

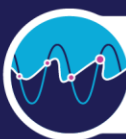


UNDERWATER ROBOTICS ROV CHALLENGE EGYPTIAN SUNKEN LOST CITY

RULE BOOK

October 2020

POWERED BY



UNDERWATER ROBOTICS
CHALLENGES
MORE THAN A CHALLENGE...

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1. About the Challenge

ROV Challenge is a new competition aims to push the students towards the new technologies, and develop their skills then apply these skills in real applications to provide modern solutions to solve the current issues or develop more stable solutions in the marine field using technology.

2020 will be the first year of the competition, and it will be an annual event comes every year with new challenges.

2. Challenge categories

The challenge is available for participating teams around the whole MENA region through these categories:

- **Seniors:** For undergrad students and postgrad with no restrictions on age or technical and non-technical level. In this category, ROV (Remotely Operated Underwater Vehicle) is required to be built by the team members to make specified simulated tasks underwater with specific scientific and engineering concepts
- **Juniors:** For high school students with no restrictions on age or technical and non-technical level. In this category, ROV (Remotely Operated Underwater Vehicle) is required to be built by the team members to make specified simulated tasks, with less complexity than the seniors' teams, underwater with specific scientific and engineering concepts

3. Rules and guidelines

3.1. Time line

- 25 Jun 2020: Teams Registration Opens
- 01 Aug 2020: Teams Registration closes
- 07 Aug 2020: Proposal and Cost Analysis submission deadline
- 15 Aug 2020: Notification for Acceptance
- 25 Aug 2020: Technical Report submission deadline
- 05 Sep 2020: Pitching 1
- October 2020: Challenge Day

3.2. Registration

- Registration will open from 25 June to 01 August 2020 on uwrchallenges.org
- Seniors Category is for postgraduate and undergraduate students
- Juniors Category is open for high school students
- All data should be written in English
- Email and phone number for each member must not be duplicated
- The team members cannot be less than 3 and not more than 20 including mentors or advisors
- **Fees:**
 - 250\$ registration fees for Seniors Category teams in the regular registration period, for 10 team members in the team, 10\$ will be added per each extra member
 - 150\$ registration fees for Juniors Category teams in the regular registration period, for 10 team members in the team, 10\$ will be added per each extra member

For more information please visit our [website](http://uwrchallenges.org).

- **Registration steps:**
 1. Choose your underwater robotics challenge and category
 2. Sign up to create your team account
 3. After signing up for the first time you will receive a confirmation link sent to your email, to verify your account
 4. After verification, go to the log in page, use your email and password to edit/complete your team data
 5. Fill and write the team data. You can save your progress and continue with the form later
 6. If you finished your team data, review for the last time and click submit
 7. You will be directed to payment page. Fees will be determined based on team category, number of participants and the challenge/s you have chosen
 8. After payment successfully completion, you will receive a confirmation mail which includes all the data you have written in the [form](#)

Note: You may start working on your vehicle during the registration steps and do not wait to the registration deadline.

3.3. Challenge Phases

3.3.1. Deliverables

- **Proposal:** Each team will be asked to send a proposal for their product before the competition to show how the product will be suitable to RFP (15 points)
Check the criteria of the proposal from [Appendix A](#)
- **Cost Analysis:** Each team should prepare cost analysis and send it before the competition (20 points)
Check the criteria of the cost analysis from [Appendix B](#)
- **Technical Report:** Each team should prepare a technical-wise document and send it before the competition (30 points)
Check the criteria of the technical report from [Appendix C](#)
- **Safety Document (Software safety check):** Each team will be asked to deliver a safety document prior the competition (15 points)
The whole rules are mentioned in [Safety section](#)

3.3.2. Pitching 1

Each team will be asked to perform a pitching prior the challenge by at least three weeks to evaluate their work through live video through 5 minutes (15 points)

Check the pitching criteria from [Appendix D.](#)

3.3.3. Challenge Day

The challenge will be divided into three section as following:

- **Safety Check:** Each team will perform the safety check according the specifications that will be described in [Safety section](#), the company that cannot pass the check, they will not be allowed to compete in the Underwater Missions (35 points)
- **Underwater Missions:** Each team will have two trials with 20 minutes for the doing the tasks underwater using their ROVs and additional devices, 5 minutes as setup time and 5 minutes for leaving the station with total time 30 minutes (180 points)
Check the whole Underwater Missions from [here](#)
- **Pitching 2 (Onsite pitching):** Each team should be well prepared for the Onsite pitching as it is required to perform a pitching talking about

the team's vehicle and their work which will be 5 minutes to present and 10 minutes for Q&A and evaluation by judges' panel (20 points)

- Check the pitching criteria from [Appendix D](#).

The teams with top score of the total score of whole phases of the Challenge will define the winning teams per category.

3.4. Playground and Stations specs

3.4.1. Playground specs

The playground will be in depth 3 meters maximum and ends about 10 meters long from the side of the pool; you should prepare a suitable tether for this.

3.4.2. Power Sources

3.4.2.1. AC Power Source

One AC Hub with 220 volts for each team will be provided by the challenge per each station.

3.4.2.2. Main power Source

- The competition will provide a power supply and its specification will be limited to 48-volts and 30-amps for seniors and juniors
- Vehicles in Juniors category can be powered by power supply less than 48 volts but in Seniors; it is mandatory to be powered by 48 volts
- Each vehicle should have a suitable fuse according to fuse calculation and maximum ampere, maximum fuse to be used 30-amp fuse
- It is allowed for any team to use their own power supply but it must pass from the safety check, but it is restricted to 48 volts maximum and 30 amperes maximum, also the vehicle must have a suitable fuse for the maximum power used
- The power supply should provide power to the vehicle through one input to operate the whole vehicle. No external power will be used
- Each component in the vehicle should be powered through the main supply (motors, valves, cameras and modules)
- No power conversion is allowed until the power reaches the vehicle
- Batteries aren't allowed for the main power
- Each vehicle and additional devices can be connected to the power supply via Red and black Anderson powerpole connectors or via XT60H (XT60 upgrade) connectors, the team connectors should be the male one of XT60H



Red and black Anderson power-pole connectors



XT60H (XT60 upgrade) connectors

3.4.2.3. Auxiliary Power Source

- The competition will provide a power supply and its specification will be limited to 12-volts and 10-amps for seniors and juniors
- The device should have a maximum fuse of 10-amps or less
- It is allowed for any team to use their own power supply but it must pass from the safety check, but it is restricted to 12 volts maximum and 10 amperes maximum, also the vehicle must have a suitable fuse for the maximum power used
- Batteries are allowed as the auxiliary power, but not in the water just on the station and with maximum 12 volts and 12 Ah

3.5. Vehicles and additional devices Specs

- Vehicles for **Seniors** are restricted to a size of 100 cm in diameter and to a weight of 40 kg, vehicles that will violate these restrictions will not be allowed to compete in the Underwater Missions
- Vehicles for **Juniors** are restricted to a size of 90 cm in diameter and to a weight of 30 kg, vehicles that will violate these restrictions will not be allowed to compete in the Underwater Missions
- Modifying on the vehicles after size and weight measurements is not allowed, this modification including adding any additional weights
- Pneumatics and hydraulics are permitted
- Lasers are permitted

- Camera is required in the main vehicle
- It is not allowed to use multiple vehicles, but it is allowed to use any additional device to help the vehicle in performing the mission
- The tether of additional devices should be hardly attached to the tether of the main vehicle
- The additional devices and the tether will be considered in the size and weight check
- Each team should submit documents for the main vehicle, additional devices and their SIDs

3.6. General Rules

- Only team members are allowed to work on the vehicle not mentors or supervisors
- In the pool during the Underwater Missions, only four members are allowed to be in the station (a pilot, two co-pilots and a tether-man)
- Direct communication during the Underwater Missions is only allowed between the pilot and the co-pilots in the team
- The time given is 5 minutes for setup, 20 minutes for the Underwater Missions tasks to be done and 5 minutes to leave the station
- The tether-man is not allowed to pull the vehicle from its tether, and the vehicle must go back to the surface under its own power
- The tether-man can communicate with one of the co-pilots to know what task to do, to attach the required devices to the vehicle
- The tether-man cannot throw the devices or things used in mission to the water, the vehicle should carry it and deliver it down
- Any debris should be returned to the surface before the mission time ends

3.7. Penalties and Disqualifications

- Trying to cheat in any way leads to disqualification
- Disrespecting the judges or the organizers leads to disqualification
- Not passing the safety check leads to disqualification from Underwater Mission

- The vehicle that cannot pass the size and weight measurements will be disqualified for participating in Underwater Missions but the team can participate in the other phases
- Participation of mentors, instructors or any person not registered with the team in any activity (mission, safety or pitching) leads to a 5-points penalty
- During the time of mission only four members are allowed on the station, any additional member will interfere leads to a penalty 5 points
- Touching the playground by the vehicle or the tether leads to a penalty 5 points
- Any debris left in the water results 5 points penalty for each one
- After the 5 minutes of leaving the station, but the team still in the station will result 2 points/minute penalty
- Any deliverable document not sent in its time will be accepted but half will multiply your score without any acceptable excuse before the deadline by 5 days

4. Safety

The safety is one of the most important concerns; therefore, we should apply some procedures to ensure safety.

This year the safety check will be divided into two checks: software safety check and hardware safety check.

4.1. Software Safety Check

Each team will be asked to deliver a safety document that will be added to the onsite safety score.

The document should be in PDF format with max size 3 MB, upload it on Google drive with naming [Team name_ Category type_Software safety_ ROV Challenge 2020], and send to info@uwrchallenges.org before 25 August, 2020.

Moreover, this document should demonstrate your own procedures you have taken to make your product safe.

The document should demonstrate:

- The IP rating of sealing and how the motors and control box are sealed
- How the motor propellers are shrouded in front and back
- The main fuse connection
- Fuse calculation

Example:

6 Motors * 3 = 18 Amp

2 Servos * 0.5 = 1 Amp

4 Cameras * 0.25 = 1 Amp

2 Valves * 0.5 = 1 Amp

Total rated current = 21 amp, the overcurrent = $1.5 * \text{total rated current} = 31.5 \text{ amp}$; you should use a 30 amper fuse.

- Other fuses: you should protect the components in the low level
- Isolation of DC and AC components from each other and mark them with labels

- Electrical Diagram should demonstrate electrical connection, joints and power. The diagram should have 2 sections (one for underwater system and one for the station)
- Fluid Diagram should demonstrate fluid connection, joints and power. The diagram should have 2 sections (one for underwater system and one for the station)
- There are no exposed wires
- Strain reliefs used
- Any Additional device used to aid the Vehicle in the task
- No sharp edges in the vehicle

The document should also include some pictures of your vehicle to visualize the points mentioned above.

4.2. Hardware Safety Check (onsite)

Prior the underwater trial each team must pass the onsite check, the judge will decide whether the team is allowed to compete or not.

The judge will evaluate according to the following:

- The motors are shrouded
- The motors and control box sealing and strain reliefs
- The main fuse
- Exposed wires
- AC and DC labels
- Additional devices safety
- Sharp edges
- Fluid power and regulators

4.3. Safety Check scoring

The score of Software check will be added to the total score of the safety with maximum of **15 points**.

The total score of the Hardware check will be **35 points** divided as follows:

- The motors are shrouded (5 points)
- The motors and control box sealing and strain reliefs (5 points)
- The main fuse (5 points)
- Exposed wires (5 points)

- AC and DC labels (5 points)
- Fluid power and regulators (5 points)
- Sharp edges (5 points)

4.4. Safety Check Rules

- Only four members from each team will be allowed to attend the onsite safety check
- Each team will be asked to make a dry test to check the vehicle, so there will be a power supply for this test
- If the team uses their own power supply, it must be tested
- Each team uses fluid power will be asked to test the fluid elements and their fluid power source
- The team should take the comments of the judges in consideration and try to solve the problem within maximum 20 minutes, after these 20 minutes if there is a missing element the team will not be allowed to do the underwater mission
- Each comment about an element to be solved the score of the element but he will get zero point for this element. However, the team must solve the problem to be allowed to participate in the underwater mission
- The teams that have passed the safety check will receive a card and the pool judge should take this card from the team before the mission starts

5. 2020 Challenge Motivation

Thonis-Heracleion (the Egyptian and Greek names of the city) is a city lost between legend and reality.



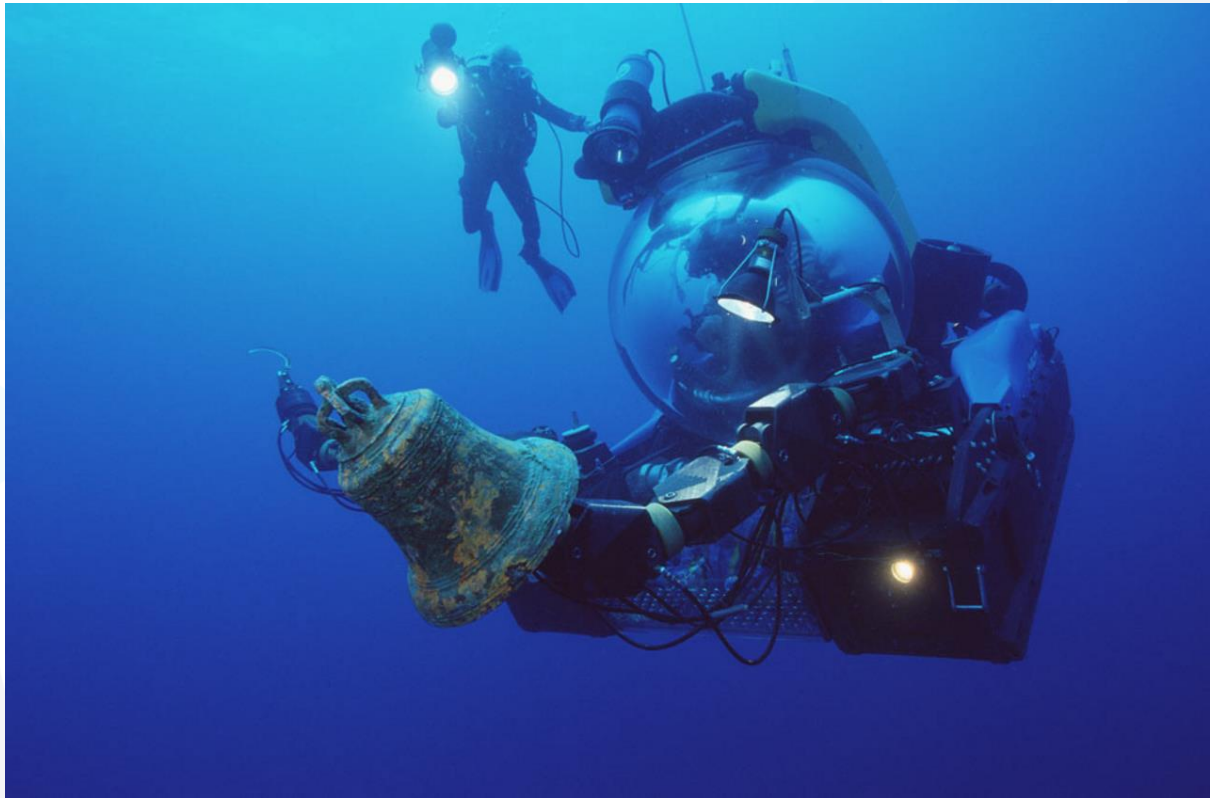
Before the foundation of Alexandria in 331 BC, the city knew glorious times as the obligatory port of entry to Egypt for all ships coming from the Greek world. It had also a religious importance because of the temple of Amun, which played an important role in rites associated with dynasty continuity. The city was founded probably around the 8th century BC, underwent diverse natural catastrophes, and finally sunk entirely into the depths of the Mediterranean in the 8th century AD.

The Underwater Archaeologists and divers paid great efforts to discover this lost city for long years of working on that by using a lot of technology like Acoustic Positioning System, Differential Global Positioning System (DGPS), NMR Magnetometer, ROVs and deep ROVers.

The objects recovered from the excavations illustrate the cities' beauty and glory, the magnificence of their grand temples and the abundance of historic evidence: colossal statues, inscriptions and architectural elements, jewellery and coins, ritual objects and ceramics - a civilization frozen in time.

The underwater archaeological research in Thonis-Heracleion is ongoing until today.

By taking a wide view on this marvellous discovery and applying the nowadays technology, that make us wondering about how the ROVs and deep rovers consider as one of the most important technology which can be used in almost the techniques of excavation.



6. Underwater Missions

6.1. Seniors Category

The Underwater Missions are divided into three tasks as following and the designs of the playground, which mentioned in each task, exist in [Appendix E](#).

6.1.1. Task1: Temple Excavation Plan (60 points)

When starting the excavation, there is, an important technique should be done. It is the excavation plan, in which any measurements and location of the archaeological site and objects that cannot be brought to the surface are taken and drawn on papers like a grid and each object pinpoint on this grid.

The excavation plan is built up day by day, until a complete picture of the archaeological site emerges. Only then, the site can be interpreted.

In this task, the team should do the following subtasks **in order** with max score **60 points**

Subtask 1.1: Discovering the lost city (10 points)

Subtask 1.2: Temple inspection (20 points)

Subtask 1.3: Mapping the discovered area and temple (30 points)

6.1.1.1. Subtask 1.1: Discovering the lost city (10 points)

- Scanning and define the area of the discovered site (10 points)

In this subtask is required from each team to scan the discovered site that is the whole playground in the challenge and define the total area of the site.

The scanning is done by flying on the whole site. To calculate the total area of the site by tracking the scale, which exists around the playground in X-Y coordinates and divided into steps each step represents 1.5 meter in the real site, the scale is made by ½-inch PVC pipe shape with black colour and each step is 10 cm * 10 cm, the team should count the steps in the scale and estimate the total area of the whole site.

The calculations can be done manually by hand or by using formula in any software program.

Example:

The Vehicle, ROV, tracks 10 steps on the scale in X-axis and 7 steps in Y-axis

The total area will equal $10 * 1.5 * 7 * 1.5 = 15 * 10.5 = 157.5$ square meters.

The team can scan and calculate the total area at the same time.

10 points will be obtained, if the team does the whole subtask, scanning and total area calculations.

The scanning and calculations of the area should be done manually. The team can scan it and calculate autonomous or using image recognition but without any additional score.

6.1.1.2. *Subtask 1.2: Temple inspection (20 points)*

- Autonomous (20 points)
- Manual (10 points)

In this subtask, it is required to inspect the temple that is one of the discovered objects but it is not able to return it to the surface so it should determine the coordinates of the temple location, vector representation, regarding to the starting point of the playground, which is considered, as the origin of the scale. The temple is a large simulated hollow block of the temple, made of ½-inch PVC pipes covered by brown corrugated plastic sheets with dimensions 150 cm* 150 cm* 100 cm.

The teams can use one of the following:

Autonomous method by using image processing, sensors or both of them in the vehicle with helping of the playground scale in X-Y coordinates to know the X, Y and Z coordinates of the temple regarding to the origin and then calculate the vector representation of the temple location, the length of vector, the angle and the depth.

By showing the result on the video screen, it is allowed to take a screen shot and make processing on it, or automatically creation, using another program by the vehicle itself the team will obtain 20 points.

During the autonomous mission, on the live video or on the screen shot, there must be borders or marks on the elements, which is measured in the current moment.

Manual method by calculate the vector of the temple on paper or using formula in program with helping of playground scale the team will obtain 10 points when it tells the judge the vector, length of vector, angle and depth.

6.1.1.3. Subtask 1.3: Mapping the discovered area and temple (30 points)

- Making a map for the scanning area (10 points)
- Mapping the temple location regarding to the scanning area
 - Autonomous (20 points)
 - Manual (10 points)

In this subtask, it required to make a grid map for the discovered scanning area and in addition map the location of the temple using the data obtained in subtasks 1.1 and 1.2.

Firstly, prior the competition each team should create a map grid (20*20) squares each one is 1cm * 1cm using any program and save it on the PC.

Making a map for the scanning area can be done by using the total area, which obtained in 1.1, rescale these dimensions each 10m to 1cm and define the area map on the prior competition map by defining the borders of the area like putting a square or rectangle around it using paint, PS or any other program manually

By drawing these borders, the team will get 10 points.

If the team did not calculate the total area correct in 1.1, the judge will give it the right dimensions to complete this task.

If the team finishes this task right, it can continue to map the location of the temple. Which can be done in two methods autonomous and manually.

Autonomous; by sending the calculations which obtained in 1.2 to the program in the device, can be the same device that used or another in the same station, and draw it on the map of the discovered area that done in the previous step by putting a mark in the correct location on the map.

The team can send only the calculations of the coordinates to program and the map created by itself regarding to the previous one and shown on the screen to the judge, in this case the team will get **20 points**.

Moreover, it can draw the location manually by using any software program like paint, PS... etc. on the previous map also and get **10 points**.

6.1.2. Task 2: Monuments discovery, sampling and labelling (60 points)

After thousands of years, the city and anything in it had been affected by environmental changes and catastrophic that make them broken and fully covered by sea organisms.

During the excavation process, there are some important techniques like; defining the dimensions of the discovered objects after cleaning and removing the algae, coral reefs and other sea organisms from the objects.

Sampling technique that happens in order to obtain the maximum possible information from a site samples are taken and sent to specialized labs to analysis them and back with the material info.

Labelling in which each item discovered in the seabed should have label with specified number.

In this task, the team should do the following subtasks **in order** with max score **60 points**.

Subtask 2.1: Cleaning and removing the algae and sea organisms from the statues (15 points)

Subtask 2.2: Statue Inspection (30 points)

Subtask 2.3: Labelling the parts of the statue (15 points)

6.1.2.1. Subtask 2.1: Cleaning and removing the algae and sea organisms from the statues (15 points)

- 3 algae max. (5 points each)

In this subtask, it is required to clean the parts of the broken statue which laying on the seabed and covered algae.

There is a broken statue divided into three parts on the top of each part, there are some algae which are simulated by ½-inch T-shape PVC fittings and attached with the part in hole.

The vehicle should remove the algae from the parts of the statue and drop it on the water for each alga removing the team will get 5 points.

6.1.2.2. *Subtask 2.2: Statue inspection (30 points)*

- Define the dimensions of the largest part of the statue (15 points)
- Retrieve a sample of the statue material (5 points)
- Determine the weight of the largest part of statue (10 points)

As mentioned in the previous subtask, there is a broken statue and divided into three parts, these three parts are made of PVC pipes with different size, dimensions, between 2-inch to 8-inch in diameter and different in length, the team should define the dimensions of the largest part of the statue, diameter and length by using their vehicle tools.

If the team inform the judge the right dimensions, it will get 15 points.

After finishing this point, the vehicle should retrieve a sample from the statue that is attached to one of the statue parts. It is a small 1-inch PVC pipe, 5 cm length with 2 end caps and a hook to be easy to pick it. The sample should be retrieved to the pool deck to get the score of 5 points.

The team could not be able to continue if it did not retrieve the sample.

To know the required lifting capability of the used hoisting machines that can be used to lift the statue later, we should estimate the largest weight, which is the weight of the largest part of the statue.

So, it is required to calculate the weight of the largest part of the statue by using the dimensions that the judge will give them to the team, diameter and length, in meters. Moreover, the density that was known by the retrieved sample of the statue, which is, like a small warped paper written on it the density of the statue material in the pipe in gram per cubic centimetres.

If the team could not get the right dimensions in the first point, the judge would give it.

The team can calculate it by hand or using software program with formula.

If the team show the judge the right answer should be in kilograms, it will get 10 points for that.

6.1.2.3. Subtask 2.3: Labelling the parts of the statue (15 points)

- 3 Labels (5 points each)

After cleaning the statue and defining its dimensions, it is the time to label each part of it.

In this subtask, it is required to label with numbering each part of the broken statue with a mark.

The labels will be provided by the competition with the following specs:

1. Corrugated plastic white sheet with dimensions 5 cm * 5 cm
2. Hold on ½-inch T-shape PVC fitting which connected with 10 cm screw and 10 mm diameter
3. Numbering in one side for each label S1, S2 and S3 with black visible colour

The vehicle has to attach each label per parts of the statue respectively, by using the screw and put it in the hole, which exists on the top of the part. Per right attachment of the label, the team will get 5 points.

If the label drops in the bottom of the pool, the vehicle can take it again.

The labels can be taken one by one from the pool deck or the three in one time.

The labels must be fixed during the time of the trial. If any label takes off from the part, the team will lose its score of this label.

6.1.3. Task3: Sunken traders' obsessions and raising artefacts (60 points)

The port of Thonis-Heracleion had numerous large basins and functioned as a hub of international trade. The intense activity in the port fostered the city's prosperity. More than seven hundred ancient anchors of various forms and over 70 wrecks dating from the sixth to the 2nd century BC are also an eloquent testimony to the intensity of maritime activity there, which is considered as the cause of the large number of the discovered boats and ships for the traders or for the city trading. In addition, the discovered obsessions of the foreign traders' habitants of the city.

ROV and deep ROvers, the ROV could carry one passenger during the inspection and the deep ROVer had a robotic arm, which had the capability for raising some objects with it,

had been used in the city excavation in the process of imaging, inspection and artefacts raising.

In this task, the team should do the following subtasks **in any order** with max total score **60 points**.

Subtask 3.1: Identify the era of the sunken traders' ships by using image recognition (25 points)

Subtask 3.2: Insure and collect the golden artefacts (20 points)

Subtask 3.3: Discover the message of the granite block (15 points)

6.1.3.1. Subtask 3.1: Identify the era of the sunken traders' ships (25 points)

- Autonomous (25 points)
- Manual (15 points)

In this subtask, there is a group of three sunken ships, which are made of ½-inch PVC pipes with trapezoidal shape and covered by white corrugated plastic sheets with approximately dimensions of 100 cm * 50 cm * 50 cm. Each ship has a coloured shape on one of the sides of the ships, which can be red circle, blue triangle, yellow square, orange star or green rectangle that fit in circle with dimension around 15 cm diameter.

It is required from each team to identify the era of the sunken ships according to the shapes on them using image recognition through following methods: autonomous or manual as described below.

Autonomously, by scanning the ships and show the era of each ship written on each on the screen during the live video using image recognition without any inputs enter to the program from the team.

The vehicle can scan manually the ships any number of times to insure the shapes on the ships.

The team should show the judge the screen of the video and the written era on all ship clear which appear autonomous, in this case, the team will get 25 points.

If any one of the eras is wrong, the team will not get the 25 points and it cannot try again but it has the chance to do this subtask manually.

The second method is manually, by using scanning the ships manually and using the [handbook](#), which will be on the pool deck, of the ships' era.

Each shape represents a specified era; the team should inform the judge the era of each one.

Per each right, the team will get 5 points if the team inform the judge the three eras right it will get 15 points.

6.1.3.2. Subtask 3.2: Insure and collect the golden artefacts (20 points)

- Insure the golden artefacts from the other materials (5 points each)
- Retrieve the golden ones to the pool deck (5 points each)

In this subtask, there are sunken artefacts, golden and other materials, it is required to insure any one is golden and any one is other and retrieve the golden artefacts to the pool deck.

The golden and non-golden are simulated by 7 cm, ½-inch PVC pipe with T-shapes at the end of the two sides of the pipe with a hook, rope, the golden is with metallic material inside it and non-golden is non-metallic material with weight less than 5 N in water.

The artefacts will be laying on the seabed bounding by a ½-inch PVC pipe frame with dimensions 40 cm * 40 cm. There will be two max golden and three max non-golden artefacts.

The vehicle should insure the golden and the team inform the judge which one is golden and any one is non-golden. Per each right insuring for the golden artefact the team will have 5 points.

The vehicle should retrieve the golden artefacts to the pool deck one per one or the two together. The team will get 5 points per one right retrieving.

During the retrieving, if the artefacts drop, the team can pick them again.

The tether man can pick the artefacts when the vehicle reaches to the side of the pool.

6.1.3.3. Subtask 3.3: Discover the message of the granite block (15 points)

- Attach the lift bag or any other device (5 points)
- Retrieve the granite block to the pool deck (10 points)

In this subtask, there is a sunken granite block, which is considered as one of important artefacts that we should raise it.

The block is a ½-inch PVC pipes shape with dimensions 30 cm * 10 cm * 40 cm with U-bolt in the centre of the top and covered by black corrugated plastic sheets. Its weight is around 50 Newton.

The team should retrieve this granite block to the pool deck to discover its message. The team can use any lifting mechanism like lift bag or any other device that will be considered as a Non-ROV device.

For right attaching of the lifting mechanism, the team will get 5 points.

After attaching the lifting the block should retrieve to the pool deck, the tether man can pick the block to the pool deck when it approaches to the poolside.

The team will get 10 points after retrieving the granite block to the pool deck.

6.2. Juniors Category

The Underwater Missions are divided into three tasks as following and the designs of the playground, which mentioned in each task, exist in [Appendix E](#).

6.2.1. Task 1: Temple Excavation Plan

When starting the excavation, there is, an important technique should be done. It is the excavation plan, in which any measurements and location of the archaeological site and objects that cannot be brought to the surface are taken and drawn on papers like a grid and each object pinpoint on this grid.

The excavation plan is built up day by day, until a complete picture of the archaeological site emerges. Only then, the site can be interpreted.

In this task, the team should do the following subtasks **in order** with max score **60 points**

Subtask 1.1: Discovering the lost city (10 points)

Subtask 1.2: Temple inspection (20 points)

Subtask 1.3: Mapping the discovered area and temple (30 points)

6.2.1.1. Subtask 1.1: Discovering the lost city (10 points)

- Scanning and define the area of the discovered site (10 points)

In this subtask is required from each team to scan the discovered site that is the whole playground in the challenge and define the total area of the site.

The scanning is done by flying on the whole site. To calculate the total area of the site by tracking the scale, which is existed around the playground in X-Y coordinates and divided into steps each step represents 1.5 meter in the real site, the scale is made by ½-inch PVC pipe shape with black colour and each step is 10 cm * 10 cm, the team should count the steps in the scale and estimate the total area of the whole site.

The calculations can be done manually by hand or by using formula in any software program.

Example:

The Vehicle, ROV, tracks 10 steps on the scale in X-axis and 7 steps in Y-axis

The total area will equal $10 * 1.5 * 7 * 1.5 = 15 * 10.5 = 157.5$ square meters.

The team can scan and calculate the total area at the same time.

10 points will be obtained, if the team does the whole subtask, scanning and total area calculations.

The scanning and calculations of the area should be done manually. The team can scan it and calculate autonomous or using image recognition but without any additional score.

6.2.1.2. *Subtask 1.2: Temple inspection (20 points)*

- Manual (20 points)

In this subtask, it is required to inspect the temple that is one of the discovered objects but it is not able to return it to the surface so it should determine the coordinates of the temple location, vector representation, regarding to the starting point of the playground, which is considered, as the origin of the scale. The temple is a large simulated hollow block of the temple, made of ½-inch PVC pipes covered by brown corrugated plastic sheets with dimensions 150 cm * 150 cm * 100 cm.

The teams can use any required sensors in the vehicle with helping of the playground scale in X-Y coordinates to know the X, Y and Z coordinates of the temple regarding to the origin and then calculate the vector representation of the temple location, the length of vector, the angle and the depth.

Manual method by calculate the vector of the temple on paper or using formula in program with helping of playground scale the team will obtain 20 points when the team correctly tells the judge the vector, length of vector, angle and depth.

6.2.1.3. *Subtask 1.3: Mapping the discovered area and temple (30 points)*

- Making a map for the scanning area (15 points)
- Mapping the temple location regarding to the scanning area
 - Manual (15 points)

In this subtask, it required to make a grid map for the discovered scanning area and in addition map the location of the temple using the data obtained in subtasks 1.1 and 1.2.

Firstly, prior the competition each team should create a map grid (20 * 20) squares each one is 1 cm * 1 cm using any program and save it on the PC.

Making a map for the scanning area can be done by using the total area, which obtained in 1.1, rescale these dimensions each 10 m to 1 cm and define the area map on the prior competition map by defining the borders of the area like putting a square or rectangle around it using paint, PS or any other software program manually.

By drawing these borders, the team will get 15 points.

If the team did not calculate the total area correct in 1.1, the judge will give it the right dimensions to complete this task.

If the team finish this task right, it can continue to map the location of the temple. Which can be done by two methods:

The team can use the calculations which obtained in 1.2 to the program, like paint, PS or any anther program, in the device, can be the same device that used or another in the same station, and draw it on the map of the discovered area that done in the previous step by putting a mark in the correct location on the map. If the mapping of the coordinates is right, the team will get 15 points.

6.2.2. Task 2: Monuments discovery, sampling and labelling (60 points)

After thousands of years, the city and anything in it had been affected by environmental changes and catastrophic that make them broken and fully covered by sea organisms.

During the excavation process, there are some important techniques like; defining the dimensions of the discovered objects after cleaning and removing the algae, coral reefs and other sea organisms from the objects.

Sampling technique that happens in order to obtain the maximum possible information from a site samples are taken and sent to specialized labs to analysis them and back with the material info.

Labelling in which each item discovered in the seabed should have label with specified number.

In this task, the team should do the following subtasks **in order** with max score **60 points**.

Subtask 2.1: Cleaning and removing the algae and sea organisms from the statues (15 points)

Subtask 2.2: Statue Inspection (30 points)

Subtask 2.3: Labelling the parts of the statue (15 points)

6.2.2.1. Subtask 2.1: Cleaning and removing the algae and sea organisms from the statues (15 points)

- 3 algae max. (5 points each)

In this subtask, it is required to clean the parts of the broken statue which laying on the seabed and covered algae.

There is a broken statue divided into three parts on the top of each part, there are some algae which are simulated by ½-inch T-shape PVC fitting with a hook and attached with the part in hole.

The vehicle should remove the algae from the parts of the statue and drop it on the water for each alga removing the team will get 5 points.

6.2.2.2. Subtask 2.2: Statue inspection (30 points)

- Define the dimensions of the largest part of the statue (15 points)
- Retrieve a sample of the statue material (5 points)
- Determine the weight of the largest part of statue (10 points)

As mentioned in the previous subtask, there is a broken statue and divided into three parts, theses three parts are made of PVC pipes with different size, dimensions, between 2-inch to 8-inch in diameter and different in length, the

team should define the dimensions of the largest part of the statue, diameter and length by using their vehicle tools.

If the team inform the judge the right dimensions, it will get 15 points.

After finishing this point, the vehicle should retrieve a sample from the statue that is attached to one of the statue parts. It is a small 1-inch PVC pipe, 5 cm length with 2 end caps and a hook to be easy to pick it. The sample should be retrieved to the pool deck to get the score of 5 points.

The team could not be able to continue if it did not retrieve the sample.

To know the required lifting capability of the used hoisting machines that can be used to lift the statue later, we should estimate the largest weight, which is the weight of the largest part of the statue.

So, it is required to calculate the weight of the largest part of the statue by using the dimensions that the judge will give them to the team, diameter and length, in meters. Moreover, the density that was known by the retrieved sample of the statue, which is, like a small warped paper written on it the density of the statue material in the pipe in gram per cubic centimetres.

If the team could not get the right dimensions in the first point, the judge would give it.

The team can calculate it by hand or using software program with formula.

If the team show the judge the right answer should be in kilograms, it will get 15 points for that.

6.2.2.3. Subtask 2.3: Labelling the parts of the statue (15 points)

- 3 Labels (5 points each)

After cleaning the statue and defining its dimensions, it is the time to label each part of it.

In this subtask, it is required to label with numbering each part of the broken statue with a mark

The labels will be provided by the competition with the following specs:

1. Corrugated plastic white sheet with dimensions 5 cm * 5 cm
2. Hold on ½-inch T-shape PVC fitting which connected with 10 cm screw and 10 mm diameter
3. Numbering in one side for each label S1, S2 and S3 with black visible colour

The vehicle has to attach each label per parts of the statue respectively, by using the screw and put it in the hole, which exists on the top of the part.

Per right attachment of the label, the team will get 5 points.

If the label drops in the bottom of the pool, the vehicle can take it again.

The labels can be taken one by one from the pool deck or the three in one time.

The labels must be fixed during the time of the trial. If any label takes off from the part, the team will lose its score of this label.

6.2.3. Task3: Sunken traders' obsessions and raising artefacts (60 points)

The port of Thonis-Heracleion had numerous large basins and functioned as a hub of international trade. The intense activity in the port fostered the city's prosperity. More than seven hundred ancient anchors of various forms and over 70 wrecks dating from the sixth to the 2nd century BC are also an eloquent testimony to the intensity of maritime activity there, which is considered as the cause of the large number of the discovered boats and ships for the traders or for the city trading. In addition, the discovered obsessions of the foreign traders, habitants of the city.

ROV and deep ROvers, the ROV could carry one passenger during the inspection and the deep ROVer had a robotic arm, which had the capability for raising some objects with it, had been used in the city excavation in the process of imaging, inspection and artefacts raising

In this task, the team should do the following subtasks **in any order** with max total score **60 points**.

Subtask 3.1: Identify the era of the sunken traders' ships by (20 points)

Subtask 3.2: Insure and collect the golden artefacts (20 points)

Subtask 3.3: Discover the message of the granite block (15 points)

6.2.3.1. *Subtask 3.1: Identify the era of the sunken traders' ships (20 points)*

- Using handbook (20 points)

In this subtask, there is a group of three sunken ships, which are made of $\frac{1}{2}$ inch PVC pipes with trapezoidal shape and covered by white corrugated plastic sheets with approximately dimensions of 100 cm * 50 cm * 50 cm. Each ship has a colored shape on one of the sides of the ships, which can be red circle, blue triangle, yellow square, orange star or green rectangle that fit in circle with dimension around 15 cm diameter.

It is required from each team to identify the era of the sunken ships according to the shapes on them using handbook of sunken ships.

The vehicle can scan manually the ships any number of times to insure the shapes on the ships.

By scanning the ships manually and using the [handbook](#), which will be on the pool deck, the team should inform the judge the era of each one, while each shape represents a specified era,

If the team identify the three-era right, it will get 20 points. If anyone is wrong, it will lose 5 points.

6.2.3.2. *Subtask 3.2: Insure and collect the golden artefacts (20 points)*

- Insure the golden artefacts from the other materials (5 points each)
- Retrieve the golden ones to the pool deck (5 points each)

In this subtask, there are sunken artefacts, golden and other materials, it is required to insure any one is golden and any one is other and retrieve the golden artefacts to the pool deck.

The golden and non-golden are simulated by 7 cm, $\frac{1}{2}$ -inch PVC pipe with T-shapes at the end of the two sides of the pipe with a hook, rope, the golden is with metallic material inside it and non-golden is non-metallic material with weight less than 5 N in water.

The artefacts will be laying on the seabed bounding by a $\frac{1}{2}$ -inch PVC pipe frame with dimensions 40 cm * 40 cm. There will be two max golden and three max non-golden artefacts.

The vehicle should insure the golden and the team inform the judge which one is golden and any one is non-golden. Per each right insuring for the golden artefact the team will have 5 points.

The vehicle should retrieve the golden artefacts to the pool deck one per one or the two together. The team will get 5 points per one right retrieving.

During the retrieving, if the artefacts drop, the team can pick them again.

The tether man can pick the artefacts when the vehicle reaches to the side of the pool.

6.2.3.3. Subtask 3.3: Discover the message of the granite block (20 points)

- Attach the lift bag or any other device (5 points)
- Retrieve the granite block to the pool deck (15 points)

In this subtask, there is a sunken granite block, which is considered as one of important artefacts that we should raise it.

The block is a ½-inch PVC pipes shape with dimensions 30 cm * 10 cm * 40 cm with U-bolt in the centre of the top and covered by black corrugated plastic sheets. Its weight is around 50 Newton.

The team should retrieve this granite block to the pool deck to discover its message. The team can use any lifting mechanism like lift bag or any other device that will be considered as a Non-ROV device.

For right attaching of the lifting mechanism, the team will get 5 points.

After attaching the lifting the block should retrieve to the pool deck, the tether man can pick the block to the pool deck when it approaches to the poolside.

The team will get 15 points after retrieving the granite block to the pool deck.

7. Appendices

7.1. Appendix A

Proposal Criteria

Each team will be asked to send a proposal for their product before the competition to show how the product, your vehicle, will be suitable to RFP (15 points)

The team should upload the proposal in PDF format with max size 2 MB on Google drive naming it with [Team name_ Category type_ proposal submission_ROV Challenge 2020] and it send to info@uwrchallenges.org before August 7, 2020.

The proposal should cover the following points:

- Identify the team
- Identify the problem
- Explain the solution
- Explain the product strategies created
- Indicate the costs (total expected budget)
- Specify the reasons for you to be chosen
- The client's benefits from your product

7.2. Appendix B

Cost Analysis Criteria

The team should prepare and send a cost analysis of their vehicle with max score 20 points.

The team should upload the cost analysis in Excel sheet format with max size 2 MB on Google drive naming it with [Team name_ Category type_ Cost Analysis submission_ROV Challenge 2020] and it send to info@uwrchallenges.org before August 7, 2020.

The sheet should contain the following:

1. Product Costs

Product costs are the costs directly incurred from the manufacturing process. The three basic categories of product costs are detailed below:

- **Direct Material:** Direct material costs are the costs of raw materials or parts that go directly into producing products. For example, if Company A were a toy manufacturer, an example of a direct material cost would be the plastic used to make the toys.
- **Direct labors (if exist):** Direct labor costs are the wages, benefits, and insurance that are paid to employees who are directly involved in manufacturing and producing the goods. For example, workers on the assembly line or those who use the machinery to make the products.
- **Manufacturing overhead:**
 - **Indirect materials:** Indirect materials are materials that are used in the production process but that are not directly traceable to the product. For example, glue, oil, tape, cleaning supplies, etc. are classified as indirect materials.
 - **Indirect labors (if exist):** Indirect labor is the labor of those who are not directly involved in the production of the products. An example would be security guards, supervisors, and quality assurance workers in the factory. Their wages and benefits would be classified as indirect labor costs.

2. Period Costs (if exists)

Product costs are costs necessary to manufacture a product, while period costs are non-manufacturing costs that are expensed within an accounting period:

- Marketing costs
- Sales costs
- Rent of the working place

Example:

Company A is a manufacturer of tables. Its product costs may include:

- Direct material: The cost of wood used to create the tables
- Direct labor: The cost of wages and benefits for the carpenters to create the tables
- Manufacturing overhead (indirect material): The cost of nails used to hold the tables together
- Manufacturing overhead (indirect labour): The cost of wages and benefits for the security guards to overlook the manufacturing facility
- Manufacturing overhead (other): The cost of factory utilities.

Company A produced 1,000 tables. To produce 1,000 tables, the company incurred costs:

- \$12,000 on wood
- \$2,000 on wages for carpenters and \$500 on wages for security guards to overlook the manufacturing facility
- \$100 for a bag of nails to hold the tables together
- \$500 for factory rent and utilities

Total product costs: \$12,000 (direct material) + \$2,000 (direct labour) + \$100 (indirect material) + \$500 (indirect labour) + \$500 (other costs) = \$15,100. As this is the cost to produce 1,000 tables, the company has per unit cost of \$15.10 ($\$15,100 / 1,000 = \15.10).

7.3. Appendix C

Technical Report

Each team should prepare a technical-wise document and send it before the competition (30 points).

The team should upload the their technical report on Google drive by naming it [Team name_ Category type_ Technical Report_ ROV Challenge 2020] in PDF format with max size 5 MB and send it to info@uwrchallenges.org before 25 August, 2020.

The team can use any required visuals to support your report

The document should demonstrate:

1. Mechanical design	<ul style="list-style-type: none"> • Vehicle materials • Isolation • Thrusters • Stability • Buoyancy • Drag force calculations • Mobility • Equations of motion ... etc.
2. Control Systems (Software)	<ul style="list-style-type: none"> • Serial and parallel communications • Movements techniques • Stability techniques • Autonomous system • Image recognition techniques ... etc.
3. Control systems (Hardware)	<ul style="list-style-type: none"> • Vehicle components • Station components ... etc.
4. Electric power	<ul style="list-style-type: none"> • Fuses • Power conversions • Power distribution ... etc.
5. Fluid power	<ul style="list-style-type: none"> • Software and hardware components ... etc.
6. Additional devices	<ul style="list-style-type: none"> • Mechanical structure • software and hardware components ... etc.
7. SIDs: shows the power and signals diagram	<ul style="list-style-type: none"> • Electrical SID • Fluid SID • Additional devices SID

8. Events	<ul style="list-style-type: none"> • If the team participated in any events before with the vehicle.
9. Future plans	<ul style="list-style-type: none"> • The plans that the team is seeking to do them.
10. Acknowledgments	<ul style="list-style-type: none"> • Acknowledgments for the team supporters.
11. References	<ul style="list-style-type: none"> • Show the references of presented info.

7.4. Appendix D

Pitching criteria

1. Pitching 1

- Each team will be asked to perform a pitching prior the competition by at least three weeks to evaluate their work (15 points)
- Each team has 5 minutes to present
- It is not required for the whole members to participate in the pitching.
- The pitching will be online via a live video, which the team will be invited to through mail
- The team may present in Arabic English with no additional score
- The team should cover some aspects:
 - The plan from the start till the end
 - How much the targets have covered
 - The mechanical systems
 - The electrical systems
 - The used techniques
 - The safety procedures
 - What makes your vehicle special?
 - Show the movements of the vehicle in the water
 - Future plans

2. Pitching 2 (On Site Pitching)

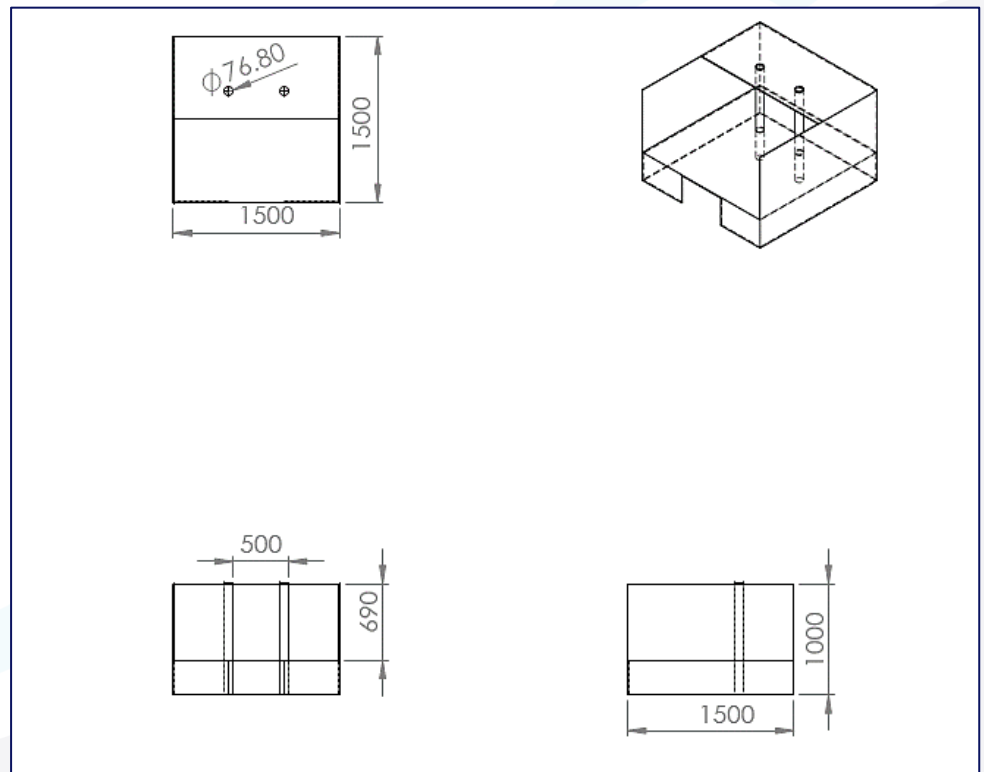
- Each team should prepare for the final pitching for the final evaluation (20 points)
- The team will be asked to present a pitching to a jury panel
- Each team has 5 minutes to present and the judges have 10 minutes for questions and evaluation
- The competition will provide a data show for presenting
- The team can use any software or hardware requirements to help them in the purpose of the pitching
- It is preferred that 3 team members max to do the Onsite pitching but the others can join for answering the questions
- The team may present in Arabic or English with no additional score

- The team should cover some aspects:
 - **Problem/ opportunity:** in which the team describes the problems that they solve in the RFP
 - **Your solution description:** in which the team gives an overall description of your solution; describing the best value proposition you give to the customer
 - **Solution features:** in which the team shows their vehicle features to solve the problem and how the solution is special
 - **Competition and market landscape:** in which the team shows the competition that they will face in the market and how to stack up with them
 - **Progress status:** in which the team shows the progress of their solution, vehicle,
 - **Future plan:** in which the team give a brief on where they are going to forward in the development of the solution
 - **The team:** by showing the team members, their field of experience and their roles in the team

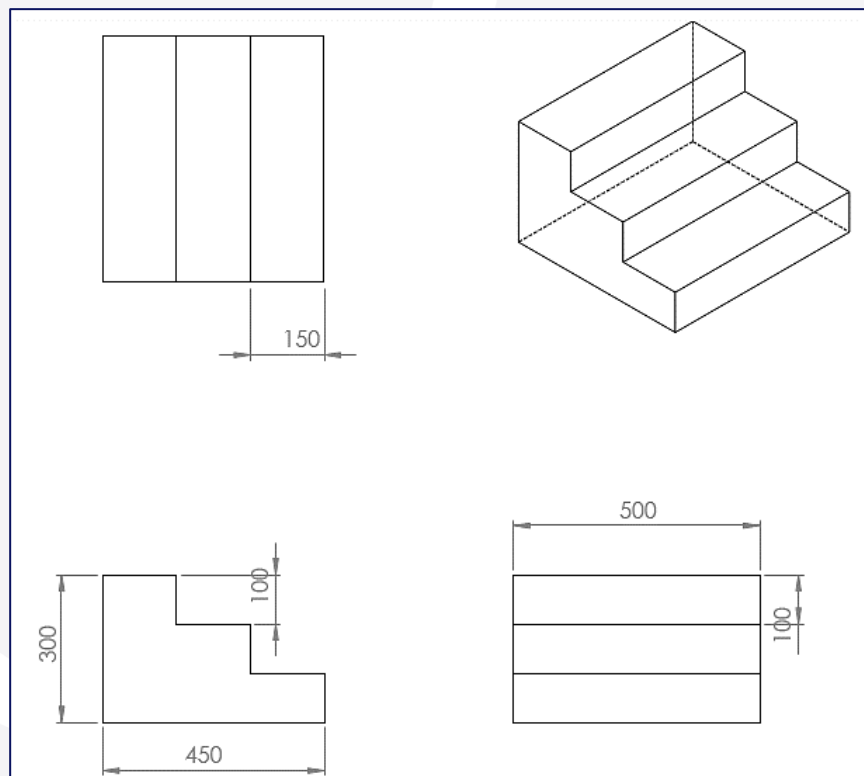
7.5. Appendix E

Playground Specs

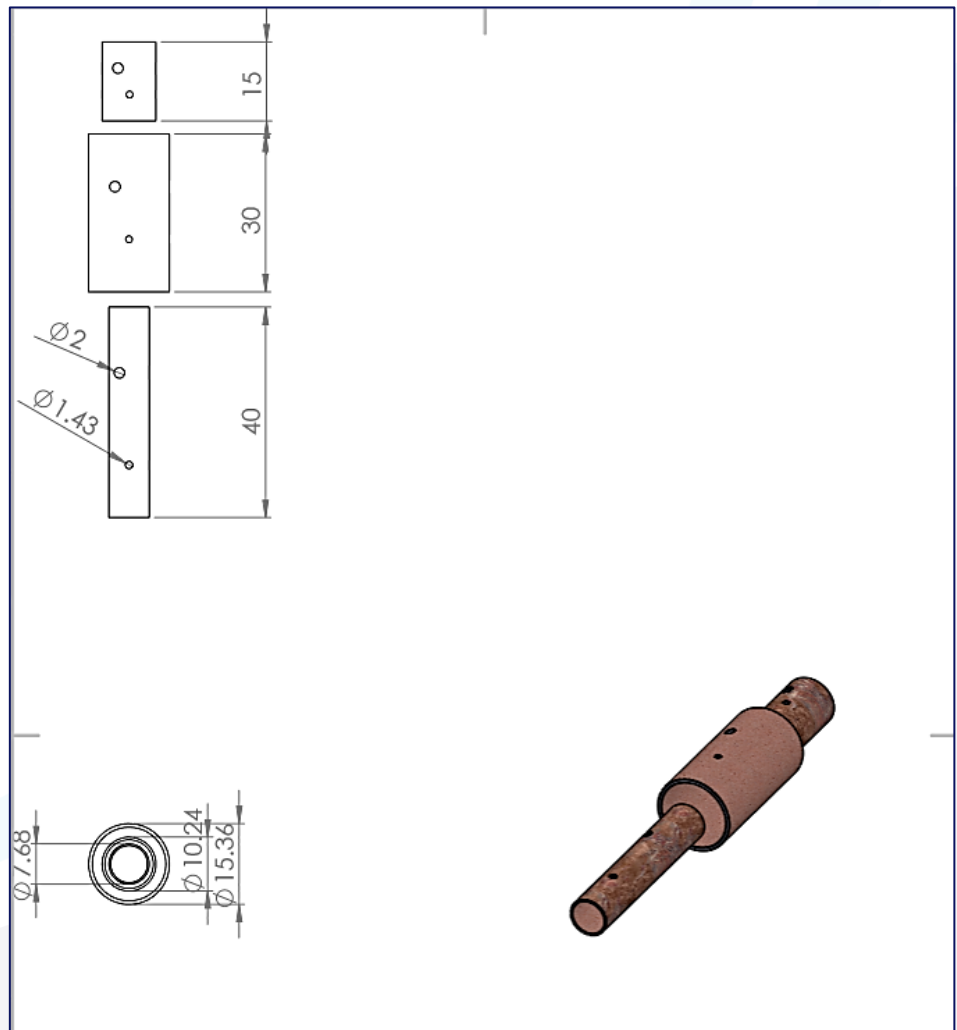
1. Task1



- Temple

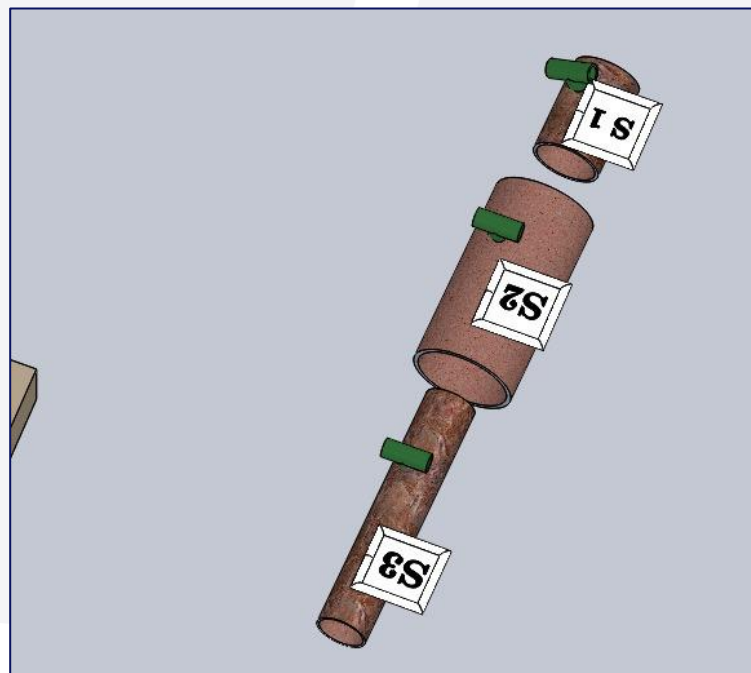


2. Task2

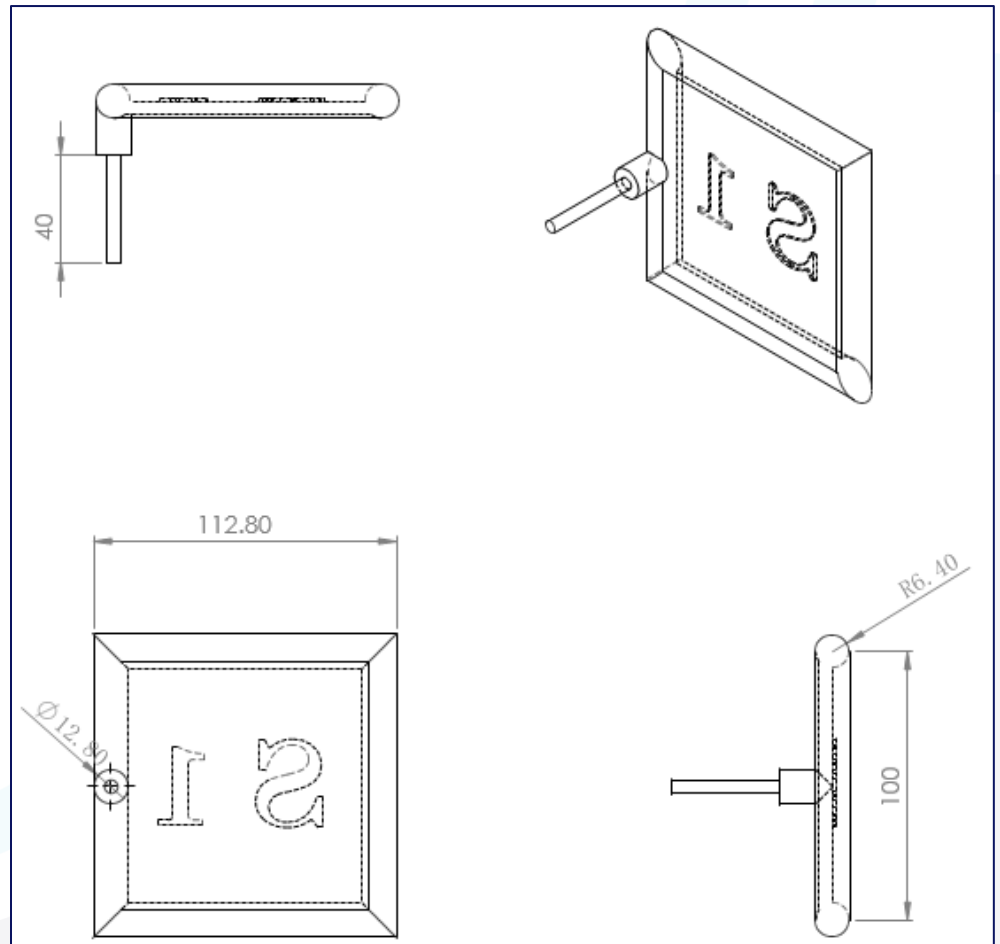


- Statue

As an example, the dimensions will be different in the competition.

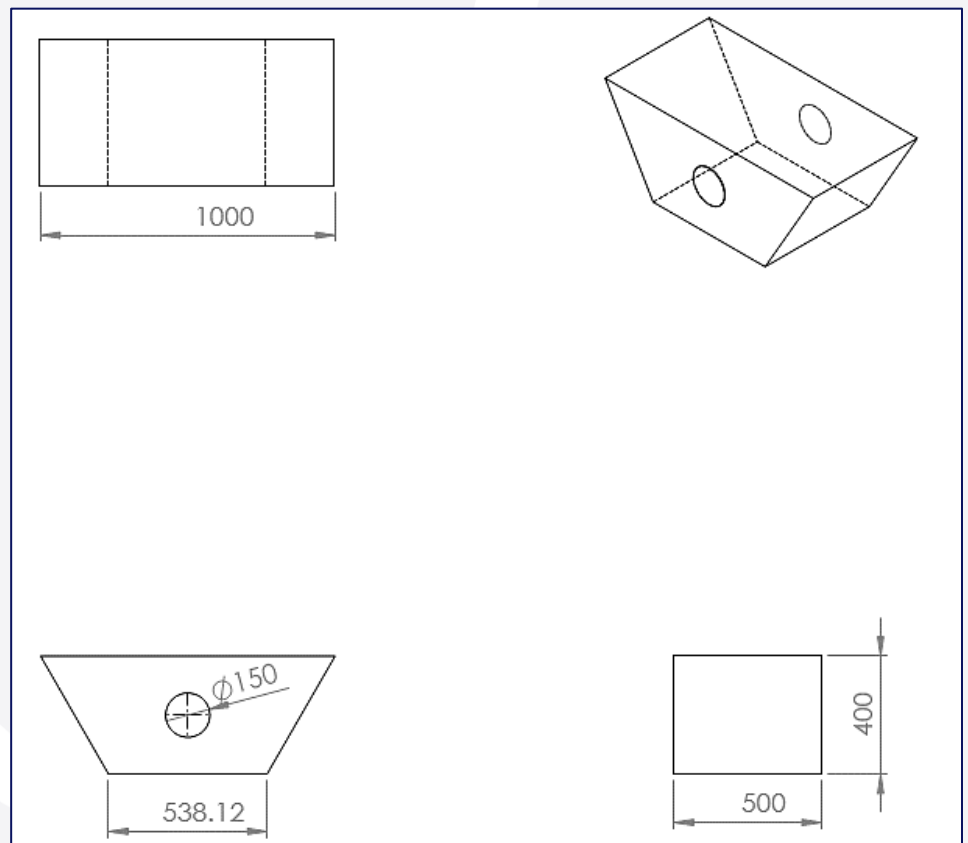


- Label

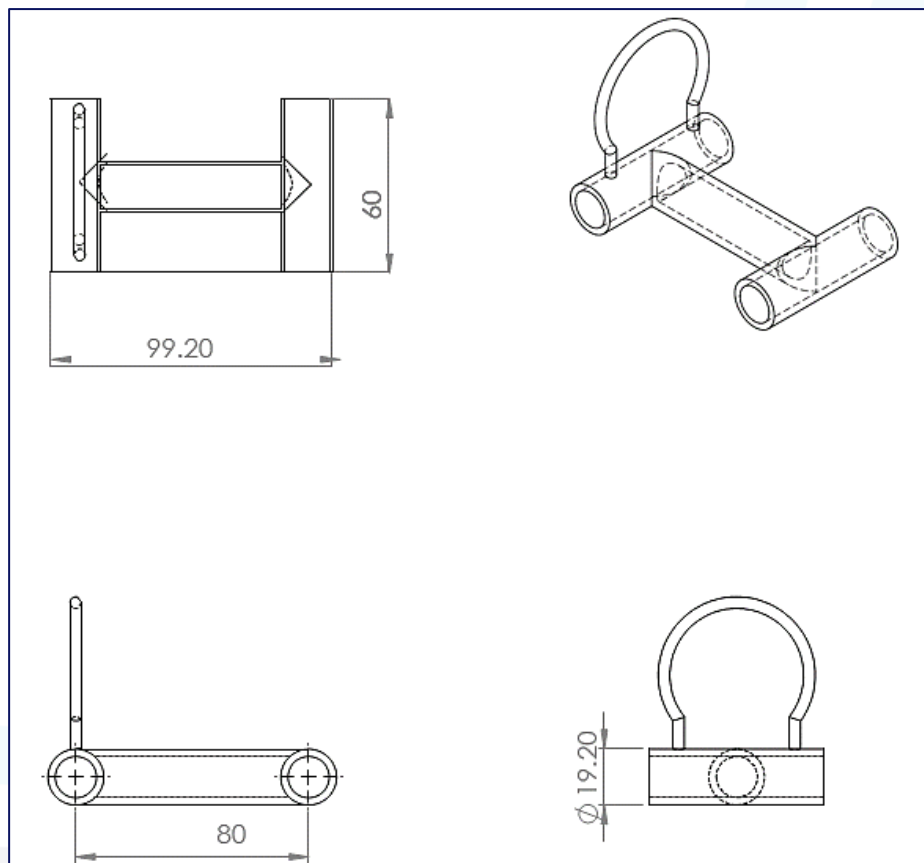


3. Task 3

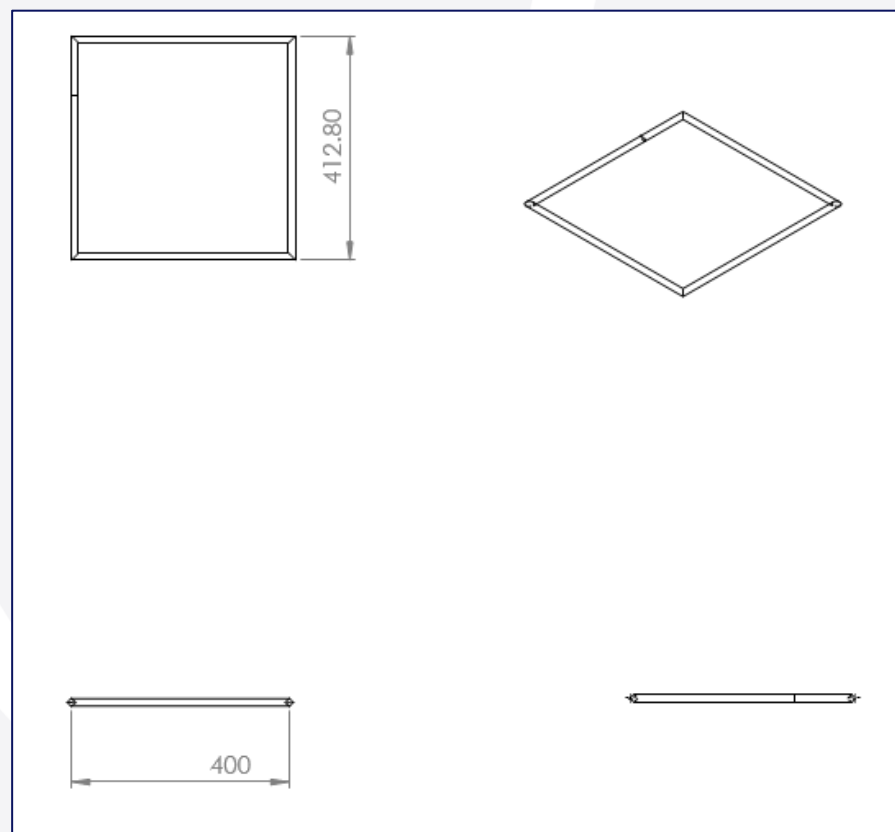
- Ship



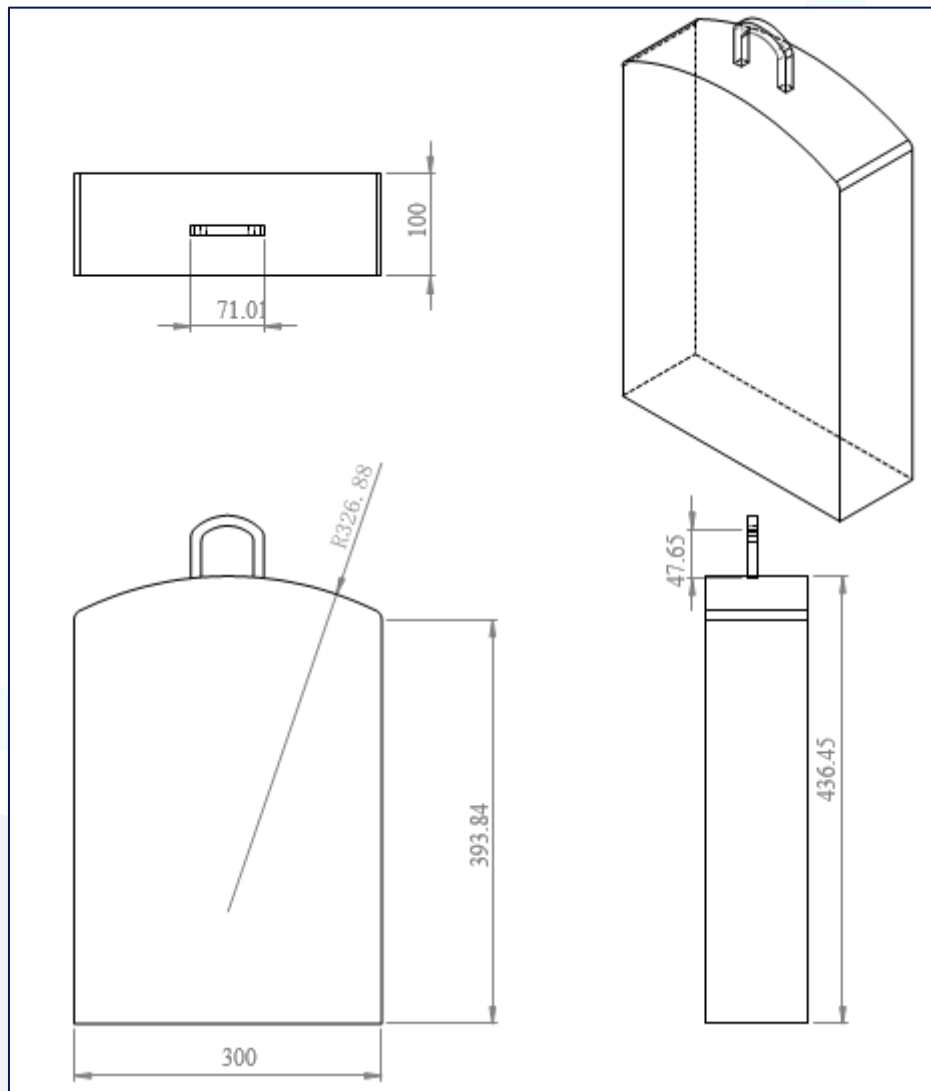
- Golden artefacts



- Golden Artefacts Frame



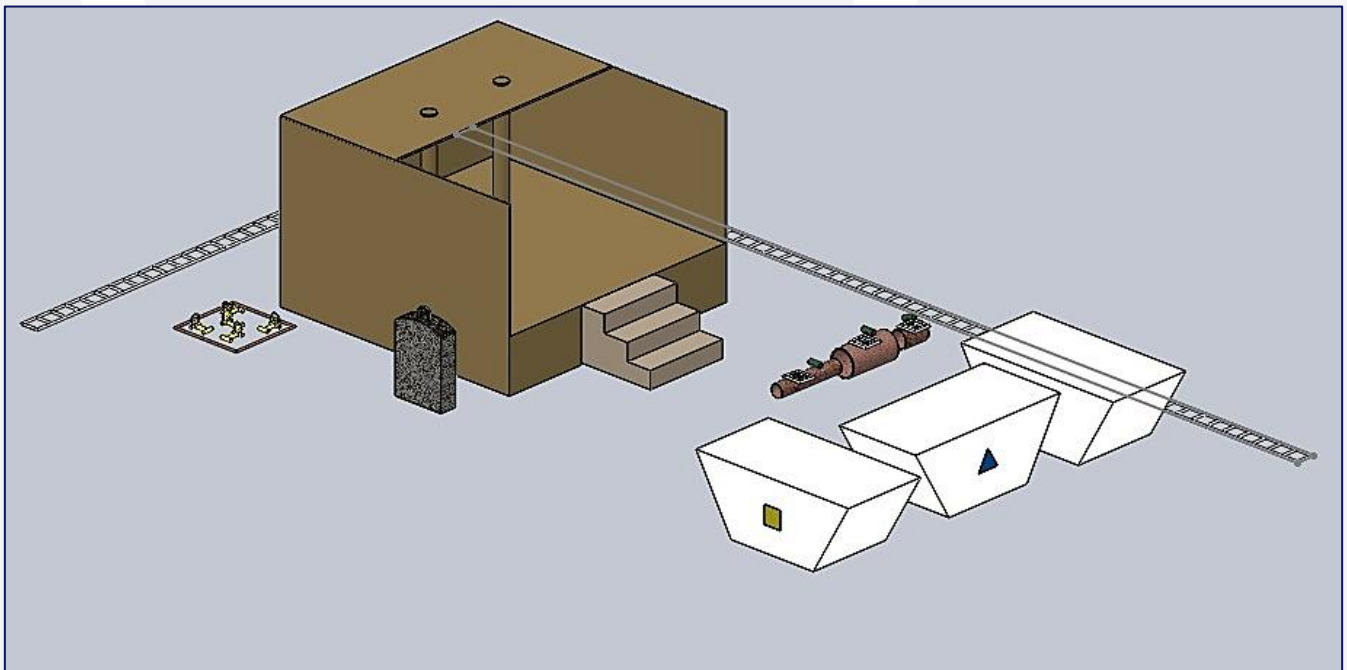
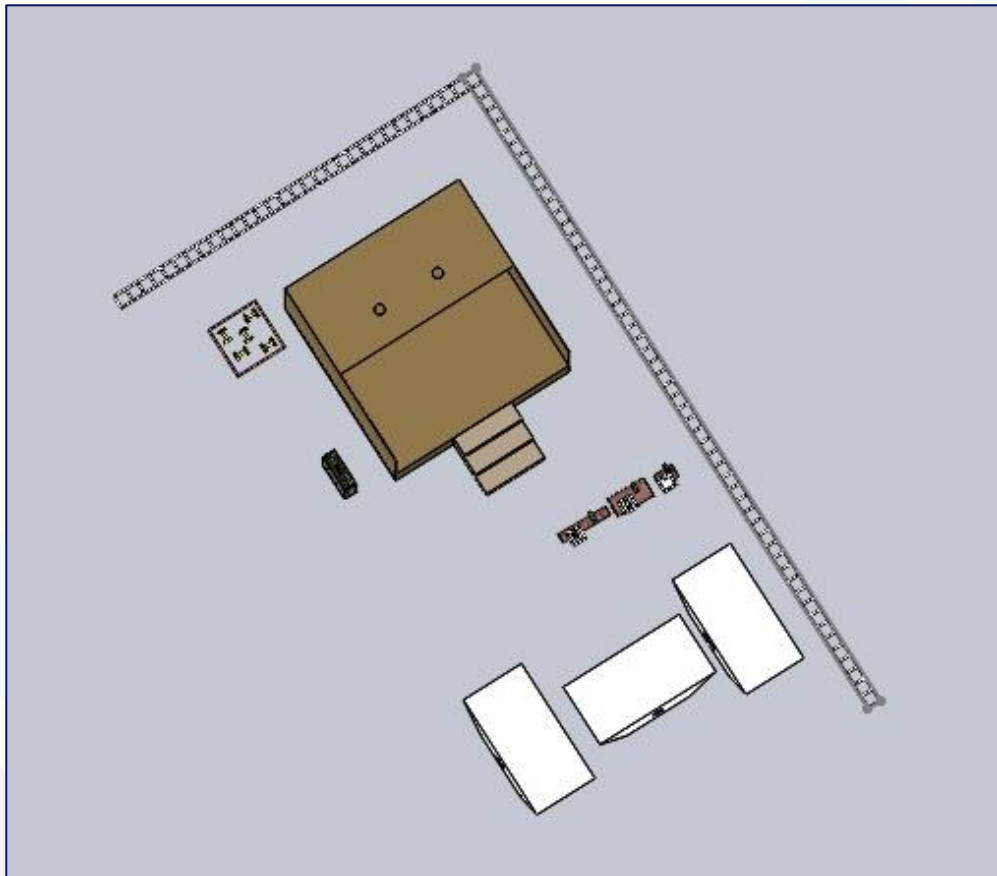
- Granite block (Rock)



Note




The dimensions in mm in the whole designs.

4. The Assembled playground



7.6. Appendix F

Ships' era Handbook

Shape	Ship's Era
	2 nd Century BC
	3 rd Century BC
	4 th Century BC
	5 th Century BC
	6 th Century BC

8. References

<https://www.franckgoddio.org/projects/sunken-civilizations/heracleion.html>

<https://aasarchitecture.com/2016/01/egypt-hopes-to-build-the-underwater-museum-in-alexandria.html/>

<https://www.franckgoddio.org/franck-goddio/system-approach-technology.html>

<https://www.youtube.com/watch?v=19lea0kn31I>

<https://www.youtube.com/watch?v=E4i5dCIKaY&t=1448s>

<https://corporatefinanceinstitute.com/resources/knowledge/accounting/product-costs/>