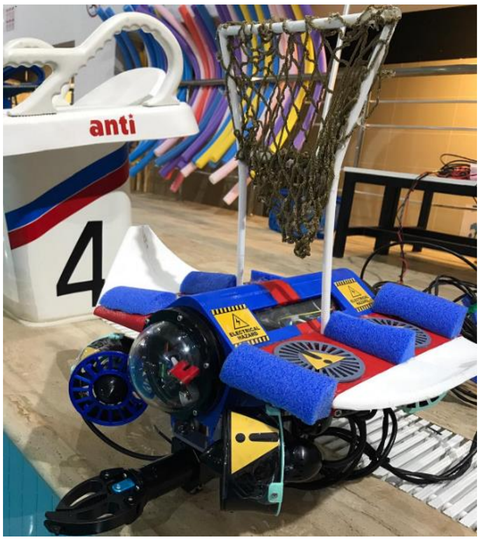
| TASK | Check box | RESPONSIBLE PERSON | | |
|---|---|---|---|---|
| Are all the necessary tools sharpened? | | Aslı Gönül Ansen | | |
| Are there any food/drinks near the veichle? | | Zeynep Keskiner | | |
| Are all the tethers tidied after test drive? | | Ali Trenova | | |
| are there any damaged components? | | Koray Koca | | |
| are there any leaks on veichle? | | Cemil Barut | | |
| are there any electrical leaks? | | Kaan Kozaklı | | |
| are there any spilled glue on table? | | Bora Baysal | | |
| are there any dangerous object? | | Alp Ethem Öcal | | |
| | | | | |
| | | | | completed |
| | | | | incompleted |

**(A seek-peek of our Safety check list)**

MATE ROV competition tasks finds solutions to the real-life problems with the contributions of climate change which raises ocean temperatures that results to affecting the health of coral reefs. The tasks forms on 3 global problems: plastic pollution, cleaning the waterways and climate change. There are 3 tasks also assigned for these problems which are the ubiquitous problem of plastic pollution, the catastrophic impact of climate change on coral reefs and maintaining healthy waterways. By the contribution of the MATE ROV competition for who helps for our future developments, we can use our robot in many ways for the benefit of humanity, such as cleaning our seas, and contribute to our future contribution of the MATE ROV competition for who helps for our future developments, we can use our robot in many ways for the benefit of humanity, such as cleaning our seas, and contribute to our future.competition for who helps for our future developments, we can use our robot in many ways for the benefit of humanity, such as cleaning our seas, and contribute to our future.

# DESIGN RATIONALE

## Back to Nature:



We have been applying the motto "The best designs are those made with inspiration from nature" in our designs for 2 years. We can define biomimicry as follows: “From bios meaning life and mimesiz meaning imitation, biomimicry is a new discipline that examines nature's best ideas and then imitates these designs and processes to solve human problems.” We were inspired by stingray fish in our robot, where we used the biomimicry method. The stingrays have a thin and flat body and have a cartilaginous skeleton. Owing to its wide wings, it moves in the water like a bat glides through the air, and owing to its wings, it advances by breaking through the surface of the water.

We made 2 drawings inspired by stingray fishes. The first was in the form of a plate and was a replica of the outer appearance of a stingray fish. We also used 6 motors. The other one was a drawing with 8 motors inspired by the wing structure of stingray fish. We have decided to use the 2nd chassis because the drawing will be produced with materials that have not been used much in the field before, at a more affordable price, and since it emphasizes the wing shapes, which is the main feature of stingrays.

**When choosing a chassis:**

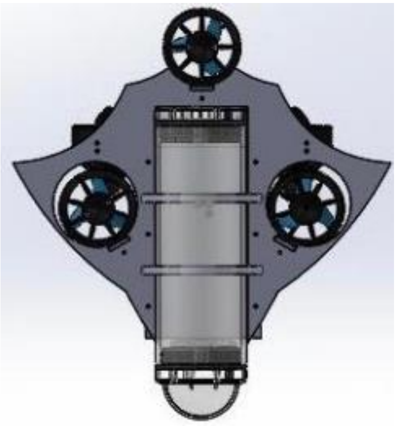
1. Aesthetic posture

2. Easy to modify

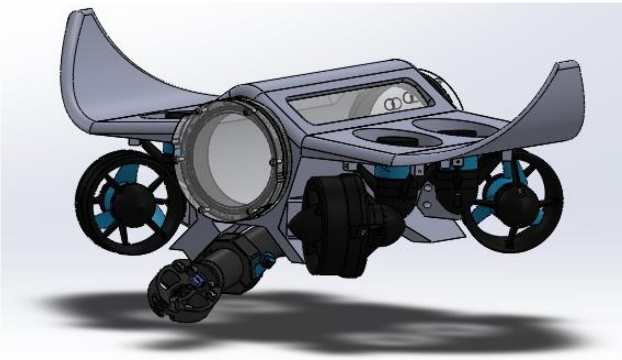
3. Authenticity

4. abality to integrate with water

Considering the criterias, we have decided on the final chassis.



**Our first drawing**

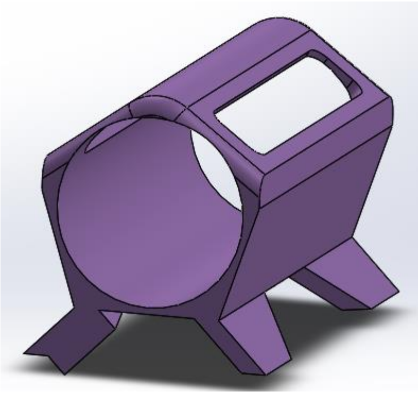


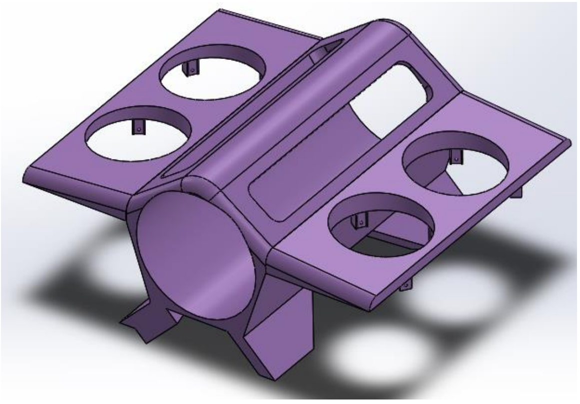
**our latest drawing**

# PRODUCTION PHASE AND MATERİAL SELECTİON

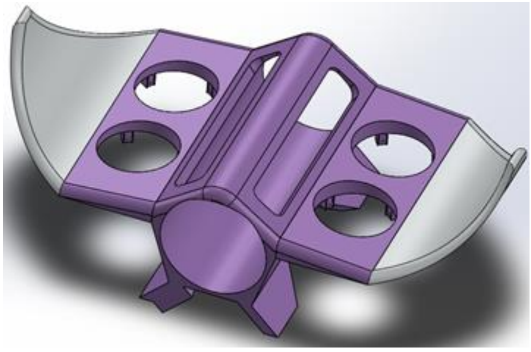
## Chassis:

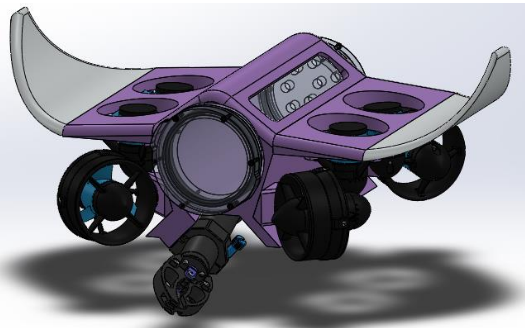
We made the chassis drawing from Solidworks application. Before drawing the drawings on the computer, we held meetings and made drawings on paper. When the drawing dimensions in our minds became clear, we switched to professional drawing on the computer. We shaped the entire drawing around the acrylic tube, which we thought as the main material in the robot. We think that making the chassis on the acrylic tube without a need for a extra part makes it easier to reach the acrylic tube, and also creates integrity in the robot.





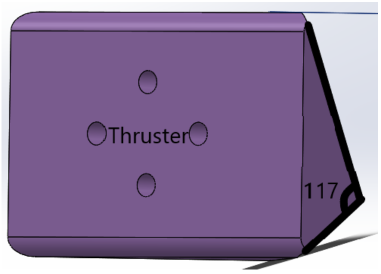
At first, we drew the chassis piece that will wrap the acrylic tube. We drilled holes in the chassis to see the electronics inside the acrylic tube. When the robot sat on the bottom of the water while performing its competition tasks, we drew a sticky foot on the chassis to cut off the contact of components such as the engine and gripper with the ground. Then we made a drawing of the part where the motors will be moutaged. This year, we did not place nozzles around our motors, instead we made our thruster protectors more comprehensive. Thus, we gained about 4 cm from the chassis length.



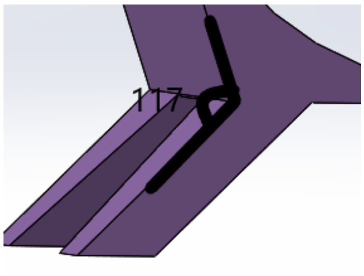


Finally, we made the drawing of our wings, which we mentioned before, and completed the drawing with the montages.

## Motor Bracket:



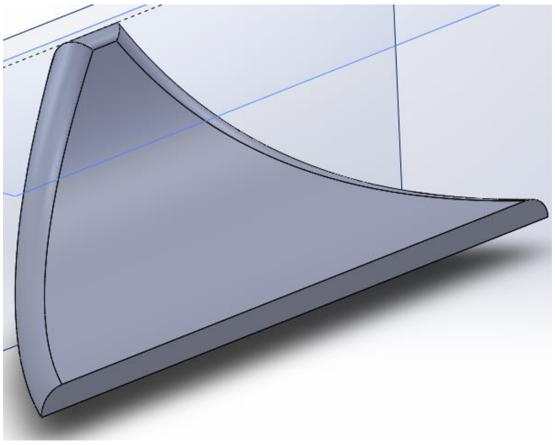

Motor Stabilizer



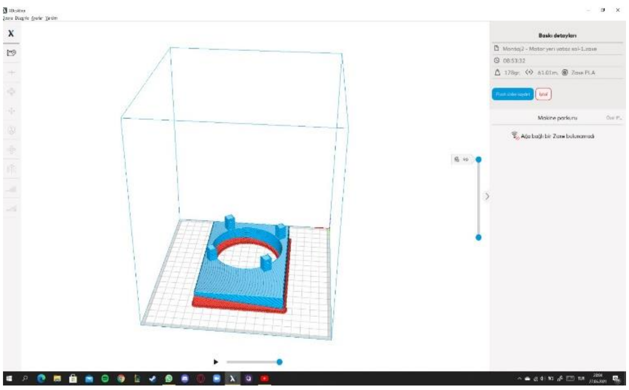

Where the stabilizer will come in the chassis

In our robot, we applied the 8-motor array that we mentioned in propolsion part. We also drew a part to fasten up the 45 degree motors to the chassis. As you can see above, we made the motor montages by drawing a stabilizer at an angle suitable for  where we will mountage the motors on the chassis. We do not draw such small and easily damaged parts attached to the chassis, because if the parts are damaged in the later stages, it will be more expensive to re-manufacture the chassis, while producing small parts will be both shorter and more economical.

## Wings:

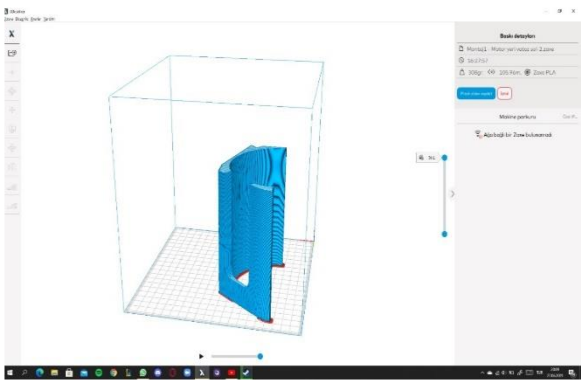


We made a wing drawing on Solidworks to imitate the wing movements of stingrays. We produced the wings with Flex Filament material from 3D printer. Flex filament is a type of filament that has become popular recently due to its flexible and durable structure, but in under water it didn't have become widespread. Since it is more flexible compared to the other filaments, the wings will take shape when going underwater. If we have used ABS, PLA type filaments in the wings, the wings would create a wall effect and reduce our speed in our right and left movements. In this case, both our forward-backward movements accelerates and the wing would not have created much of a friction in our right-left movements



We produced the remaining parts of the chassis from the 3D printer. Prints from the 3D printer are in good quality when the correct settings are made. We preferred filament due to the ease of access to the material and its cheapness. You can see the 3D printer settings of the chassis parts down below.

We've added 30% support to parts so that the prints come out properly. At the same time, according to the information we read in The International Journal of Advanced Manufacturing Technology (October 2020) article, as the layer thickness of the printers increases, the waterproofing also increases, so the parts become more durable. That's why we maximized the layer thickness.

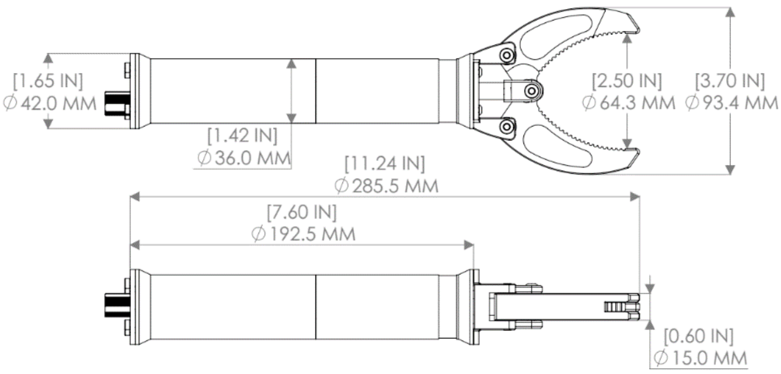


## Task Net:

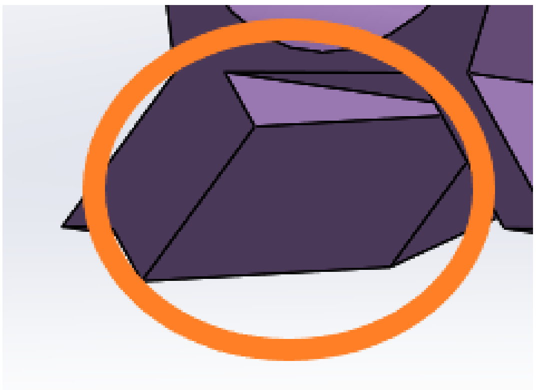

We produced the component that we will use to collecting ping-pong balls from shopping nets and pipes. We think that the easiest and cheapest way to collect multiple ping pong balls at the same time is a mechanism like the one in the photo. We opened up the mouth of the net a little wider and the net deeper, so that we can collect the ping pong balls more easily and the balls we put in the net would not falls out while moving. We have 2 strategies for the robot camera to see the net. The first is to adjust the length of the net as close to the camera as possible, using the servo motor in the camera we mentioned in ... ; the other is to see the ping pong balls from the minirov's camera by holding the gripper and minirov towards the net by drawing a separate and angled 3D part on the minirov that we have described in “mini ROV” part, which we should use in another task. With these strategies, we will collect the ping pong balls in the competition in a short time.

## Gripper:

When we analyzed the tasks in the competition, we saw that we needed 2 basic components to perform many tasks. Camera and Gripper. That's why we used the Bluerobotics gripper, whose performance we know from previous years, in our final robot, in order not to risk it. In our first drawing, we attached the gripper to the chassis with a flat piece, however when we saw that it was more comfortable to attach the gripper to the chassis with an angled piece due to the angle of the camera during the test drives, we drew a attached piece to the chassis. In the last drawing, the gripper is fixed to form an angle to the legs on the chassis. With this arrangement, the driver will be able to see both the gripper and the objects under the gripper from the camera when he picks up the mission objects.

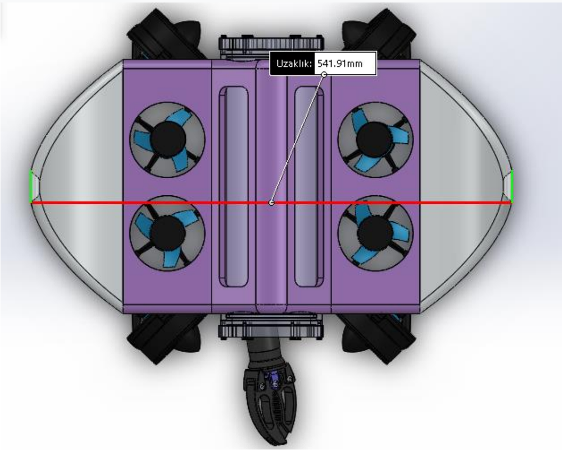


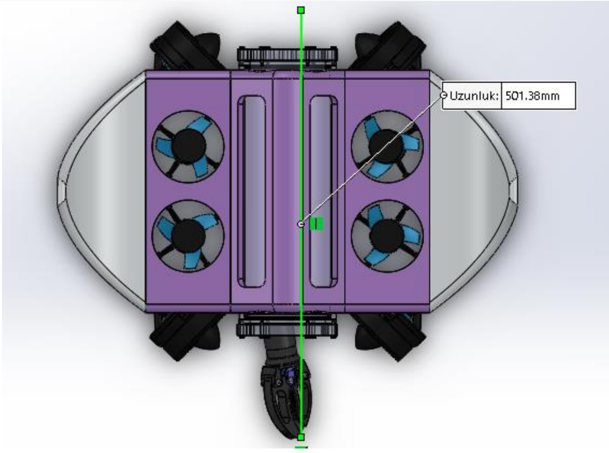

**Gripper’s physical feature**



**Post-drawn angled gripper stabilizer**

## Robot Dimensions:




**Width: 54.1 cm** **Mass: 5927 g** **Length: 50.1 cm** **Height: 40 cm**

## PAYLOAD AND TOOLS:

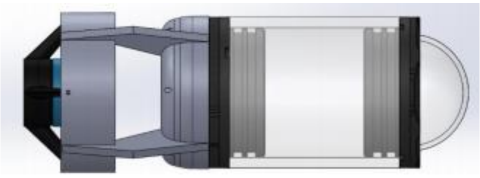
Our Main Robot has 1 raspberry pi camera. The reason why we choose the Raspberry pi camera: to get quality images at a cheap price and since it is a fisheye camera, it has a wide-angle view under water. We have also preferred to use the Raspberry pi camera that we used in our main robot. Both robots have 180-degree servo motors connected to the Raspberry pi camera. In the main robot, we placed the servo motor to move up and down and it is to move the mini-rov to left and right. We also planned to place 1 underwater light under the mini-rov, despite the fact that the inside of the drainage pipe is too dark for the task related to the mini-rov.

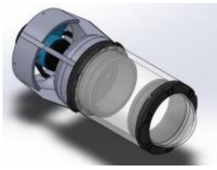
| Parameter | Value |
|---|---|
| **Electrical** | |
| Supply Voltage (V in ) | 7 - 48 volts |
| Full Brightness Supply Voltage (V in ) | 10 - 48 volts |
| PWM Logic Voltage | 3 - 48 volts |
| Peak Current | 15 / V in amps |

**Technical details of the light we will use**

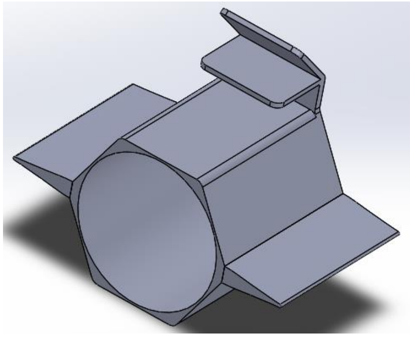
## Mini ROV:

We had 2 options for the production of the Mini Rov. The first is to use acrylic tubes and flanges from Bluerobotics. The other is to make a hole in the vacuum container for motors and using a pump to vacuum the storage container and isolate it from water with epoxy. Our research for the 2nd option are still ongoing. For the first option, we drew through Solidworks.





**Drawing images of Micro Rov**



In the drawing, we used 1 motor to move only forward-backward. Since the diameter of the drainage pipe that Mico Rov will go through is small, we drew a part so that the motor will be mountaged behind the acrylic tube. We think that using a single motor has the following disadvantages: Since there is only one propeller direction when we use a single motor, for example, we guessed that while the motor propeller turns to the left, the activate tube will rotate to the right and the mini Rov will rotate where it is instead of moving in the forward direction. So instead of using a 2nd engine, we drew small wings on the mini Rov to provide balance.

**Part to be moutaged on acrylic tube**

## Bouyancy:

| Contact With Water | Piece | Capacity (cm^3) | Weight in Air(g) (1 p | Lifting Force | Weight in Water | Not in Contact With Water | Piece | Weight in Air |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Pixhawk | 1 | 38 |
| Enclosure | 1 | 1029.05 | 200 | | -829,05 | Raspberry pi | 1 | 50 |
| T200 Motor | 8 | - | 344 | 0 | 156 | ESC | 8 | 16,,3 |
| Gripper | 1 | - | 616 | 0 | -260 | Camera | 1 | 30 |
| Chassis | 1 | 4349.975 | 2216 | -4349.975 | -2133,975 | Power Module | 1 | 15 |
| | | | | | | Servo | 1 | 10 |

## Electronics:

In order to safely isolate electronic components from water, we preferred acrylic tubes and flanges, which we also used in pur previous competitions. We used a tray where we will place the electronic components which is also suitable for the acrylic tube. Due to the geometric shape of the acrylic tube, the tray we used ensured the safe and regular placement of the electronic circuit. The holes in the flanges that we created at the back of the acrylic tube to enable the motors, power and ethernet cables to reach the circuit in isolation from water, with the method we described in; O-rings on the flange also ensured that the flanges were tightly attached to the acrylic tube. We could use 2 types of components in the part where the camera is located. Oring flat, plastic sheet or dome. Light is refracted when passing from air to water, and this refraction changes depending on the angle. While there is no break at 90 degrees, the amount of breakage increases as the angle moves away from 90 degrees. The dome minimizes these breaks due to its shape. In addition, while the pressure distribution under water in varies from place to place on the plate, the pressure is evenly distributed in the dome and the dome is more resistant to hydrostatic pressure than the flat plate.

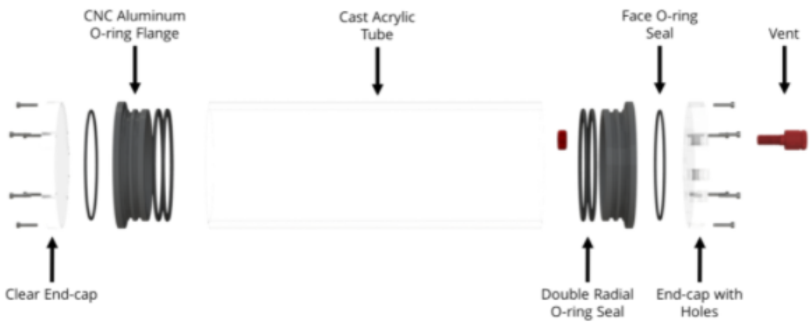
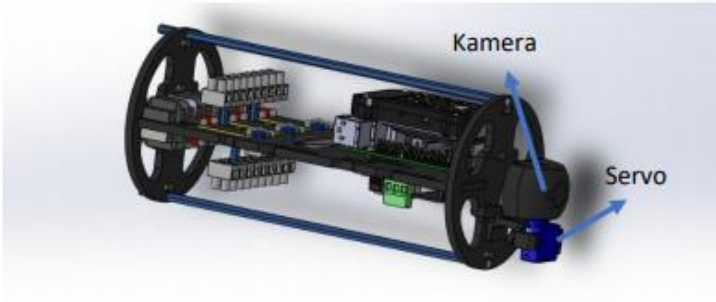
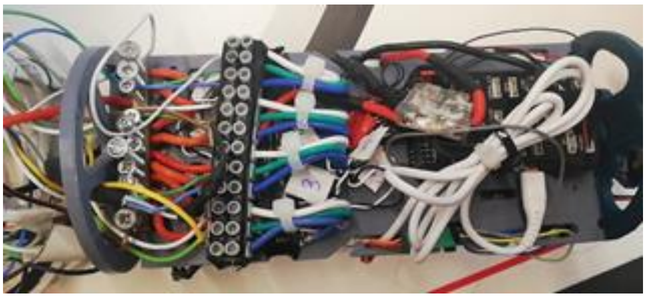


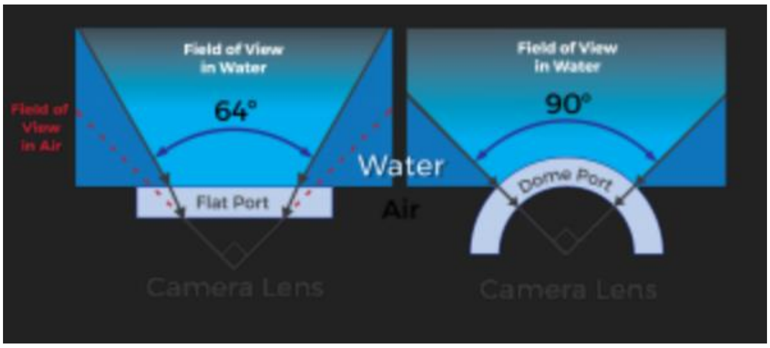

Diagram of the watertight enclosure components.



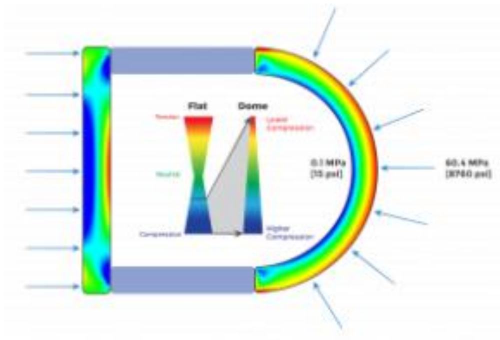

Electronic components that we consubstantiate in the Solidworks



Latest state of electronics compenents




View angle difference between flat plate and dome




Hydrostatic pressure distribution difference of flat plate and dome

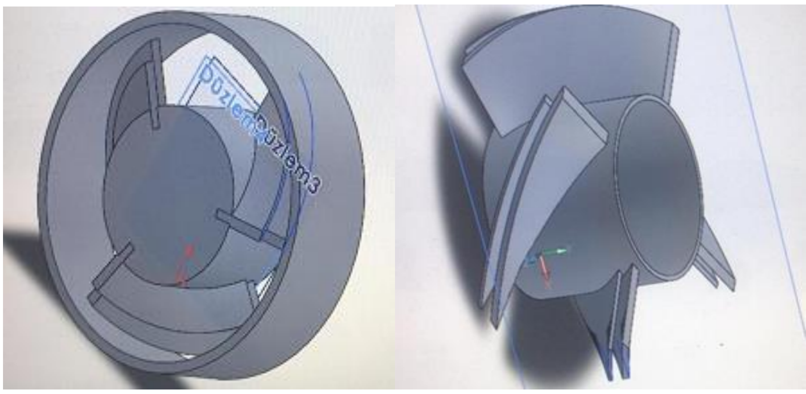
## Thrusters:

We had 2 options for the motors that will be used in the robot. The first option was Bluerobotics' T200 brand motors, which we have also used in previous years, and the other is the motors that we bought as a hub from Turkey and produced modified parts from a 3D printer to try beforehand. We first tested these motors in Solidworks' fluid analysis. Down below are the steps for making the motors that we bought  as hubs which is suitable for underwater.

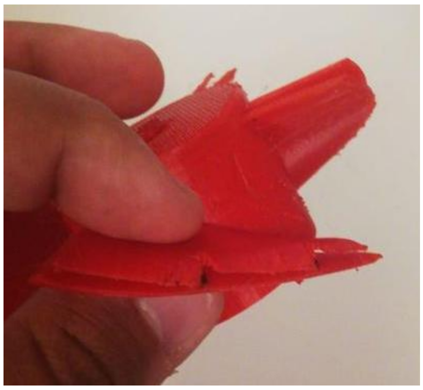
At first we bought our motor hub. Then, we soldered our cables to the junction area of the motor with the cable. In order to isolate the soldered area from water, we epoxyed it and covered a part of the cable with a tubing.

To test it, we attached the propeller of BlueRobotics and combined it with the nozzle.

For the propeller, our members in the mechanical unit worked to develop a new propeller design. We planned to 3D print these propellers. However, since the pressure did not come out as we wanted, the possibility of the propeller to roll under water arose. So we are currently researching to manufacture our propeller in other ways. We are also making improvements to our propeller drawing.



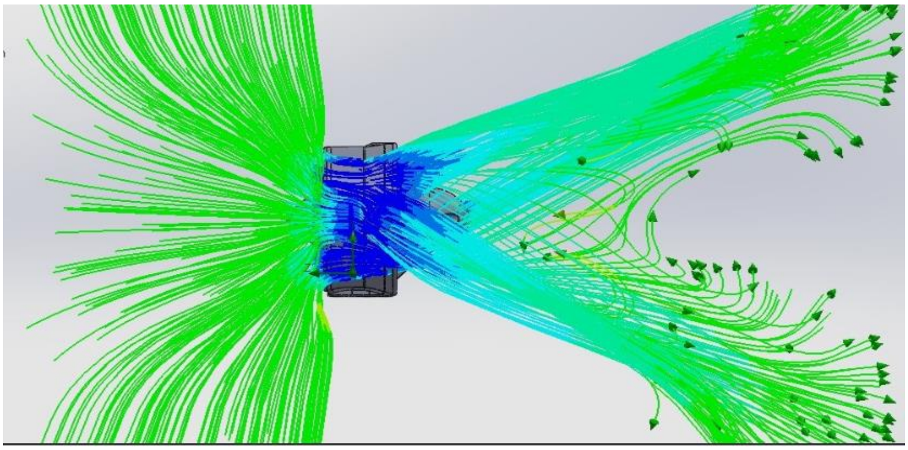
the propellers we drew



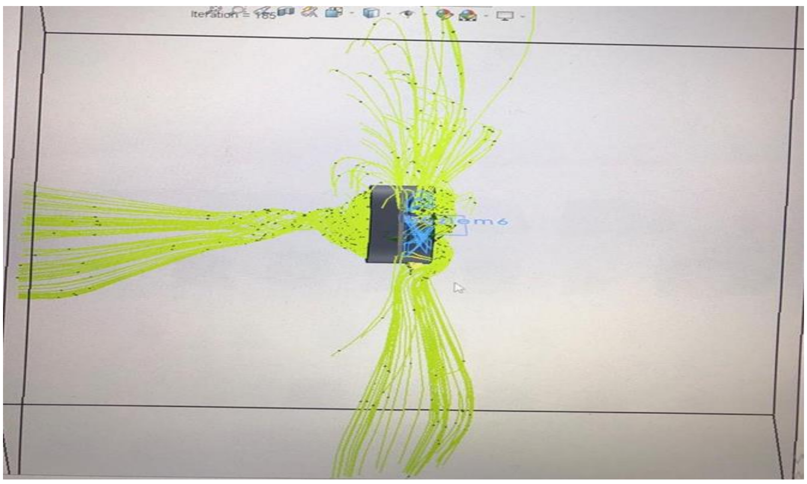
the propeller we took out of the 3d printer

## What is the flow simulation:

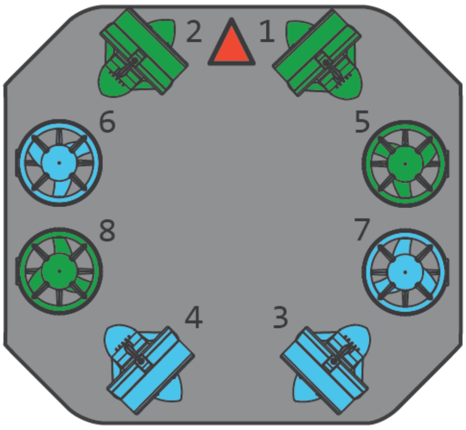
Fluid analysis is a modeling of the fluid flowing around any structure or object. It is used to determine the feature of the fluid by solving mathematical methods. Fluid analysis and simulations are very important because they save time in the design process. Thus, cheaper and faster results can be obtained compared to traditional tests to obtain data. The tests that has to be done in reality can be done in any number of times by using different parameters with fluid analysis.



**Fluid analysis result of T200 Thruster: water inlets and outlets are smooth, at the level that can be used underwater**



**The result of the engine we bought from Turkey and modified: Water inlets and outlets are still regular and suitable for use under water.**




After comparing both motors, we planned to use T200 engines in our main rov and use the other motor in the minirov.

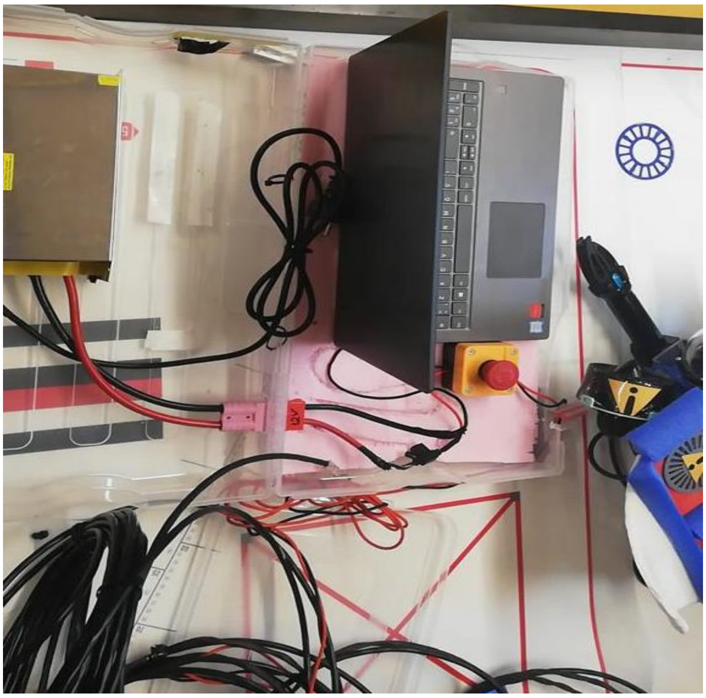
**Propulsion:** We used BlueRobotics' T200 Thrusters on our robot. We used 8 motors. We placed the 4 motors vertically, the other 4 engines on an angle of 45 degrees. While the vertical motors will be used to carry objects during the missions, the 45 degree angled motors will be used for sway and yaw movements.

In addition, in the tests we carried out, we reached the lifting capacity of our motors and the speed information in a frictionless environment. The lifting capacity of our motors is approximately 4kg and the speed values in a frictionless environment are as follows:

**Vertical Movement: 2.9 m/s**

**Lateral Movement: 2.9*cos45= 2.05 m/s**

**Forward Movement: 2.9*cos45= 2.05 m/**



## Control box:

Our main purpose in the control box: to carry our cables and computer in a safe and orderly way. For this reason, we made a control box ourselves using foams from a shoe box. We carved places on the foams to put the pc, emergency button, cable and placed these components there.

## Coding:

Coding was a new type of experince to our team this year. We are still working on the autonomous missions in order to get the maximum score. We watched training videos on the YouTube platform for software training. As a result of the training videos, we wrote the codes to be used in the tasks. Our research on software is still ongoing.

```python
import cv2
import numpy as np
import imutils

cap = cv2.VideoCapture(0)

while True:
    ret, frame = cap.read()
    frame = cv2.flip(frame, 1)
    frame = imutils.resize(frame, width=600,height=600)
    hsv_frame = cv2.cvtColor(frame, cv2.COLOR_BGR2HSV)
#purple
    lower_purple = np.array([80, 10, 10])
    upper_purple = np.array([120, 255, 255])
    purple_mask = cv2.inRange(hsv_frame, lower_purple, upper_purple)
    purple = cv2.bitwise_and(frame, frame , mask = purple_mask)
####
    mask = cv2.erode(purple_mask, None, iterations=2)
    mask = cv2.dilate(purple_mask, None, iterations=6)
    cnts = cv2.findContours(mask.copy(), cv2.RETR_EXTERNAL,cv2.CHAIN_APPROX_SIMPLE)[-2]
    center = None
    if(len(cnts) >0):
        print(cnts)
        c = max(cnts, key=cv2.contourArea)
        ((x, y), radius) = cv2.minEnclosingCircle(c)
        M = cv2.moments(c)
        center = (int(M["m10"] / M["m00"]), int(M["m01"] / M["m00"]))
        if(x > 280 and x <320):
            print("şu an hedef merkezde")
        elif(x< 280):
            print("renk sol tarafta")
        elif(x>320):
            print("renk sağ tarafta")
####


#gray
    lower_gray = np.array([105, 5, 5])
    upper_gray = np.array([165,255, 255])
    gray_mask = cv2.inRange(hsv_frame, lower_gray, upper_gray)
####


####
    cv2.imshow("Webcam", frame)
    #cv2.imshow("Gray", gray_mask)
    cv2.imshow("Purple", purple)

    if cv2.waitKey(1) & 0xFF == ord("q"):
        break

cap.release()
cv2.destroyAllWindows()
```

**The code we wrote to detect the line in the picture**

```python
import cv2
import numpy as np


cap = cv2.VideoCapture(0)

def nothing(x):
    pass
# Creating a window for later use
cv2.namedWindow('result')

# Starting with 100's to prevent error while masking
h,s,v = 100,100,100

# Creating track bar
cv2.createTrackbar('h', 'result',0,179,nothing)
cv2.createTrackbar('s', 'result',0,255,nothing)
cv2.createTrackbar('v', 'result',0,255,nothing)

while(1):

    _, frame = cap.read()

    #converting to HSV
    hsv = cv2.cvtColor(frame,cv2.COLOR_BGR2HSV)

    # get info from track bar and appy to result
    h = cv2.getTrackbarPos('h','result')
    s = cv2.getTrackbarPos('s','result')
    v = cv2.getTrackbarPos('v','result')

    # Normal masking algorithm

    print(h, s, v)

    lower_blue = np.array([h,s,v])
    upper_blue = np.array([180,255,255])

    mask = cv2.inRange(hsv,lower_blue, upper_blue)

    result = cv2.bitwise_and(frame,frame,mask = mask)

    cv2.imshow('result',result)

    k = cv2.waitKey(5) & 0xFF
    if k == 27:
        break

cap.release()

cv2.destroyAllWindows()
```

**The code we wrote to find the line in the video**

File Edit Selection View Go Run Terminal Help

Getting Started | 30.py

C: > Users > Pc > Desktop > open cv > ders30 > 30.py > ...

```python
import cv2
camera=cv2.VideoCapture(0)

width=int(camera.get(cv2.CAP_PROP_FRAME_WIDTH))
height=int(camera.get(cv2.CAP_PROP_FRAME_HEIGHT))

print(width,height)

fourcc= cv2.VideoWriter_fourcc(*'MP4V')

writer= cv2.VideoWriter("kayit.mp4",fourcc,20,(width,height))

while True:
    ret,frame=camera.read()
    writer.write(frame)
    cv2.imshow("Video",frame)

    if cv2.waitKey(25) &0xFF==ord("q"):
        break

camera.release()
writer.release()
cv2.destroyAllWindows()
```

**The code we wrote to get the image from the camera**

## External İnterface:


As the external interface, we will use the Qground Control interface that we used in competitions in previous years.

QgroundControl; provides full flight control and vehicle setup for PX4 or ArduPilot powered vehicles. It provides assistance with all its features while driving and presents the camera view with the GPS to the user. At the same time, with the image coming to the interface thanks to the camera, our operator and our assistant operator will use the robot synchronously to use one robotic arm and one robot.

## WIRING PROTOCOL

There are 2 cables connectes the robot to the land. One of it is the ethernet cable that connects to the Raspberry Pi and provides land-underwater communication, and the other is the AWG cable that powers the robot. We tied the two cables together with a zip-tie to prevent the cables from getting tangled while driving. In addition, we made the ethernet and AWG cable isolated them from water. In order to prevent the Ethernet cable from breaking, we extended the life of the cable by placing a plastic material between the cables.

We applied epoxy to the peneterators and cables to ensure waterproofing at the junction of the cables and with the electronic components. O-rings inside the peneterators also prevent water from entering the electronic tube from outside. Finally, we wrapped the cables with a material called “cable socks” to ensure the arrangement of the cables. We also installed floaters at regular intervals so that the cables do not put a load on the robot while compliting the missons.

**What is epoxy procress:**

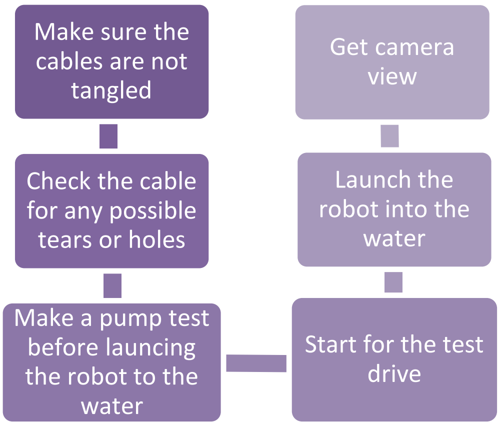
Epoxy; is a easily cleaned matterial which is applied as a liquid and then becomes a water, acid and alkali resistant when it is dried; It is an adhesive chemical resin used in many areas including boat building and repair. While the cables are isolated from water and since the cables that enters the acrylic tube contains the electronics compenents, epoxy chemical gets sprayed to the peneterators along with the cables and the epoxy chemical is waited for drying. While removing the epoxy chemical from where it is, epoxy is melted with a hot material such as solder and the surface is deposited in acetone.

**Epoxy-treated cables**

## Critical Analysis

We set up the tasks in the test pool at least 1 month before the competition and start to work in order to develop a strategy in the missions and to accelerate the driver on the missions. We are trying to finish the entire tasks as soon as possible. Our goal is to go at least 3 minutes below the maximum time given by the competition committee.

In addition to the driver, the members who will hold the cable in the competition also test themselves, memorize the taks and works out how to hold the cable without getting tangled. The diagram down below shows what we did step by step before putting the robot in the water.




## LESSONS LEARNED

1. Attention should be paid to the motor rotation directions. If it is not correct, it must be adjusted from the interface. There must be a dome in the part where the camera is located. Otherwise, objects appear in different places with the refraction of light in water.

2. fr the safety of the parts and the diver in the pool, it is necessary to insulate the robot well. Because this may cause loss of electronic circuits or a serious current risk in the pool since the metal parts on the cables are conductive.

3. Epoxy should be preferred in most places to thoroughly insulate the robot. The robot should not be put into the pool before it dries. Epoxy is the safest material for insulating the robot.

4. Kablo (AWG) değerlerine uygun kablolar kullanılmalıdır. Çünkü robota aşırıyüklenmelere bağlı kablolarda yanma meydana gelebilmektedir. Cables suitable for cable (AWG) values should be used. Because the cables connected to the robot may burn by a cause of a overload.

5. Cable (AWG) wires must be insulated. Because the wire inside is conductive, if it comes into a contact with water, the current will spread to the whole pool. This can cause health problems for a person in the pool by being caught in the current because he/she is in contact with the water.

6. Since all electronic parts are inside the waterproof tube, the tube arrangement must be done very well and tightly closed. Otherwise, the electronic circuit will become very confused, which can lead to both confusion and short circuit.

7. Care should be taken to not to break the ESC wires.

8. When the robot is put into the pool, it should be checked whether it takes water or not. If it is getting water, it should be carefully removed from the pool without powering it up.

9. The robotic arm must be placed in the field of view of the camera. Thus, while performing the tasks, we can see from the camera whether the robotic arm picks up objects or not and we can control the robot according to it.

10. Manufacturability should be taken as a basis in chassis construction. Everything must be drawn in SolidWorks up to the screw holes. This prevents us to save time while producing the robot.

11. For chassis's drawing, biomimicry should be taken as a basis.

12. Time planning should be flexible. So when we encounter a surprise situation,trouble won't occur.

13. Electronic circuitry should be handled sensitively. Attention should be paid to PWM cables. Otherwise, the PWM wires will break and be damaged.

14. Motor cables should be named with a label. Since the tube of the robot is small and the electronic circuit is complicated, this helps us to find out which motor belongs to the which the cable.

15. It should be checked that there are no holes in the cables going to the robot, and if there are tears, holes, etc. it should be screwed. Our biggest experience last year: Since there was a small hole in the Ethernet cable and we did not see this hole, water got into the robot by walking 20 meters from the cable and this left us in a difficult situation.

16. After the robot is turned on, it must be calibrated. This prevents us a much more comfortable driving.

17. The robot must be shaken on the surface before being submerged in water. This is to make it easier for the robot to sink by filling the air gaps with water.

18. Attention should be paid to the connection points of the cables. If not, combustion occurs in electronic circuit materials.

19. Attention should be paid to the aluminum bars which the electronic board is attached. Rods can break.

**FUTURE IMPROVMENTS:**

1. Acrylic tube: This year we used a cylindrical acrylic tube. We are planing to use an acrylic tube with different geometric shapes in the following years. Although we have created our chassis to harmonize with the acrylic tube, we can use the geometric shape of the acrylic tube differently to integrate it further with the chassis and move away from mediocrity.

2. Motors: Our current motors are Bluerobotics' T200 motors (we use them in the main rov), as we mentioned on the previous pages, instead of buying new motors in the future, we want to produce our own motors and use them in the competition.

3. External interface: We have been trying to create our own interface for years, we have been doing research, but we still could not achieve the result we wanted. We think that we can create our own interface when we develop ourselves a little more in the software part.

4. Gripper: We are still working on the gripper that we purchased. We plan to produce our own gripper until the competition and if we can produce it, we plan to use our own gripper.

**BUILD VS BUY NEW VS USED.:**

As a team, we treat the components kindly and do not neglect their maintenance. We hold meetings before a new component is purchased for the team, and we buy it if it is really necessary and we cannot manufacture it ourselves.

The electronics of the robot are the same since the first year, except for the ESCs that we will use. We recycled the old Bluerobotics ESC's to use them in the minirov missions. In addition, the materials we have used since the first year are acrylic tube, flanges, peneterator, ethernet and AWG cable. We have different materials that we use for innovation this year, and we have explained them where it was necessary. In addition to these, instead of buying the acrylic tube that we will use for Minirov from sites such as an Bluerobotics one, we made one much more cheaperly. Down below you can see the paths that we followed before purchasing a component.

## Acknowledgements and References

Believing and trusting in us during the process of preparing for the MATE ROV competition; We would like to thank the organizations and people who always stand behind us and supported us while making our dreams come true. First of all, we would like to thank our families and mentors, who did not spare their moral support and provided all kinds of support during our work days. Without them, we would not have been mentally comfortable during this difficult process. Secondly, we would like to thank our school Bahcesehir College Future Campus Nakkastepe 50th Year High School for supporting us for 3D printer and workspace, and to which we can ask for help when we need anything. We see the steps they have taken in the way of raising global citizens and we are even more encouraged. At the same time, we would like to express our gratitude to our sponsor T3 Foundation, who provided material and logistical support, for believing and guiding us. Also we would like to thank our other sponsor BAUROV, who provided us mentorning and compenents. Finally, we would like to thank the MATE Rov Competition, which adds a new dimension to underwater robotics, shows that robotics is not just about technical issues, and contributes to the training of people who will make a difference in the world.

## Budget Planning

| Expenses | | | | |
|---|---|---|---|---|
| **Equipments** | Price (1 Piece) | Piece | Total Price | |
| **Mechanic** | | | | |
| **Waterlight Enclosure for ROV** | $136,5 | 1 | $136,5 | Owned |
| **Enclosure Went and Plug** | $5,5 | 2 | $11 | Owned |
| **Gripper** | $264,70 | 1 | $264,70 | Owned |
| **Penetrator** | $3,50 | 15 | $52,5 | Owned |
| **Penetrator Wrench** | $8,30 | 1 | $8,30 | Owned |
| **Vacuum Pump** | $20 | 1 | $40 | Owned |
| **Electronic** | | | | |
| **Pixhawk** | $82,75 | 2 | $165,5 | Owned |
| **ESC** | $21,80 | 8 | $174,4 | Owned |
| **Quad Motor Driver** | $103,5 | 2 | $207 | Purchased |
| **Rasberry Pi Camera Module** | $34,5 | 2 | $69 | Owned |
| **Rasberry Pi 3 Model B** | $31,10 | 2 | $62,20 | Owned |
| **Thruster Cable** | $3,5 | 15 | $56 | Owned |
| **Fathomslim Rov Tether** | 1,7 | 20 | $34 | Owned |
| **Tether Cable Thimble** | $3,4 | 1 | $6,8 | Owned |
| **Total** | | | 1.287,9 | |

Mechanic 513$ / Electronic 774,9

### Paid by Sponsors

| **Equipments** | Price (1 Piece) | Piece | Total Price | Sponsor |
|---|---|---|---|---|
| **T200 Thruster** | $144 | 10 | $1440 | T3 Foundation |
| **PLA 3D Filament** | $22,5 | 2 | $45 | T3 Foundation |
| **Flex 3D Filament** | $24,70 | 2 | $49,40 | T3 Foundation |
| **Series 3 Acrylic Tube** | $57 | 1 | $57 | Baurov Team |
| **Series 3 Dome** | $29 | 1 | $29 | Baurov Team |
| **Series 3 Enclosure Went and Plug** | $5,5 | 1 | 5,5 | Baurov Team |

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