

# **ABU Asia-Pacific Robot Contest 2021**

## **Online**

**SDRT, China**



## **Theme and Rules**

**Throwing Arrows Into Pots**

**~The ABU Robocon 20th Anniversary Game~**

**ABU Asia-Pacific Robot Contest 2021**

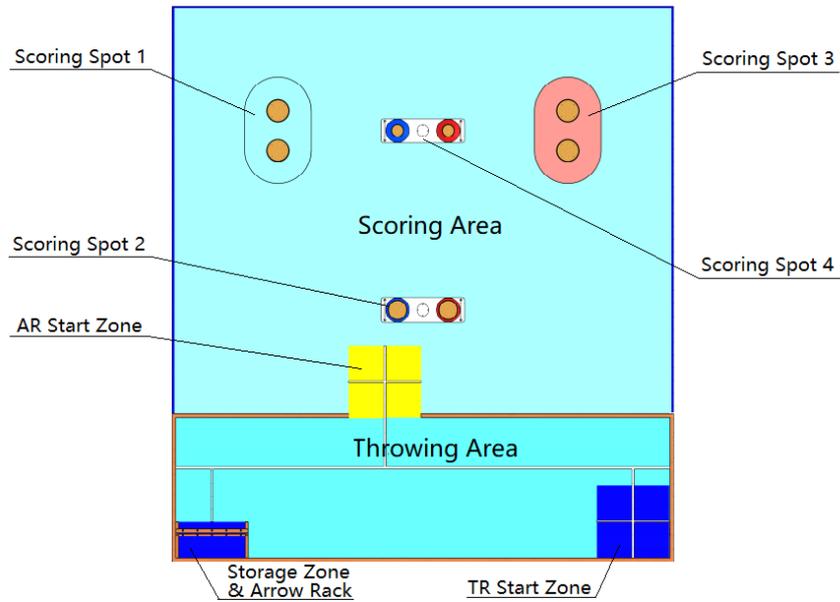
**China Host Organizing Committee**

<http://robocon2021.com>

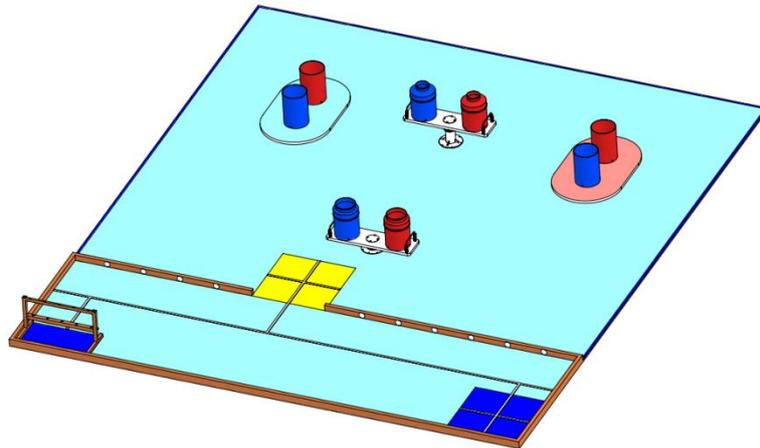
**Sep., 2020**

## Background

The epidemic situation in 2021 of new coronavirus pneumonia is hard to be predicted. If we can't get together in China, we can only regret to turn the game online again. Therefore, this online game rules as “Plan B” will be released with ABU ROBOCON 2021 real game rules at the same time. The online contest will use the same robots as those in the real contest, but the game field and rules are simplified certainly. No matter how the virus rages, our robots will still be active on the game field shown in Fig. 1!



**Fig.1 Game Field and Its Function Areas**



**Fig.2 Game Field (Perspective View)**

# Game Rules

## 1 Terms and Definitions

Terms and definitions used in the rules of ABU Robocon 2021, Online, are given in the following table.

No.	Term	Definition
1	Throwing Robot TR	A manual or automatic robot that can only move and throw arrow into pot in the Throwing Area.
2	Arrowkid Robot AR	A manual or automatic robot that assists the Throwing Robot to earn the scores like a caddy who helps the player on a golf course. AR can run in the Scoring Area and Throwing Area.
3	Game Field	The place where the Throwing Robot and Arrowkid Robot run and complete their task. It consists of a Throwing Area sized in 2050mm×7000mm and a Scoring Area sized in 5950mm×7000mm.
4	Throwing Area	An area where TR and AR can run. It includes a TR Start Zone and a Storage Zone.
5	Scoring Area	An area where only AR can run. It includes a AR Start Zone. There are four Scoring Spots in the Scoring Area.
6	Scoring Spot	The place where the Arrow thrown by robot can enter into the Pot to score. There are four Scoring Spots in the Scoring Area. They are two I-type Pot Tables, one II-type Pot Table and a III-type Pot Table, as shown in Fig. 1 and Fig. 2.
7	Fence	Barriers around the Throwing Area, used to restrict the movement of the robots, 80mm in height and 50mm in width. Robots cannot touch the top surface and outer side of the Fence, but they can touch the inner side. There are some white marks on the inner side of the Fence's section near the Scoring Zone, and they can be used as reference points for robot positioning if needed.
8	Pot	A cylindrical container for holding arrows thrown by robot. It is made by PVC tube and colored in red or blue. In the online contest, teams can use red and blue pots at will.
9	I-type Pot Table	Table setting on the ground of the Scoring Area. There are two I-type Pot Tables with a red Pot and a blue Pot each.
10	II-type Pot Table	A table of medium height setting in the scoring area. It can

		horizontally rotate within the whole range of 360° around its vertical axis under the action of external force. There are a red Pot and a blue Pot on it.
11	III-type Pot Table	The highest table setting in the scoring area. It can horizontally rotate within the whole range of 360° around its vertical axis under the action of external force. There are a red Pot and a blue Pot on it.
12	Arrow	Rod-like scoring object in the game, consisting of head, body and plume wings. In the online contest, teams should use the standard Arrow specified by the Organizing Committee.
13	TR Start Zone (TRSZ)	A square starting area for Robot TR sized in 1000mm×1000mm. When the robot retries, it is also the Retry Zone for TR.
14	AR Start Zone (ARSZ)	A square starting area for Robot AR sized in 1000mm×1000mm. When the robot retries, it is also the Retry Zone for AR.
15	Storage Zone (SZ)	Area used for setting Arrow Rack.
16	Arrow Rack	A rack where 5 arrows can lay up. In the online contest, teams should use the Arrow Rack in accordance with the regulations of the Organizing Committee.
17	Support	A state between objects. If object A is in contact with object B, and the removing object B will lead to a change in the position or orientation of object A, it can be considered that object B supports object A. The referee will gently push away object B to check whether object A is supported.
18	Twinning	A state of having an Arrow in each of the two Pots on a Scoring Spot.

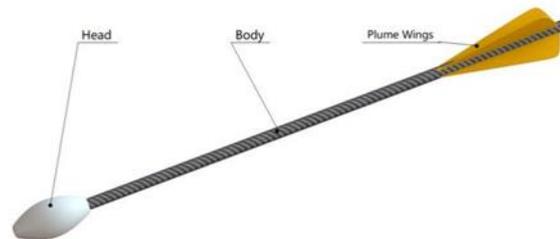
## 2 Game Procedure and Competition Tasks

### 2.1 Game Facilities and Score Objects

a) In this game, the team's method to earn points is to throw Arrows into the pot. Therefore, the main facilities involved in the game procedure are the Arrow Racks, Pots and the Pot Tables which support the Pots, and the scoring objects are Arrows.

b) The Arrow, as shown in Fig. 3, is 640mm in total length and 86g in total mass. Its body is made by carbon fiber tube and sized as 12mm in diameter. The arrow head is made of silicone rubber and sized as 40mm in maximum diameter and about 80mm in length. At the tail of the

arrow, four plume wings are spaced equally around the arrow body. They all are 130mm in length and 25mm in maximum radial width. In each game, the team itself should prepare twenty (20) Arrows that meet the requirements.



**Fig.3 Arrow**



**Fig.4 Pot Table**

c) There are four (4) Scoring Spots in the Scoring Area. Each Spot has a Table for putting red and blue Pots, as shown in Fig. 4. The pot is PVC round barrel with inner diameter of 305mm and height of 460mm. There is a foam buffer with thickness of 30mm in its bottom. The vertical axis of the Pot is perpendicular to the ground. There are three types of Pot Tables, named as I, II and III. Two (2) I-type Pot Tables are set in the Scoring Spots 1 and 3 respectively. A pair of red and blue Pots is fixed on the Table. The bases of the Tables are fixed on the ground of the Scoring Area. The opening of the Pots is 500mm above ground. One (1) II-type Pot Tables and one (1) III-type Pot Table are set in the Scoring Spots 2 and 4 respectively. A pair of red and blue Pots is also fixed on each Table. Near each pot, there is a handle that the robot can hold. The shape of the Pots on the II-type and III-type Table are slightly different from that on the I-type Table. Each of them has a neck with smaller opening. In the II-type Tables, the opening of the Pot is 600mm above ground and 250mm in inner diameter, and in the III-type Table, the opening of the Pot is 800mm above ground and 160mm in inner diameter. The rotation resistance moment of II-type or III-type Pot Table is within a range of 3Nm ~7Nm.

d) Arrows that meet the specifications in 2.1 b) can be arranged on the Arrow Rack made in Fig. 05.00, see ABU ROBOCON 2021 Figures of Game Field.

e) Team members are not allowed to touch the Arrows, Pots or Pot Tables during the game, except in retry and loading Arrows to the Rack.

## 2.2 Before the Game Starts

2.2.1 Before getting online, team should prepare for robots and game field.

2.2.2 Throwing Robot TR and Arrowkid AR must respectively and completely fit into TR Start Zone and DR Start Zone before the game starts. If the team has only one robot, it can choose either TRSZ or ARSZ as the start zone at will.

2.2.3 All items unrelated to the game and debris on the Game Field must be cleared out. The team members should withdraw from the Game Field. Only three (3) team members are allowed to operate the robot.

2.2.4 Before the game starts, five (5) Arrows are arranged in the Arrow Rack. Other (5) Arrows are loaded on the robot TR or AR, or on the two robots separately. The remaining ten (10) will be arranged on the ground outside the field near the SZ .

2.2.5 If the referee is in doubt about the specifications of the game facilities and/or score objects, the team may be asked to check.

2.2.6 After confirming that the team has completed the preparatory work, the referee can announce the beginning of the game by voice and start timer.

## 2.3 Start the Online Game

a) After the online game starts, the robots depart from their own start zone to complete their respective tasks.

b) All team members must be outside the game field except during start of operation or retry.

c) During the game, when an Arrow Rack is completely empty, one assigned team member can enter into the field near the Arrow Rack to replenish the five (5) spare Arrows to the Rack, at a time. In other words, the Rack can only be replenished twice during the game at most. After putting Arrows, the team member must leave out from the field immediately.

## 2.4 Tasks of Robots

### 2.4.1 Tasks of Robot TR

a) After the game starts, TR can move out from the TR Start Zone.

b) TR can throw or launch Arrows to any Pot in the Scoring Area from any location in the throwing Area. But, it can only throw one (1) Arrow each time. Before the Arrow enters into a Pot or lands on the ground, it can't throw out next Arrow.

c) Only after the five Arrows preloaded on TR and/or AR are used up, TR can

i. pick up the Arrows from Arrow Rack; or;

ii. pick up the Arrows that landed on the ground of the Throwing Area; or

iii. directly receive the Arrows delivered by AR.

d) During the game, TR is not allowed to enter or extend into outside the Throwing Area

including its above space.

e) Any activity of TR violating the above provisions will result in compulsory retry. The Arrow having entered in any Pot during the violation shall be taken out by the team leader and shall not be used for this game.

#### **2.4.2 Tasks of Robot AR**

a) AR departing from AR Start Zone can enter into the Scoring Area or Throwing Area directly.

b) AR can turn the II-type Pot Table and/or III-type Pot Table to cooperate with TR that throws Arrow into a Pot. During AR rotates any Pot Table, only the handle on the Table can be utilized, and no contact with any part of the Table or Pot shall be allowed, except accidental contact.

c) AR can pick up the Arrows that landed on the ground of the Scoring Area or the Throwing Area and throw/put them into the Throwing Area or directly deliver them to TR running in the Throwing Area.

d) AR is allowed to extend its body partially out of the game field when it picks up the arrows landed on the ground. However, AR cannot be outside the Field completely. The judgment criterion of completely being outside the field is that the orthographic projection of the robot on the ground does not intersect with the Game Field.

e) The Robot AR running in the Scoring Area shall not throw any Arrow into any Pot. However, it can throw Arrow to any Scoring Spot when it is in the Throwing Area. Of course, it should also comply with Rule 2.4.1 when throwing Arrows.

g) Any activity of AR violating the above provisions will result in compulsory retry. The Arrow having entered in any Pot during the violation shall be taken out by the team leader and shall not be used for this game.

#### **2.5 Retry**

a) If any robot falls in fault or a task is not completed, the team can apply for a retry. The retry can be made only after the referee's permission. The robot that needs to retry should return to its Start Zone.

b) When the team violates any rule, a compulsory retry should be made according to the referee's instruction. Both robots of the team should return to their respective Start Zones when retry.

c) When preparing for a retry, the team members must place the retried robot at an assigned location.

d) During retry, the team members can adjust and change the position of the Arrows carried

on the robot.

e) In the retry, the team members are not allowed to pick up Arrows that have fallen to anywhere.

f) After necessary adjustments to the robot, the team members can start the robot themselves.

g) There are no limits to the number of times for retry. Retry must be done according to the rules with approval from the referee.

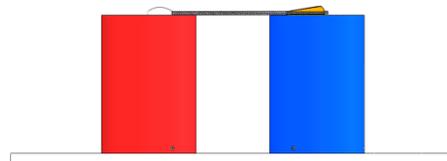
## 2.6 Scoring

2.6.1 After the game ends, the referee checks the scores of the team.

2.6.2 Any Arrows thrown out before the end of the game are likely to score, but only those Arrows which meet all of the following conditions can score:

- a) It contacts with a Pot or other scoring Arrow.
- b) It does not contact with the surface of the Game Field or the Pot Table.
- c) It is not supported by any unscored Arrow.
- d) It does not contact with the robot.

2.6.3 If one (1) Arrow is in any Pot of a Scoring Spot, the team earns 1 point. If there is one (1) Arrow in each pot of a Scoring Spot, called as a "twinning", the team earns 8 points. If an Arrow contacts with both Pots and/or Arrows in these Pots, it can score, but it is not the Arrow in a Pot and it is not considered as an Arrow in a "twinning", shown in Fig. 5.



**Fig.5** An Arrow contacts with both Pots

2.6.4 Multiple "twinning" in a Scoring Spot is allowed. For example, there are three (3) Arrows in a Pot of a Scoring Spot, two (2) Arrows in another Pot of that Scoring Spot, then two times of "twinning" are achieved, each scores 8 points, and remainder single Arrow scores 1 point. Thus, the total score in this Pot is 17 points.

2.6.5 In any Scoring Spot, the maximum times of "twinning" is 3. The excess "twinning" is not considered as "twinning".

2.6.6 The total score of a team is the sum of the points that the team earns in the four Scoring Spots.

2.6.7 The maximum possible total score is 80.

## 2.7 End of the game

2.7.1 In the game, if the team thinks it has earned 80 points or had no arrows available, its member

can raise his/her hand to signal the referee to stop the timing and the game ends immediately. For the team that finishes the game early, the referee needs to record its remaining time in seconds. After post-game checking, if the team does not get 80 points, then its remaining time is 0.

2.7.2 Otherwise, the game will last 3 minutes and then end.

2.7.3 The game may take N rounds. After each round, the achievement, in that round, of each team is measured by its total score and the remaining time. When all online games are complete, the average score S and the average remaining time T of each team are calculated.

### **3 Deciding the winner**

All teams will be ranked on the basis of their average achievements:

a) For the teams whose average scores are 80, the team with bigger average remaining time T is ahead. If a tie occurs, the team with higher average score at the Score Spot 4 is ahead. If the tie is not broken, the team with higher average score at the Score Spot 2 is ahead. If tie again, the referee will determine the front-runner team.

b) For the teams whose average scores are less than 80, the team with higher average score is ahead. If a tie occurs, the team with higher average score at the Score Spot 4 is ahead. If the tie is not broken, the team with higher average score at the Score Spot 2 is ahead. If tie again, the referee will determine the front-runner team.

### **4 Robot**

4.1 Each team can build 2 robots at most. If a team has only one (1) robot, in the game, it can be TR or AR, and it can also switch between TR and AR at any time. In this Rulebook, it can be considered as TR and /or AR.

4.2 The robots can be manual, semi-automatic or autonomous robot.

4.3 Each robot cannot be split into sub-units or connected by flexible cords during the game.

4.4 The robots in the contest must be built by the team members from the same university or college or polytechnics.

4.5 Teams are not allowed to set up any equipment in the contest site, except robots, spare parts used in the game and some tools.

4.6 Robot Size

a) At the game beginning, TR and AR must all be less than 1000mm in width and 1000mm in length, its height is unlimited.

b) After the game starts, the robots are allowed to expand, stretch or extend without any limitation, provided that it does not violate other rules in this Rulebook.

c) The robot AR can only be operated remotely and wirelessly by team member standing

outside the game field. The robot TR can be operated wirelessly or through cable. When using cable control, the length of cable is unlimited. Teams should be careful to avoid cable winding with the field facilities and game objects. Both wireless or cable operation, the team members are not allowed to enter the game field.

#### 4.7 Weight of Robots

Total weight of two robots, controllers, primary set of batteries used in the game must not exceed 50 kg. Any other equipment that the team brings for setup purposes, tools, air container and backup batteries (of the same type as that originally installed in the robot) are exempt.

#### 4.8 Power Source of Robots

- a) Teams can use only batteries, compressed air, and/or elastic force as power source.
- b) The nominal voltage of any battery used in the robot, controller, and any other devices during the game shall not exceed of 24V. However, when connecting batteries in series, the total voltage must be 24V or less.
- c) The voltage in the circuit should be set to 42 V or less by actual measurement.
- d) Teams using compressed air must use either a container made for the purpose, or a plastic bottle in pristine condition that is prepared appropriately. Air pressure must not exceed 600kPa.
- e) Any power source deemed dangerous may be banned from use.

#### 4.9 Communication between Robots

- a) It is allowed for two robots to cooperate with each other to complete the task by means of communication.
- b) There are not any restrictions on the way of communication.
- c) For radio frequency communication, it is only allowed to use Wi-Fi (IEEE 802.11), Zigbee (IEEE 802.15) and Bluetooth for the communications between controller and robot and between two robots.

4.10 Some parts that may help the arrow to enter into the pot are not allowed to fit on the robot AR. They include but are not limited to funnel and slideway etc.

4.11 Before the contest, referees will make online inspection to the robots. Robots that do not meet the above requirements will not be allowed to participate the game.

## 5 Violations

Team will subject to a compulsory retry for each violation. The violations are categorized as follows:

- a) Any part of any robot enters an area that is not allowed to enter.
- b) Any team member touches any part of robot, except controller of the manual robot and the situations this rulebook allows.

- c) The robot violates the provisions in Rule 2.4.
- d) Team makes a false start.
- e) Other actions that infringe on the rules but without mentioning in the disqualifications are considered as violation.

## **6 Disqualifications**

A team will be disqualified if it takes any of following actions during the game:

- a) The design and build of the robot are not in accordance with the regulations in Section 4 .
- b) The team performs any acts that are not in the spirit of fair play.
- c) The team fails to obey instructions or warning issued by referees.

## **7 Team**

7.1 Only one (1) representing team from each country or region shall participate in ABU Robocon 2021. China, as the host country, may be represented by two (2) teams.

7.2 The student team members and instructors all belong to the same college, university, or polytechnic.

7.3 Participation of graduated students is not permitted.

## **8 Others**

8.1 The contest rules maybe partially modified or changed according to the circumstances.

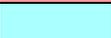
8.2 The legitimacy of any actions not mentioned in this rulebook is subject to the discretion of the referee.

8.3 The dimensions, weights, etc., of the field, facilities and equipment described in this Rulebook have an error margin of  $\pm 5\%$  unless otherwise stated. However, the dimensions and weights of the robots shown in the rulebook are the maximum and cannot be tolerated.

8.4 All questions should be addressed to the official website of the ABU Asia-Pacific Robot Contest 2021, <http://robocon2021.com>, FAQ section is provided on it. Notification of any additions and/or corrections to this rulebook is made on the official website.

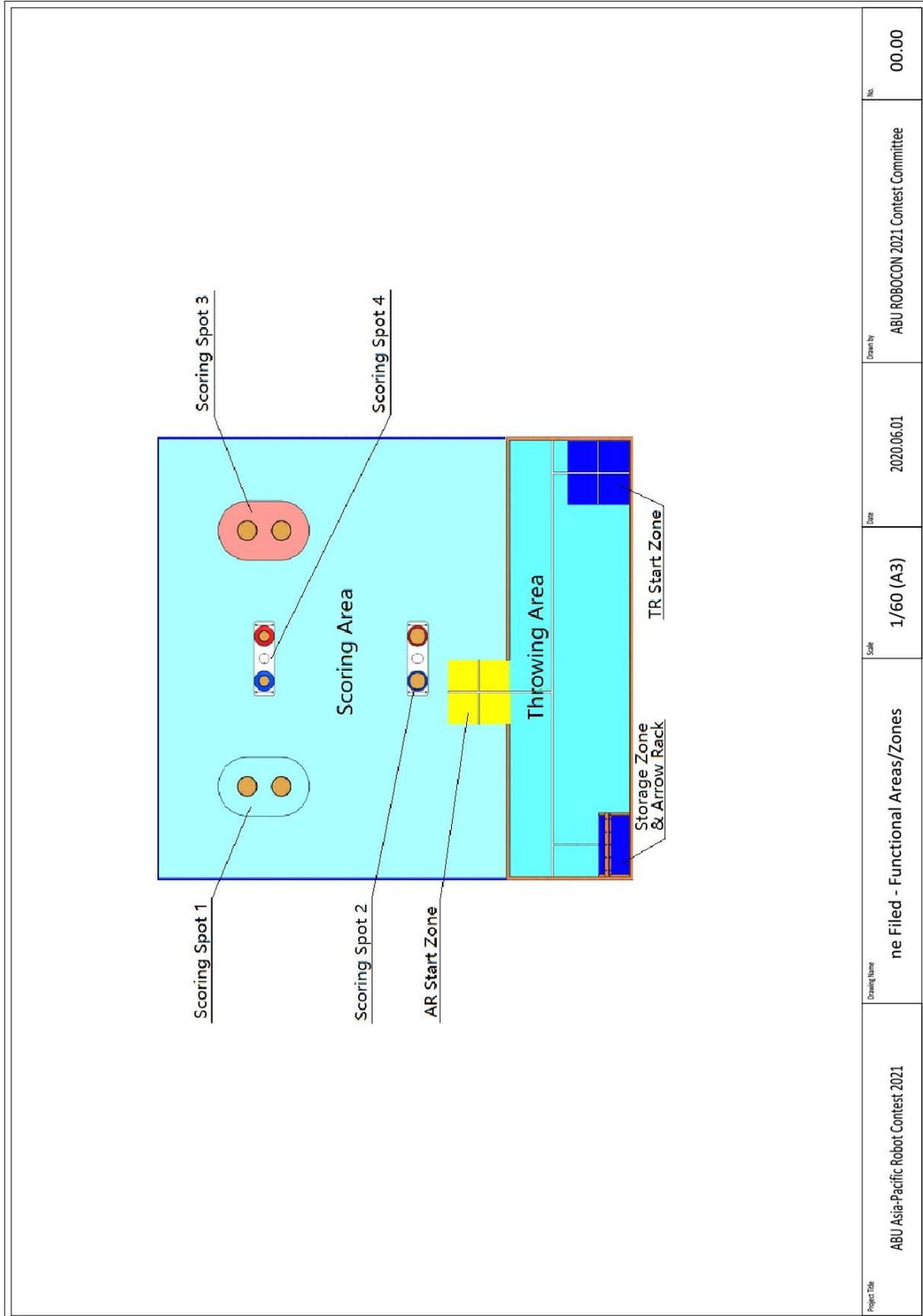
## Appendix 1

Materials and colors of the game field, facilities and objects

Item		Color	R	G	B	Material
Throwing Area			105	255	255	Plywood, Water Paint
Scoring Area			170	255	255	
TR Start Zone			5	5	255	
AR Start Zone			255	255	5	
Storage Zone			5	5	255	
Fence			227	134	75	Plywood, Water Paint
Guideline			255	250	245	Non-Shiny Vinyl Tape
Arrow Rack			255	207	151	Metal/Steel, Oil Paint
Pot	Red		255	5	5	PVC Tube and Connector
	Blue		5	5	255	
I-type Pot Table	Top		255	154	154	Plywood, Water Paint
			170	255	255	
	Side		255	250	245	
II or III-type Pot Table			255	250	245	Plywood, Water Paint
Arrow	Head		255	250	245	Silicon Rubber
	Body		0	0	0	Carbon Fiber Pipe
	Plume		255	180	0	Silica

## Appendix 2

ABU ROBOCON 2021 Figures of Game Field are suitable for online contest, except 00.00, 00.01 and 00.03. Those three figures can be replaced by following three figures.





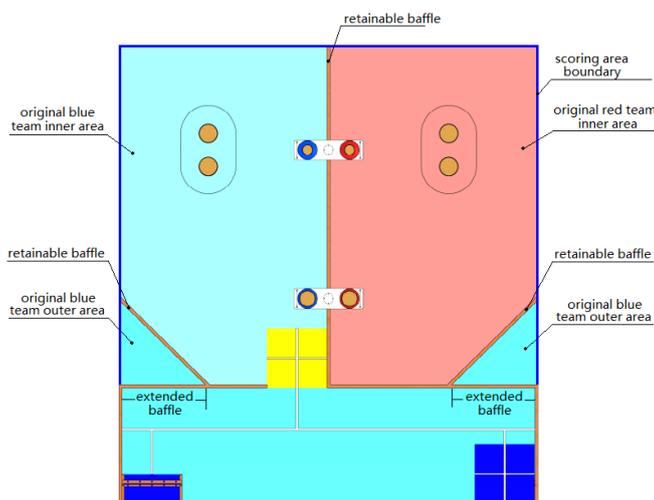


### Appendix 3 Low Cost Field Options

The online contest is played on the game field built by the team itself. This is one of the differences between an online contest and a real contest. Although the online game field and field facilities are described in detail in the ABU ROBOCON 2021 Figures of Game Field and in the three figures in Appendix 3, and some field facilities and scoring objects, such as the Pot Table, Arrow Rack and Arrow, can be ordered on ABU ROBOCON 2021 website, teams may still choose the low cost field options.

#### 1. Transforming the real game field into an online game field

Some teams may have made complete real game field or blue (red) outer area plus complete inner area to prepare the real contest. If the real contest can't be held, the original game field can be transformed into an online game field when preparing for the online contest. Now, take the blue outer area as an example to illustrate the transformation steps.



a) Extend the octagonal baffle's side parallel to the original fence to form a fence of the throwing area. If not necessary, the inside of the extended fence need not affix white circular marks.

b) According to Figure 00.01 in Appendix 2, reduce the length of the throwing area and rearrange the TR start zone and storage zone.

c) Affix white tape of 30 mm in width to the throwing area as shown in Figure 00.01 of Appendix 2,

d) Affix the scoring area boundary with blue tape of 30 mm in width, as shown in Figure 00.01 of Appendix 2.

e) If the original octagonal baffle in the scoring area does not interfere with the motion of the robot AR, it can be retained.

f) The original red team inner area and the blue team outer area in the scoring area can remain the original color.

## 2. Direct fabrication of online game field

Some teams are limited by various conditions and do not make complete or partial real game field when preparing for real contest. But, in preparation for the online contest, they have to make online game field themselves. Teams may reduce the fabrication costs as far as possible, according to their own conditions and Figure 00.01 in Appendix 2, providing that the dimensions of the online game field are ensured.

a) Whether the online game field is set on the wooden or cement floor, teams need not lay the wooden field floor as long as they think that it has no effect on the robot's movement and facilities' installation.

b) If the original ground in the scoring and throwing areas is light color, the ground needs not be painted, but the colors of the TR and AR start zones must be clearly different from the ground.

c) If not necessary, the inside of the fence need not affix white circular marks.

## 3. Low cost pot table

Rule 2.4.2 b) allows AR to rotate II-type and III-type pot tables. If a team does not think it necessary to rotate the pot table, it needs not to order or make a rotatable pot table and needs only to design and make blocks to lift the II-type and III-type pot tables. The heights of the openings of II type kettle and III type kettle must be raised to 600mm and 800 mm, respectively. And, these two pots must be firmly set in the appointed position as shown in Figure 00.02 of Appendix 2.

## 4. Low cost arrow rack

Teams can design and make the arrow rack, using any materials, according to the dimensions in Figure 05.00 of the ABU ROBOCON 2021 Figures of Game Field. The five arrows must be arranged in parallel on the rack with the head down and the plume up. Distance between two arrows is 200 mm. The height of the head center is about 240 mm above ground. The dip angle of the arrow body is about 10 degree.