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Technologies

2021-2022 **FIRST**<sup>®</sup> Tech Challenge

# Game Manual Part 2 – Remote Events

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Revision History		
Revision	Date	Description
1	9/7/2021	Limited Program Delivery Partner Release
1.1	9/18/2021	<ul style="list-style-type: none"> <li>Kickoff Release</li> <li>Figure 4.3-1 – New image showing correct location of Alliance Shipping Hub</li> <li>Figure 4.3-2 – New image showing correct location of Alliance Shipping Hub</li> </ul>

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## 1.0 Introduction

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### 1.1 What is FIRST® Tech Challenge?

*FIRST*® Tech Challenge is a student-centered program that focuses on giving students a unique and stimulating experience. Each year, teams engage in a new game where they design, build, test, and program autonomous and driver operated robots that must perform a series of tasks. To learn more about *FIRST*® Tech Challenge and other *FIRST*® Programs, visit [www.firstinspires.org](http://www.firstinspires.org).

## 2.0 Gracious Professionalism®

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*FIRST*® uses this term to describe our programs' intent.

*Gracious Professionalism*® is a way of doing things that encourages high-quality work, emphasizes the value of others, and respects individuals and the community.

Watch Dr. Woodie Flowers explain *Gracious Professionalism* in this [short video](#).

## 3.0 How to Use This Document

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The Game Manual Part 2 – Remote Events is a resource for all *FIRST*® Tech Challenge *Teams* competing in a remote event format. There are two types of event formats a *Team* might experience this season; traditional events and remote events. This manual describes the game and rules for remote events. Remote events were developed to mimic traditional *FIRST* Tech Challenge events, while practicing social distancing guidelines. Since *Teams* are not able to gather and compete in the traditional head-to-head competition format, the season's official full *Playing Field* has been adapted to allow *Teams* to play *Matches* as a single *Team*. Remote *Teams* may order an official half version of this season's field or compete using a low-cost version of the field.

The intent of this manual is that the text means exactly, and only, what it says. Please avoid interpreting the text based on assumptions about intent, implementation of past rules, or how a situation might be in "real life". There are no hidden requirements or restrictions. If you have read everything, you know everything.

Key words that have a specific meaning within this document are defined in the Game Definitions section and are indicated with the first letter capitalized, and the entire word in *Italics*.

## 4.0 The Game

### 4.1 Introduction

This document describes FREIGHT FRENZY<sup>SM</sup> presented by Raytheon Technologies, the FIRST® Tech Challenge game for the 2021-2022 season. We recommend viewing the game animation prior to reading this manual to gain a general understanding of the game. The animation is not intended as a replacement for official game rules. The animation can be accessed on our website under “Videos and Promotional Materials”: <https://www.firstinspires.org/resource-library/ftc/game-and-season-info>.

*Teams* must comply with all the rules and requirements stated in this document and in the Game Manual Part 1 - Remote Events. Clarifications to the game rules are issued on the question & answer section of the forum at [ftcforum.firstinspires.org](https://forum.firstinspires.org). Forum rulings take precedence over information in the game manuals.

Teams should refer to the [Game Manual Part 1 – Remote Events](#) for information about the competition such as how rankings work (Ranking and TieBreaker Points), advancement, judged awards, *Robot* rules, and general competition rules.

### 4.2 Game Description

*Matches* are played on a *Playing Field* initially set up as illustrated in Figure 4.3-1 below. Two *Alliances* – one “Red” and one “Blue”, made up of two *Teams* each – compete in each *Match*. The object of the game is to attain a higher *Score* than the opposing *Alliance* by

#### 4.2.1 Game Narrative

The world of transport is undergoing some of the greatest changes of its time, all the while natural disasters, humanitarian crises, and food shortages are happening all around us. Of all the technological advances continuously inserted into our daily lives, which ones will help us transport hard to move goods and solve these global challenges?

Providing basic needs are necessary for cultivating a safe and more equitable world. But doing so can be quite complex. Our world depends on a strong transportation system to get essential items into the hands of those who need it most and move those in danger to safety. When our transportation networks improve with efficiency and scale, our people, our animals, and our livelihoods prevail.

The future of transporting relief to those in need is about inventing creative solutions, pushed by the recognition of the inefficiencies, inequities, and the choices we make around them.

Will we be able to work together and deliver a solution in the race against time? Only time will tell. A better, safer world is possible.

#### 4.2.2 Gameplay Overview

Welcome to FREIGHT FRENZY<sup>SM</sup> presented by Raytheon Technologies. *Matches* are played on a *Playing Field* initially set up as illustrated in Figure 4.3-1. The object of the game is to the highest *Score* by performing the achievements outlined below.

The *Match* starts with a 30-second *Autonomous Period* in which *Robots* operate using only pre-programmed instructions and sensor inputs. During the *Autonomous Period*, *Teams* earn points by: *Delivering Pre-Loaded Boxes* to a randomly selected level of the *Alliance Shipping Hub*. *Teams* may opt to use the *Duck* placed on the field, or may use their *Team Shipping Element*, which provides more points when *Freight* is delivered to the correct level of the *Alliance Shipping Hub*. *Teams* also earn points for *Navigating* to the *Storage Unit* or

*Warehouse, Scoring Freight in the Storage Unit or Alliance Shipping Hub, and Delivering Ducks onto the Playing Field Floor via the Carousel.*

The two-minute *Driver-Controlled Period* follows the *Autonomous Period*. *Teams* earn points by collecting *Freight* from the *Warehouse* and *Scoring the Freight* in the *Storage Unit* or their *Alliance Shipping Hub*.

The final 30 seconds of the *Driver-Controlled Period* is called the *End Game*. In addition to the previously listed *Driver-Controlled Period Scoring* activities, *Teams* may *Deliver Ducks* onto the *Playing Field*. If the *Team Shipping Element* was not introduced during *pre-Match* setup, *Teams* may now *Deliver* their *Team Shipping Element*. The *Team Shipping Element* may be used to *Cap* their *Alliance Shipping Hub* to earn points. A *Team* will earn *Balance* points for the *Alliance Shipping Hub* being *Balanced*.

#### **4.2.3 Gameplay Technology**

Each game comes with its own unique set of technology challenges. In FREIGHT FRENZY, there are multiple ways *Teams* can utilize technology to assist them in the challenge. *Teams* may use the built-in technology, or they can come up with their own solutions to solve the challenges.

This season, the challenges include:

1. Object Identification
  - a. The *Robot* can use its on-board control system to identify an object placed on one of the three *Barcode* locations. Correctly locating the object and then placing their *Pre-Loaded Box* onto the *Scoring Level* that corresponds to the *Barcode* location earns the *Team* bonus points.
  - b. *Teams* can use the built-in TensorFlow technology to identify the default object, a yellow *Duck*, but *Teams* that can train technologies like TensorFlow or use more traditional sensors to identify their *Team-built Team Shipping Element* will earn additional points.
2. Field Navigation
  - a. *Teams* can use the *Navigation Images* along with the built-in vision processing software, Vuforia, and an on-board camera to help identify their location on the field. This is especially useful during the *Autonomous Period*.
3. Sensor Use
  - a. *Teams* can add sensors to their *Robot* to help it identify the *Boxes*, as there are three different weighted *Boxes* located in the *Warehouse*.

For resources on how the available technologies please visit <https://github.com/FIRST-Tech-Challenge>.

### 4.3 Playing Field Illustrations

The following illustrations identify the *Game Elements* and give a general visual understanding of the game. *Teams* should refer to [andymark.com/FTC](http://andymark.com/FTC) for the exact *Game Element* dimensions. The official *Playing Field* documents, including the official Field Setup Guide, are available at <https://www.firstinspires.org/resource-library/ftc/game-and-season-info>. Please Note: The following illustration shows the *Playing Field* with optional perimeter wall as the *Playing Field Boundary*.

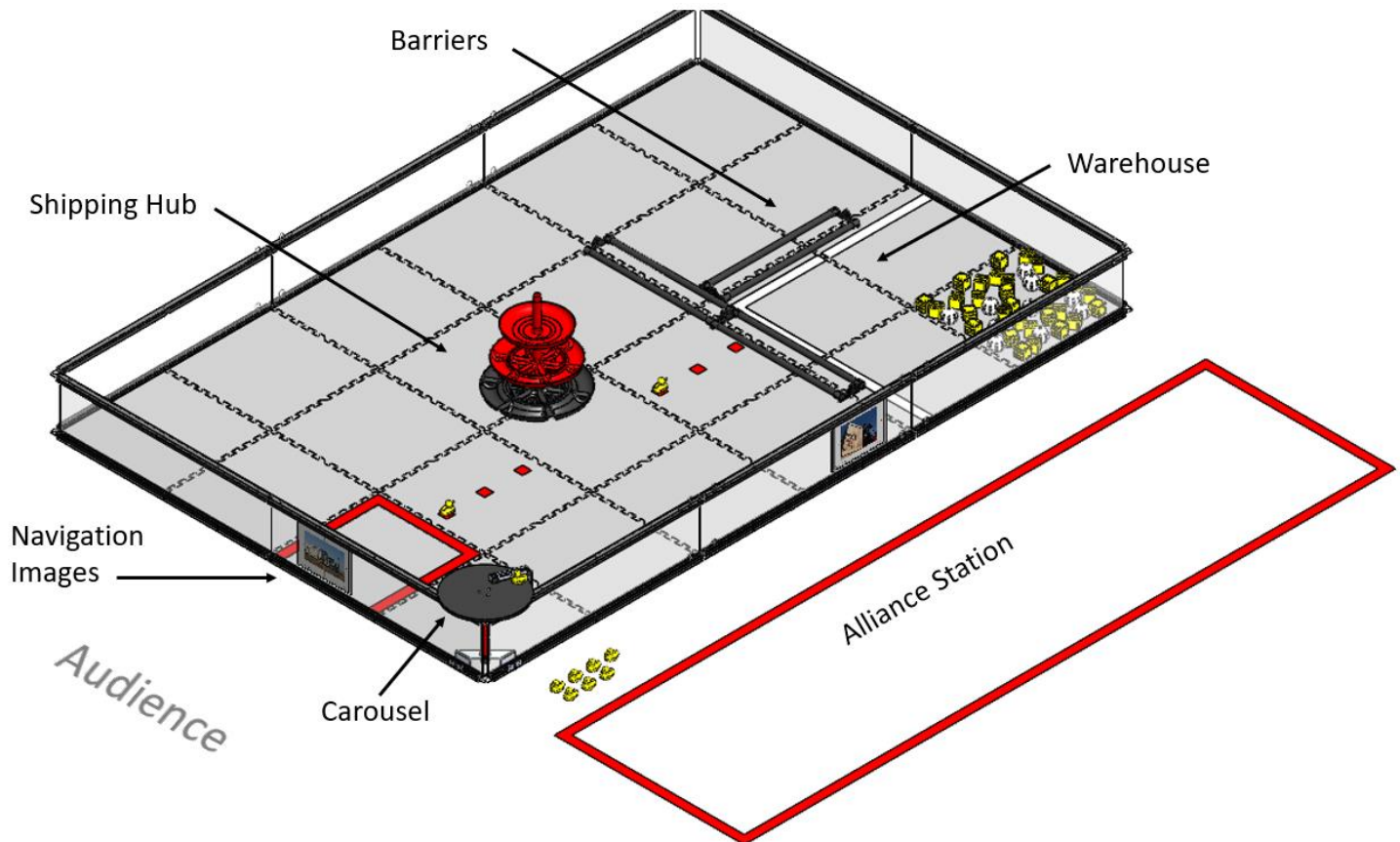
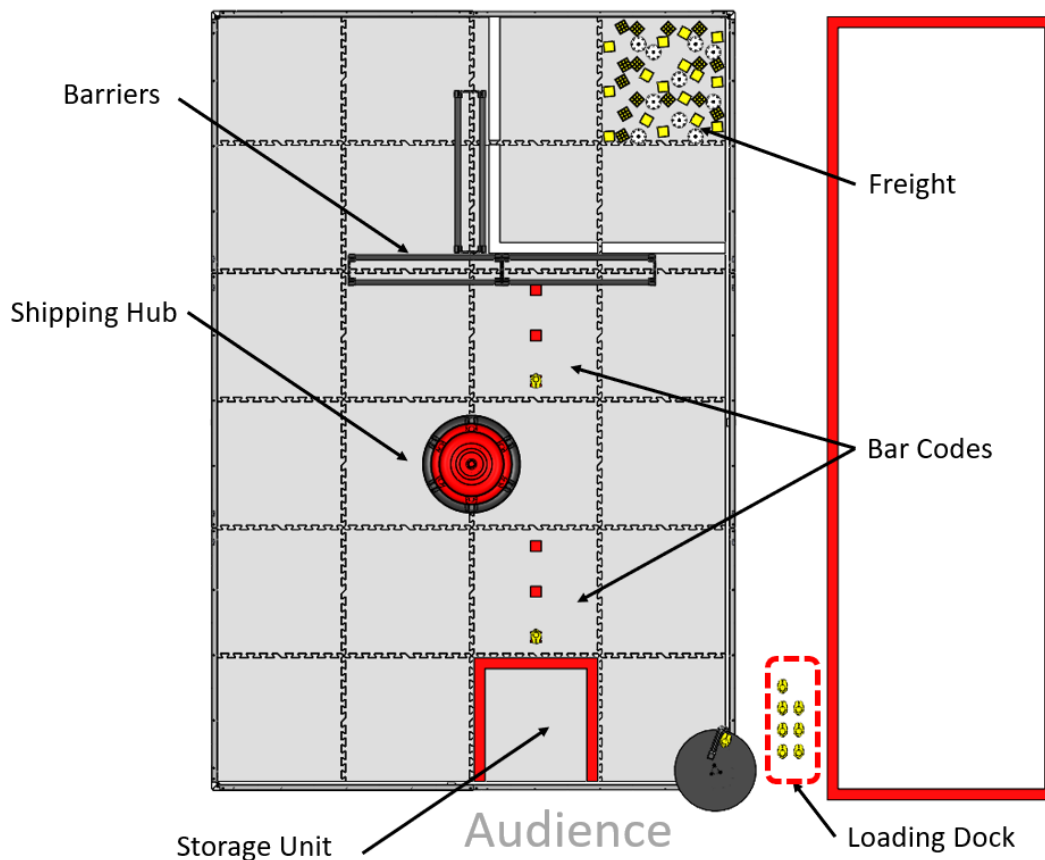


Figure 4.3-1 – Isometric view of the *Playing Field*





**Figure 4.3-2 – Top view of the *Playing Field***

#### 4.4 Game Definitions

The following definitions and terms are used for FREIGHT FRENZY<sup>SM</sup>. Game definitions are capitalized and *italicized* throughout the manual.

**Alliance Shipping Hub** - An *Alliance Specific Game Element* with three (3) *Scoring Levels*. There is one (1) *Alliance Shipping Hub*. The three *Scoring Levels* are as follows (all dimensions are approximate):

- Level 1:** 18 inches (457 mm) diameter and 3 inches (76.2 mm) above the *Playing Field Floor*.
- Level 2:** 15 inches (381 mm) diameter and 8.5 inches (215.9 mm) above the *Playing Field Floor*.
- Level 3:** 12 inches (305 mm) diameter and 14.75 inches (374.6 mm) above the *Playing Field Floor*.

**Alliance Station** – The designated *Team Area* adjacent to the *Playing Field* where the *Drivers* and *Coach* stand during a *Match*.

**Area** – The space defined by the vertical projection of the outside edge of a region's boundary (for example, gaffer tape, goal, *Playing Field Boundary*). The boundary element (tape, markings, etc.) is part of the *Area* for the purposes of determining *Inside* and *Outside*.



**Autonomous Period** – A thirty-second *Match* period in which the *Robot* operates and reacts only to sensor inputs and to commands pre-programmed by the *Team* onto the onboard *Robot* control system. Human control of the *Robot* is not permitted during this time.

**Balanced / Unbalanced** – A *Shipping Hub* is *Balanced* when it is *Completely Supported* by the *Playing Field Floor* and only the *Shipping Hub* domed base is touching the *Playing Field Floor*. All other states are *Unbalanced*.

**Barcode** – The two locations on the *Playing Field Floor* that consist of three taped squares each, where a *Duck* or *Team Shipping Element* is placed during pre-*Match* setup.

**Barrier** – Approximate 1-inch high by 5.5-inch wide (25.4 mm x 139.7 mm) obstacles on the *Playing Field* that delineate *Areas*. *Barriers* do not belong to nor do they form the boundary of any defined *Area*.

**Cap / Capping** – Placing a *Team Shipping Element* on top of the *Alliance Shipping Hub* pipe.

**Carousel** - The *Carousel* is located in the corner of the *Playing Field* adjacent to the *Alliance Station*. There is one (1) *Carousel*. The *Carousel* is not self-powered and may only be rotated by a *Robot* on the *Playing Field* in a manner described in Section 4.5. The following are components of the *Carousel*:

- a) **Platform** – A rotating portion of the *Carousel* used to *Deliver Ducks* and *Team Shipping Elements* into the *Playing Field*.
- b) **Rim** – The vertical surface at the perimeter of the *Platform* where *Robot* contact is allowed.
- c) **Sweeper Plate** – The stationary portion of the *Carousel* that causes the *Duck* or *Team Shipping Element* to fall from the *Platform* and into the *Playing Field*.

**Coach** – A student *Team* member or adult mentor designated as the *Drive Team* advisor during the *Match*.

**Competition Area** – The *Area* where the *Playing Field* is located.

**Control / Controlling** – An object is *Controlled* by a *Robot* if the object is following the movement of the *Robot*. Objects that are *Controlled* by a *Robot* are considered to be a part of the *Robot*. See also the definition of *Possess/Possessing*. Examples include, but are not limited to:

- a) Carrying one or more *Game Elements*.
- b) *Launched Game Elements* are considered *Controlled* until they make contact with something other than the *Playing Field Floor* or *come to rest*. See also the definition of *Launching* in this section.
- c) *Herding* of *Game Elements* is considered *Control*. See also the definition of *Herding* in this section.
- d) *Trapping* one or more *Scoring Elements* against a *Game Element* or *Playing Field Boundary* to shield or guard them. See also the definition of *Trapping* in this section.

Examples of interaction with *Game Elements* that are not *Controlled* include, but are not limited to:

- e) *Plowing* of *Game Elements* is not considered *Control*. See also the definition of *Plowing* in this section.
- f) *Inadvertent* contact with a *Launched Game Element* as it bounces off the *Playing Field* or a *Robot*. See also the definition of *Inadvertent* in this section.

**Deliver / Delivered** – The action of introducing a *Duck* or *Team Shipping Element* onto the *Playing Field*. A legal *Delivery* follows this sequence:

- a) *Drive Team* places a *Duck* or *Team Shipping Element* onto the *Carousel Platform Completely In the Drive Team* side of the *Sweeper Plate*. The *Duck* or *Team Shipping Element* must be in contact with the *Sweeper Plate*; then
- b) The *Robot* must rotate the *Carousel Platform*, then
- c) The *Sweeper Plate* must knock the *Duck* or *Team Shipping Element* off the *Carousel* onto the *Playing Field Floor*.

**Disable / Disabled** – A *Robot* that is no longer active for the remainder of the *Match* due to a *Robot* failure.

**Drive Team** – Up to three (3) representatives; two (2) *Drivers* and one (1) *Coach* from the same *Team*.

**Driver** – A pre-college student *Team* member responsible for operating and controlling the *Robot* and identified by wearing a tournament supplied *Driver* badge or identifying marker.

**Driver-Controlled Period** – The two-minute *Match* time period in which the *Drivers* operate the *Robot*.

**Driver Station** – Hardware and *FIRST* supplied software used by a *Drive Team* to control their *Robot* during a *Match*. A detailed description of *Driver Station* rules are listed in [Game Manual Part 1 – Remote Events](#).

**End Game** – The last thirty seconds of the two-minute *Driver-Controlled Period*.

**End of the Period/Match** - The moment when the *Match* timer reaches 2:00 for the *Autonomous Period* or 0:00 for the *Driver-Control Period* and which coincides with the start of the sound that designates the *End of the Period*.

**Field Personnel** – People selected by the *Team* to help run an official remote competition *Match*. Typical activities performed by *Field Personnel* include preparing the *Playing Field* for a *Match*, randomizing the *Barcode*, keeping track of the *Match Score*, running the cloud-based scoring system, and providing as needed technical assistance to the *Drive Team* during pre-*Match* setup. One person may fill several roles. At a Traditional competition, these activities are performed by trained volunteers. *Teams* may select anyone except for the *Drive Team* to be *Field Personnel*. Some *Field Personnel* roles require specialized knowledge. For example, the person scoring the *Match* should be able to recall rules and *Penalties* in real time while watching an official *Match*.

**Freight** – *Freight* consists of *Cargo*, *Boxes*, and *Ducks*.

- a) **Cargo** – 2.75 inch (69.9 mm) diameter balls, weight: 1.18 oz. (33.5 grams). Quantity: Twenty (20)
- b) **Boxes** – 2 inch (50.8 mm) cubes. There are four (4) types of *Boxes*:
  - i. *Pre-Load* – 1.79 oz (50.5 grams). Quantity: Four (4)
  - ii. *Light* – 1.79 oz (50.5 grams). Quantity: Twenty-Six (26)
  - iii. *Medium* – 3.28 oz (93.1 grams). Quantity: Twenty (20)
  - iv. *Heavy* - 4.78 oz. (135.4 grams). Quantity: Ten (10)
- c) **Ducks** – 2.125 inches x 2.0 inches x 2.0 inches (54.0 mm x 50.8 mm x 50.8 mm) rubber ducks, weight: 0.56 oz. (15.8 grams). Quantity: Twenty (20)

**Game Element** – Any item a *Robot* interacts with to play the game. *Game Elements* for this year's game include: *Alliance Shipping Hub*, *Carousel*, *Team Shipping Element*, and *Freight*.

**Herding** – Pushing or moving one or more *Scoring Elements* to a desired location or direction that gains a strategic advantage beyond moving the *Robot* around the *Playing Field*. See also the definition of *Plowing* in this section.

**In (Inside) / Completely In (Completely Inside)** – An object that has crossed into the upwards vertical (i.e., at a right angle to the *Playing Field Floor*) extension of a defined *Area*'s boundary is *Inside* the *Area*. An object that is entirely within the upwards vertical extension of a defined *Area*'s boundary is *Completely Inside* the *Area*. The boundary element (tape, wall, markings, etc.) is part of the *Area* for the purposes of determining *Inside* and *Outside*, unless otherwise specified.

**Inadvertent** – An unintended side effect of an allowed *Robot* action. Unforced or unexpected *Robot* actions based on software commands are not considered to be *Inadvertent*.

**Inconsequential** – An outcome that does not influence *Scoring* or gameplay.

**Launching** – Propelling *Game Elements* with enough force such that they move independent of contact with the *Robot*. Movement solely due to gravity is not *Launching*.

**Loading Dock** – The unmarked *Area* outside the *Playing Field* located between the *Playing Field Boundary* and the *Alliance Station*.

**Match** – A *Match* consists of a thirty (30) second *Autonomous Period*, an eight (8) second transition and a two (2) minute *Driver-Controlled Period* for a total time of two minutes and thirty-eight seconds (2:38).

**Match Manager** – Any person selected by the *Team* to oversee an official *Match* and *Field Personnel*. The *Match Manager* cannot be a part of the *Drive Team*.

**Navigating** – An *Autonomous Period Scoring* task where a *Robot* is *Parked In* or *Completely In* a specified *Area*.

**Navigation Image** – Three (3) unique images mounted on the *Playing Field Boundary* that a *Robot* can use to navigate around the *Playing Field*. Images are printed on standard letter size paper, 8 1/2 inches x 11 inches (216 mm x 279 mm) or A4 (210 mm x 297 mm) paper. For detailed locations please see the official Field Setup Guide, as well as Appendix F for general image locations.

**Off / Completely Off** – Not physically in contact with or *Supported* by an object, surface, etc. Objects that are *Off* are also considered *Completely Off*.

**On / Completely On** – An object that is physically in contact with and at least partially *Supported* by an object, surface, etc. is considered *On*. An object that is entirely *Supported* by an object, surface, etc. is *Completely On*.

**Out / Outside** – An object that does not extend into any part of a defined *Area* is *Outside* the *Area*.

**Park / Parked** – The condition where a *Robot* is motionless.

**Penalty** – The consequence imposed for a rule or procedure violation that is identified by a referee. When a *Penalty* occurs, points will be deducted from the *Score* of the *Alliance* that incurred the *Penalty*. *Penalties* are defined into *Minor Penalties* and *Major Penalties*.

**Playing Field** – The *Area* that includes the 12 ft. x 8 ft. (3.66 m x 2.44 m) field and where the *Game Elements* are located, and the *Robot* plays *Matches*. There are two equivalent official versions of the *Playing Field*: red and blue, that are mirror images of each other.

**Playing Field Boundary** – A taped line or a wall that marks the *Area* where a *Robot* operates.

**Playing Field Damage** – A physical change to a *Game Element* or *Playing Field* that affects gameplay.

**Playing Field Floor** – The top surface of the *Area* inside the *Playing Field Boundary*.

**Plowing** – *Inadvertent* contact with *Game Elements* while in the path of the *Robot* moving about the *Playing Field* that provides no additional advantages beyond field mobility.

**Possess / Possessing** – An object is in *Possession* by a *Robot* if, as the *Robot* moves or changes orientation (for example, moves forward, turns, backs up, spins in place), the object remains in approximately the same position relative to the *Robot*. Objects in *Possession* by a *Robot* are considered to be *Controlled*, and they are part of the *Robot*. See also *Control/Controlling*.

**Pre-Load** - A *Game Element* that a *Drive Team* positions during pre-Match setup so that it touches a *Robot* or is *Possessed* by a *Robot* at the start of the *Autonomous Period*.

**Robot** – Any mechanism that has been built to compete in the game challenge and complies with the *Robot* rules outlined in Section 7 of [Game Manual Part 1 – Remote Events](#).

**Scoring / Score** – A *Robot* earns points by interacting with *Scoring Elements* and *Parking* in specific *Areas* of the *Playing Field*. *Scoring Elements* still in contact with a *Robot* have zero score value, unless stated otherwise in Section 4.5 or 4.6.

Scoring determination is done by one of three methods: “*Scored Live*”, “*Scored at End of the Period*”, and “*Scored at Rest*.” The specific method for each *Scoring* achievement will be stated in the achievement’s description in Section 4.5.

**Scored Live:** The achievement is considered *Scored* the moment it is successfully completed, i.e., all criteria are met.

**Scored at End of the Period:** The achievement’s *Scoring* status is determined based on the *Robot* or *Scoring Element*’s position at the *End of the Period*.

**Scored at Rest:** The achievement is considered *Scored* based on the position of the *Robot* or *Scoring Element* when the entire field has come to rest after the *Match Period* ends.

**Scoring Elements** – Objects that a *Robot* manipulates to earn points for their *Team*. The *Scoring Elements* for FREIGHT FRENZY are *Freight* and a *Team Shipping Element*.

**Storage Unit** – An approximate 22.75-inch by 22.75-inch (57.8 cm x 57.8 cm) *Scoring Area* where the *Robot* can place *Freight*. The *Storage Unit* is located toward the audience side of the *Playing Field*.

**Support / Supported / Completely Supported** – An object (i.e., *Robot*, *Scoring Element*, *Game Element*, etc.) is *Supported* by another object if the second object is bearing at least some of the weight of the first object. If the second object is bearing all the weight of the first object, it is *Completely Supported* by the second object.

**Team** – Mentors, supporters, and pre-college-aged students affiliated with an entity registered with *FIRST* and for the competition.

**Team Shipping Element** – A *Team* designed and manufactured part that may be used in the *Match*. A detailed definition of *Team Shipping Element* as well as construction rules are located in section XXX of the *Game Manual Part 1 – Remote Events*.

**Tile** – An approximate 24 inch x 24 inch (610 mm x 610 mm) foam rubber mat.

**Warehouse** – An approximate 43.5-inch x 43.5-inch (110.5 cm x 110.5 cm) Area of the *Playing Field* that is bounded on two sides by white tape and two sides by the *Playing Field Boundary*.

**Warehouse Operation** - In order to remove a piece of *Freight* from the *Warehouse*, a *Robot* must perform the following sequence:

- a) Start *Completely Out* of the *Warehouse*, then
- b) Drive *Completely In* the *Warehouse*, then
- c) Collect one (1) piece of *Freight*, then
- d) Drive *Completely Out* of the *Warehouse* with the collected *Freight*.

**Warning** - *Warnings* apply to the entire *Team*. *Warnings* have no effect on a *Teams' Score*. Individual actions of a single *Team* member will count as a *Warning* for the entire *Team*.

## 4.5 Gameplay

Prior to the start of the *Match*, the *Drive Team* performs some basic *Robot* setup steps that are described in section 4.5.1. *Matches* are made up of several periods totaling two (2) minutes and thirty (30) seconds. There is a thirty (30) second *Autonomous Period*, followed by a two (2) minute *Driver-Controlled Period*. The last thirty (30) seconds of the *Driver-Controlled Period* is called the *End Game*.

### 4.5.1 Pre-Match

- 1) *Field Personnel* set up the *Playing Field* as depicted in Figure 4.3-1.
  - a) One (1) *Pre-Load Box* is placed at the *Robot* starting location for *Pre-Loading* by the *Drive Team*.
  - b) The remaining *Freight* (*Cargo*, *Light Box*, *Medium Box*, *Heavy Box*) is placed in the *Warehouse* as described in Appendix B.
  - c) The *Alliance Shipping Hub* is placed at its starting location.
  - d) Ten (10) *Ducks* are placed as follows:
    - i. One (1) *Duck* is placed on the *Carousel* in contact with the outer vertical surface of the *Sweeper Plate*. See Appendix B-4 for position and orientation.
    - ii. One (1) *Duck* is placed on each center *Barcode*. See Appendix D for position and orientation.
    - iii. The remaining *Ducks* are placed *In* the *Loading Dock*.
- 2) The *Drive Team* sets up their *Robot* on the *Playing Field* with the following constraints:
  - a) **Starting Location**
    - i. The *Drive Team* selects their *Robot's* starting location.
    - ii. The *Robot* and its *Pre-Load Box* must be placed *Completely Inside* the *Playing Field Boundary*.



- iii. The *Drive Team* must place their *Robot*, in any orientation, touching the *Playing field Boundary* adjacent to their *Alliance Station*.
  - iv. The *Robot* cannot start in the *Warehouse*, in contact with the *Carousel*, or *On a Barrier*.
- b) **Pre-Loaded Freight** – A *Robot* must *Pre-Load* exactly one (1) *Pre-Load Box*.
- c) **Team Shipping Element** – A *Drive Team* intending to use their *Team Shipping Element* have two options:
- i. The *Team Shipping Element* may be placed in the *Loading Dock*, or
  - ii. The *Team Shipping Element* may be placed on their corresponding center *Barcode* with the *Duck* moved to the *Loading Dock*.
- d) **Op Mode** – *Drive Teams* use their *Driver Station* Android device to:
- i. Select an *Autonomous Op Mode*. If the *Team* does not have an *Autonomous Op mode*, these steps can be skipped.
  - ii. The thirty-second timer must remain enabled.
  - iii. Press the *Driver Station* “Init” button.
  - iv. *Drive Teams* may not touch their *Driver Stations* or controllers until the *Autonomous Period* has ended, except to start their *Autonomous* program with a single touch to the *Driver Station* Android device screen using the built-in thirty-second timer.
- 3) Once the *Match Manager* gives the set-up complete signal:
- a) The *Drive Team* may no longer touch their *Robot* until the conclusion of the *Match*.
  - b) The *Drive Team* may not touch their *Driver Stations* or controllers until the *Autonomous Period* has ended. Exceptions to this include using the *Driver Station* to start their *Autonomous* program or to *Disable* their *Robot* as instructed by a referee.
  - c) After the *Robot* set-up process is complete, *Field Personnel* will randomize the field into one of three (3) configurations as chosen by the scoring system or a dice throw as shown in Appendix D. *Field Personnel* will attempt to maintain the orientation of the *Team Shipping Element* as it was placed on the field by the *Drive Team*.

#### **4.5.2 Autonomous Period**

The *Match* starts with a thirty (30) second *Autonomous Period* where the *Robot* is operated only via pre-programmed instructions. The *Team* is not allowed to control *Robot* behavior with the *Driver Station* or any other actions during the *Autonomous Period*. The *Driver Station* is placed in a hands-off location during the *Autonomous Period* so that it is evident that there is no human control of the *Robot*. The only exception is to allow the *Drive Team* to start their *Robot* with a “start” commands issued on the *Driver Station* touch screen. The *Team* must use the built-in thirty-second timer.

Following a countdown by *Field Personnel*, the *Autonomous Period* begins. The *Drive Team* may issue a *Robot* start command with their *Driver Station* Android device to run the *Autonomous Op Mode* that was initialized during *Pre-Match* setup. Failure to adhere to this procedure may subject the *Team* to a *Penalty* as

specified in the game rules in section 4.6.2. The *Drive Team* is not required to start executing an *Op Mode* during the *Autonomous Period*.

During the *Autonomous Period*, the *Drive Team* may not place *Ducks* or the *Team Shipping Element* On the *Carousel*.

*Autonomous* points are *Scored at Rest* for the following achievements:

- 1) **Carousel** – Delivering the preplaced *Duck* from the *Carousel* earns ten (10) points.
- 2) **Navigating** –
  - a) A *Robot Parked In the Storage Unit* earns three (3) points.
  - b) A *Robot Parked Completely In the Storage Unit* earn six (6) points.
  - c) A *Robot Parked In the Warehouse* earns five (5) points.
  - d) A *Robot Parked Completely In the Warehouse* earns ten (10) points.
- 3) **Freight** – A *Robot* placing *Freight* earns points as follows:
  - a) Each piece of *Freight* positioned *Completely In the Storage Unit* earns two (2) points.
  - b) Each piece of *Freight* placed *Completely On the Alliance Shipping Hub*, regardless of *Level*, earns six (6) points.
- 4) **Autonomous Bonus** – A *Robot* will earn ten (10) bonus points for placing its *Pre-Loaded Box* on the *Alliance Shipping Hub* level (#1, #2, #3) that corresponds to the randomly selected *Barcode* location (#1, #2, #3). A *Robot* may earn only one (1) bonus for correctly placing its own *Pre-Loaded Box*.
  - a) A *Robot* that uses the pre-placed *Duck* to detect the correct *Level* earns ten (10) points
  - b) A *Robot* that uses the *Team Shipping Element* to detect the correct *Level* earns twenty (20) points.

#### **4.5.3 Driver-Controlled Period**

Directly following the end of the *Autonomous Period*, the *Drive Team* has five (5) seconds plus a "3-2-1-go" countdown to prepare their *Driver Station* for the start of the 120 second *Driver-Controlled Period*. On the countdown word "go," the *Driver-Controlled Period* starts, and the *Drive Team* presses their *Driver Station* start button to resume playing the *Match*.

During the *Driver-Controlled Period*, the *Carousel* may not be rotated until the *End Game*.

*Driver-Controlled tasks are Scored at Rest*:

- 1) **Freight** –
  - a) Each piece of *Freight Scored Completely In the Storage Unit* earns one (1) point.
  - b) Each piece of *Freight Scored In the Alliance Shipping Hub* earns two (2) points for being *Completely On Level #1*, four (4) points for being *Completely On Level #2*, and six (6) points being *Completely On Level #3*.



#### **4.5.4 End Game**

The last thirty seconds of the *Driver-Controlled Period* is called the *End Game*. *Driver-Controlled Period Scoring* can still take place during the *End Game*. *End Game* tasks, with the exception of *Parking* and the *Balance* position of the *Shipping Hub*, started prior to the start of the *End Game* will earn zero (0) points for those tasks.

*End Game* tasks are Scored at Rest.

- 1) ***Duck and Team Shipping Element Delivery*** – Each *Duck* or *Team Shipping Element Delivered* to the *Playing Field Floor* earns six (6) points.
- 2) ***Shipping Hub Status*** – If the *Alliance Shipping Hub* is *Balanced*, the *Team* receives ten (10) points.
- 3) ***Parking*** –
  - a) A *Robot Parked In the Warehouse* earns three (3) points.
  - b) A *Robot Parked Completely In the Warehouse* earns six (6) points.
- 4) ***Capping*** – A *Team Shipping Element* that is fully *Supported* by the center pole above *Level #3* of their *Alliance Shipping Hub* earns fifteen (15) points.

#### **4.5.5 Post Match**

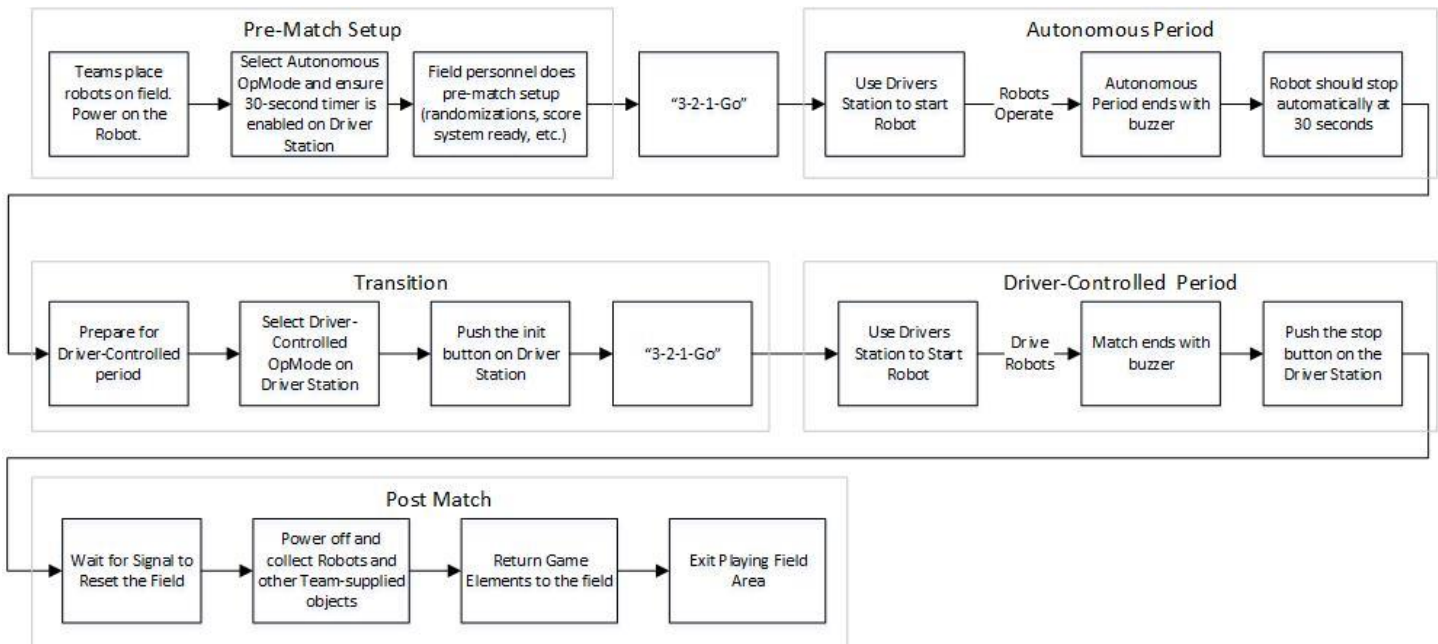
After the *Match*, *Field Personnel* will finalize the *Score*. The *Match Manager* will signal for the *Drive Team* to enter the *Playing Field* and retrieve their *Robot* and *Team Shipping Element*. The *Drive Team* should return any *Game Elements* that are *Possessed* by the *Robot* to the *Playing Field*. *Field Personnel* will set up the *Playing Field* for the next *Match*.

#### **4.5.6 Penalties**

*Penalty* points are subtracted from the *Team's Score* at the *End of the Match*. *Minor Penalties* subtract ten (10) points per occurrence. *Major Penalties* subtract thirty (30) points per occurrence.

### 4.5.7 Flowchart of Match Play

The following figure shows the typical flow of the *Match* and the actions taken on the *Driver's Station* Android device.



## 4.6 Rules of Gameplay

Gameplay is restricted by the Safety rules (<S#>), the General rules (<G#>), and the Game-Specific rules (<GS#>). Other rules to pay close attention to are the *Robot* rules, the inspection rules, and the tournament rules defined in the [Game Manual Part 1 – Traditional Events](#). Violation of rules may lead to *Penalties*, *Yellow Cards*, *Red Cards*, a *Disabled Robot*, or *Disqualification* of the offending *Team* or *Alliance* from either a *Match* or the tournament. Rules apply to all periods of play unless otherwise specified. If rules are in conflict, Safety rules take precedence over all rules and Game-Specific rules take precedence over General rules. The official FIRST Tech Challenge Question & Answer Forum rulings take precedence over all information in the game manuals.

There are rules in the Game Manual Part 2 – Traditional Events, that do not apply to *Teams* competing remotely. Those rules have been removed from this manual; however, the numbering of the rules has been kept the same for consistency. The remaining rules may have modifications as appropriate for single *Robot* gameplay.

### 4.6.1 Safety Rules

**<S1> Unsafe Robot or Playing Field Damage** – If at any time the *Robot* operation is deemed unsafe or has damaged the *Playing Field* the *Robot* may be *Disabled* by *Field Personnel*.

**<S2> Robot Extension Outside the Playing Field Perimeter** – For safety reasons, no portion of the *Robot* may contact anything *Outside* the *Playing Field Boundary*. A *Major Penalty* will be assessed per occurrence. See the game definitions in section 4.4 for a complete description of the *Playing Field Boundary*.

The intent of this rule is not to *Penalize* a *Team* for *Inadvertent*, safe *Robot* extension *Outside* the *Playing Field Boundary*. Intentional *Robot* extension *Outside* the *Playing Field* is not permitted.

**<S3> Safety Gear** – *Matches* must not be played until all members of the *Drive Team* are wearing approved eye protection and shoes with closed-toes and a closed-back.

#### **4.6.2 General Game Rules**

**<G1> Autonomous to Driver-Controlled Period Transition** – At the conclusion of the *Autonomous Period*, the *Robot* will remain in a hands-off state. *Field Personnel* will not enter the field and will not touch the *Robot* on the field during the *Autonomous to Driver-Controlled* transition. The scoring system display will provide visual and audio cues for the *Drive Team* to pick up their *Driver Station*. The *Drive Team* will have five (5) seconds to pick up and prepare their *Driver Station*. After five (5) seconds, there will be a “3-2-1 go” countdown and the *Driver-Controlled Period* of the *Match* will begin.

**<G2> Score Certification at the End of the Match** – Scores will be tracked by *Field Personnel* throughout the *Autonomous* and *Driver-Controlled Periods* of the *Match*. At the *End of the Match*, the final *Score* will be certified as quickly as possible. A change in state of a *Game Element* or *Robot* at the *End of the Match* after its final *Score* is recorded will not change an already-recorded *Score*. *Scoring Elements* will not be recounted after the *End of the Match* unless otherwise specified by a Game-Specific rule.

**<G4> Robot Manipulation of Scoring Elements** – *Scoring Elements* that are *Controlled* or *Possessed* by a *Robot* are part of the *Robot* except when determining the location of the *Robot* or otherwise specified by a Game-Specific rule.

For Example: If a *Robot* Possesses a *Scoring Element*, and only that *Scoring Element* breaks the plane of a *Scoring Area*, the *Robot* does not receive points for being *In* that *Area*.

**<G5> Robot or Scoring Elements In Two or More Scoring Areas** – A *Robot* or *Scoring Elements* that are *In* two or more *Scoring Areas* earn points only for the highest value achievement. If the achievement values are equal, only one achievement counts as *Scored*.

**<G6> Scoring Elements in Contact with Robots** – *Scoring Elements* in a *Scoring Area* that are in contact with or *Controlled* by a *Robot* for the *Scoring Area* have zero *Score* value.

**<G7> Disabled Robot Eligibility** - A *Disabled Robot* is not eligible to *Score* or earn points for the remainder of the *Match*.

**<G8> Playing Field Tolerances** – *Playing Field* and *Game Elements* will start each *Match* with tolerances that may vary by as much as  $\pm 1.0$  inch (25.4 mm). *Teams* must design their *Robots* accordingly.

Commercial Off The Shelf and Do it Yourself *Playing Field* and *Game Elements* are expected to be manufactured, assembled, and set up using a high standard for dimensional and location accuracy. The intent of the generous  $\pm 1.0$  inch tolerance is to accommodate unintentional size and location variations that may occur. The tolerance is not an excuse for intentional or imprecise accuracy in construction or setup.

**<G9> Match Replay** – Once started, *Matches* are not paused or replayed. Unexpected *Robot* behavior will not result in a *Match* replay. *Team*-induced failures, such as low battery conditions, processor sleep time-outs, *Robot* mechanical, electrical, software, or communication failures, etc. are NOT valid justifications for a replaying of a *Match*.

**<G10> Inadvertent and Inconsequential** - Robot actions that violate a rule may be ruled by *Field Personnel* to be *Inconsequential* and *Inadvertent* and will not be *Penalized*.

**<G12> Playing Field Access** – *Drive Team* members must not enter the *Playing Field* for any reason other than to place/retrieve their *Robot*. While placing the *Robot*, the *Team* may not measure, test, or adjust *Game Elements* unless allowed by Section 4.5.1.

The consequences for violating this rule are:

- a) *Minor Penalty* for violations during *Match* setup or following the *End of the Match*.
- b) *Major Penalty* for violations that delay the start of the *Match*.

If a *Team* feels the *Playing Field* is not set up correctly, *Teams* should notify *Field Personnel* prior to the start of the *Match*.

**<G13> Pre-Match Robot Placement** – At the beginning of a *Match*, the *Robot* must be set up on the *Playing Field* according to section 4.5.1 *Pre-Match*. After the *Robot* is set up on the *Playing Field*, the *Drive Team* must stand *Inside* their *Alliance Station*.

**<G14> Robot Starting Volume** – Before the start of a *Match*, the *Robot* in its starting location must not exceed a volume of 18 inches (457.2 mm) by 18 inches (457.2 mm) by 18 inches (457.2 mm). A *Pre-Loaded Scoring Element* may extend *Outside* the 18-inch (457.2 mm) cube volume constraint. *Match* play must not begin until the *Robot's* starting volume constraint is satisfied.

After the start of a *Match*, the *Robot* may extend in any direction unless otherwise specified by the Game-Specific rules detailed in section 4.6.3.

**<G15> Robot Setup Alignment** – The *Drive Team* may align their *Robot* during *Pre-Match* setup if they do so with legal components that are part of the *Robot* and can be reset to be within the 18-inch (457.2 mm) cube starting volume constraint. A single member of the *Drive Team* may also align the *Robot* by sight if they are next to the *Robot* and their action does not delay the start of a *Match*. A *Minor Penalty* will be assessed to the *Team* for violation of this rule.

**<G16> Alliance Stations** – During a *Match*, the *Drivers* and *Coach* must remain *In* their *Station*.

- a) The *Drive Team* may be anywhere in their *Alliance Station*.
- b) The first instance of leaving the *Station* will result in a *Warning*, with any following instances during the *Match* resulting in a *Minor Penalty*. Leaving the *Station* for safety reasons will not result in a *Warning* or *Penalty*.

The intent of this rule is to prevent *Drive Team* members from leaving their assigned *Station* during a *Match* to gain a competitive advantage. For example, moving to another part of the *Field* for better viewing, reaching into the *Field*, etc. Simply breaking the plane of the *Station* during normal *Match* play is not a *Penalty*.

**<G17> Post-Match Removal of the Robot** – The *Robot* must be designed to permit easy removal of *Game Elements* from the *Robot* after the *Match*. The *Robot* should also be able to be removed from the *Playing Field* without damaging the *Playing Field*. A *Minor Penalty* will be assessed for violations of this rule.

**<G18> Starting Gameplay Early** – A *Robot* that starts playing the game (*Autonomous* or *Driver-Controlled Period*) prior to the start of a *Match Period* receive a *Minor Penalty*. *Field Personnel* have the option of issuing a *Major Penalty* in place of the *Minor Penalty* if the early start results in a competitive advantage for the offending *Team*.

The intent of this rule is to have timely removal of the *Robot* from the *Playing Field* following a *Match*. The *Drive Team* is expected to stage their *Robot* for a *Match*, and remove them from the *Playing Field* afterwards, safely and swiftly. *Drive Team* efforts that either intentionally or unintentionally delay the start of a *Match* or the *Playing Field* reset are not allowed. Examples include, but are not limited to:

- 1) Failing to exit the *Playing Field* once instructed by *Field Personnel*.
- 2) Failing to remove *Driver Stations* in a timely manner.

**<G19> Late Start of the Autonomous Period** – A *Drive Team* that starts their *Robot's Autonomous Op Mode* late will receive a *Minor Penalty*. Referees have the option of issuing a *Major Penalty* in place of the *Minor Penalty* if the late start results in a competitive advantage for the offending *Alliance*.

**<G20> Robot Actions at End of the Period** –

- a) The *Robot* must *Park* at the *End of the Autonomous* and *Driver-Controlled Periods*. A *Robot* that is not *Parked* at the conclusion of the “game sound” receives a *Minor Penalty* and the actions of the *Robot* do not count towards their *Team's Score*. The *Drive Team* should make their best effort to stop gameplay immediately when the *End of the Period* game sound begins. *Field Personnel* have the option of issuing a *Major Penalty* in place of the *Minor Penalty* if the late stop results in a competitive advantage (other than *Scoring*) for the offending *Team*.
- b) *Scoring* achievements that were started (unless disallowed by Game-Specific rules) before the *End of the Period* are eligible to be counted as *Scored*.
- c) *Robot Scoring* achievements that occur after the announced end of the *Autonomous Period* and before the start of the *Driver-Controlled Period* do not count towards the *Score* for the *Autonomous* or *Driver-Controlled Periods*.

**<G21> Robot Control During Autonomous Period** - During the *Autonomous Period*, the *Drive Team* may not directly or indirectly control or interact with their *Robot* or *Driver Station*. Early stopping of the *Robot* while running its *Autonomous* code is not allowed, except in cases of personal or equipment safety, and any achievements earned due to early stoppage will not *Score* points. A *Major Penalty* will be assessed for violating this rule. *Teams* that stop their *Robot* during the *Autonomous Period* are allowed to participate in the *Driver-Controlled Period* provided it can be done safely.



**<G22> Drive Team Contact with the *Playing Field* or *Robot*** – During a *Match*, the *Drive Team* is prohibited from making contact with the *Playing Field*, the *Robot*, or any *Game Element*. The first instance of contact will result in a *Warning*, with any following instances resulting in a *Minor Penalty*. Contact that affects *Scoring*

For example, a *Game Element* is *Launched* from a *Robot* on the *Playing Field* and it *Inadvertently* hits a *Team* member in the *Alliance Station* and is deflected back onto the field. The *Team* would not receive a <G22> *Penalty* because the *Team* member was protecting themselves (safety). However, if that same *Game Element* is caught and/or directed to a specific location on the *Playing Field*, the *Team* may be issued a <G22> *Penalty*.

and/or gameplay will result in a *Major Penalty*. Contact with the *Playing Field*, a *Game Element*, or a *Robot* for safety reasons will not result in a *Warning* or *Penalty*.

**<G23> Drive Team Coach Driver Station Control** – During the *Driver-Controlled Period*, a *Robot* must be remotely operated only by the *Drivers* using the Gamepads connected to the *Team's Driver Station* and/or by software running on the on-board *Robot* control system. The first instance of *Coach* operating a gamepad will result in a *Warning*, with any following instances resulting in a *Major Penalty*. During the *Driver-Controlled Period*, *Drive Team Coaches* and/or *Drivers* are allowed to hold the *Team's Driver Station* Android device and interact with it to select an Op Mode, view information displayed on the screen, and initialize, start, stop, and reset the *Robot*.

**<G24> Robots Deliberately Detaching Parts** – A *Robot* may not deliberately detach parts during a *Match* or leave mechanisms on the *Playing Field* unless permitted by a Game-Specific rule. *Possessed* or *Controlled Scoring Elements* are not considered to be a part of the *Robot* for the purpose of this rule. The consequence of deliberately detaching a part is a *Minor Penalty* per occurrence. A *Robot* will receive a *Minor Penalty* each time gameplay is affected by the deliberately detached component or mechanism. *Robot* parts that are released but remain connected by a tether are considered detached for the purposes of this rule.

Tethered components that move independently of the main *Robot* are considered a detached component and are illegal.

**<G25> Robots Grasping Game Elements** – A *Robot* may not grab, grasp and/or attach to any *Game Element* or structure other than *Scoring Elements*, unless specifically allowed by Game-Specific rule(s) listed in section 4.6.3. The first instance will result in a *Warning* with any following violations resulting in a *Major Penalty*.

**<G26> Destruction, Damage, Tipping, etc.** – *Robot* actions aimed at the destruction, damage, tipping over, or entanglement of *Game Elements* are not in the spirit of the FIRST Tech Challenge and are not allowed unless permitted by Game-Specific rules. Some tipping, entanglement, and damage may occur as a part of normal gameplay. If the tipping, entanglement, or damage is ruled to be deliberate or chronic, the offending *Team* will receive a *Major Penalty*.

**<G27> Removing Game Elements from the *Playing Field*** – A *Robot* may not deliberately remove *Game Elements* from the *Playing Field* during a *Match*. *Game Elements* that *Inadvertently* fall *Outside* the *Playing Field* will be returned to the *Playing Field* by *Field Personnel* at the earliest safe and convenient opportunity at a non-*Scoring* location approximately where it left the field. *Game Elements* removed from the *Playing Field* in an attempt to *Score* are also not subject to this *Penalty*. *Teams* deliberately removing *Game Elements* from the *Playing Field* will incur a *Minor Penalty* per *Game Element* removed from the *Playing Field*. Game-Specific rules listed in section 4.6.3 that address the removal of specified *Scoring Elements* from the *Playing Field* take precedence over this general game rule.

**<G29> Illegal Usage of Game Elements** – A *Robot* may not deliberately use *Game Elements* to ease or amplify the difficulty of any *Scoring* or game activity. A *Major Penalty* will be assessed for violations of this rule.

#### **4.6.3 Game-Specific Rules**

**<GS1> General Rule Exceptions** - The following instances of gameplay are Game-specific exceptions to General Game Rules in section 4.6.2:

- a) The *Drive Team* may interact with *Scoring Elements* in the *Loading Dock* at any time during the *Match* as an exception to rule <G22>.
- b) As a part of pre-*Match Robot* placement or post-*Match Robot* retrieval, the *Drive Team* may also place or retrieve their *Team Shipping Element* as an exception to rule <G12>.

**<GS3> Alliance Shipping Hub Constraints** - the following are constraints placed on the *Robot* with respect to the *Alliance Shipping Hub*:

- a) A *Robot* may not intentionally relocate the *Alliance Shipping Hub*. *Inadvertent* and *Inconsequential* contact is allowed but intentional movement that affects gameplay is assessed a *Major Penalty*.
- b) The *Shipping Hub Balance* shall be determined only by the weight and position of the *Shipping Hub*, the *Scored Freight*, and the *Scored Team Shipping Element*.
  - i. A *Robot* contacting the *Alliance Shipping Hub* at the *End of the Match* will result in that *Shipping Hub* being considered *Unbalanced*.

**<GS5> Freight Constraints** -

- a) *Freight* removed from the *Warehouse* must follow defined *Warehouse Operations*. *Pre-Loaded Freight* is considered to be already removed from the *Warehouse*.
- b) A *Robot* must be *Completely Outside* of the *Warehouse* to *Score Freight*.

Each violation of this rule will result in a *Minor Penalty*.

**<GS6> Launching Scoring Elements** - *Scoring Elements* may not be *Launched*. Each violation of this rule results in a *Minor Penalty*.

**<GS7> Carousel Constraints** – A *Robot* may not:

- a) Intentionally place items *On* the *Carousel*. Each violation of this rule results in a *Minor Penalty*.
- b) Contact the top or bottom surfaces of the *Carousel Platform*. A *Robot* may only contact the *Carousel Rim*. An immediate *Minor Penalty* for each violation and an additional *Minor Penalty* for every 5 seconds of contact will be assessed.
- c) Contact a *Scoring Element* *On* the *Carousel*. A *Minor Penalty* is assessed for each violation.

The intent of this rule is that the *Robot* may only interact with the *Carousel* at the *Rim*, incidental contact with the top or bottom of the *Carousel* will not be penalized.



**<GS8> Control/Possession Limits of Scoring Elements** – A Robot may Control or Possess a maximum of one (1) Freight and one (1) Team Shipping Element at a time.

- a) *Plowing* through any quantity of Scoring Elements is allowed but *Herd*ing or directing Scoring Elements above the allowed limit to gain a strategic advantage (for example., Scoring, accessibility) is not allowed. The Penalty for Controlling or Possessing more than the allowed quantity is an immediate Minor Penalty for each Scoring Element above the limit plus an additional Minor Penalty per Scoring Element in excess of the limit for each 5-second interval that this situation continues.
- b) A Major Penalty will be assessed for each Scoring Element that is Scored while a Robot Controls or Possesses more than the allowed quantity.
- c) Freight already Scored in a Robot's Alliance Scoring Area does not count towards the Control/Possession limit.

**<GS9> Delivery Constraints -**

- a) Delivered Ducks and the Team Shipping Element must contact the floor before a Robot may Control them. Each violation of this rule results in a Minor Penalty. Inadvertent and Inconsequential contact with the Robot will not be penalized.
- b) Once the Match begins, Ducks and Team Shipping Elements may only be introduced onto the Playing Field via Delivery. Each violation of this rule results in a Major Penalty.
- c) The Drive Teams may not place or interact with Ducks or the Team Shipping Element On the Carousel during the Autonomous Period. Each violation of this rule results in a Major Penalty.
- d) Ducks or the Team Shipping Element may only be Delivered onto the Playing Field Floor during the Autonomous and End Game Periods of a Match. Each violation of this rule results in a Major Penalty.
- e) Only one (1) Duck or Team Shipping Element is allowed On the Carousel at a time. Each violation of this rule receives a Major Penalty.
- f) Ducks or Team Shipping Elements on the Carousel must be in contact with the Sweeper Plate before a Robot can rotate the Carousel. Each violation of this rule results in a Major Penalty.
- g) Once the Carousel begins to move; the Drive Team can no longer touch a placed Duck or Team Shipping Element unless it falls off on its own outside of the Field. Each violation of this rule results in a Major Penalty. Ducks that fall outside the Field will be placed back in the Loading Dock by the Drive Team or Field Personnel depending on where it falls.
- h) The Drive Team may not interact with the Carousel (for example, touching, placing a Duck or Team Shipping Element) when the Carousel is in motion. Each violation earns a Major Penalty.

## 4.7 Scoring Summary

The following table shows the possible *Scoring* achievements and their point values. The table is a quick reference guide and not a substitute for a thorough understanding of the game manual. All achievements are *Scored at Rest*.

<b>Scoring Achievement</b>	<b>Autonomous Points</b>	<b>Driver-Controlled Points</b>	<b>End Game Points</b>	<b>Reference</b>
<i>Carousel: Delivering a Duck</i>	10			4.5.2.1
<i>Parking: Robot In Storage Unit</i>	3			4.5.2.2a
<i>Parking: Robots Completely In Storage Unit</i>	6			4.5.2.2b
<i>Parking: Robot In Warehouse</i>	5			4.5.2.2c
<i>Parking: Robot Completely In Warehouse</i>	10			4.5.2.2d
<i>Freight Completely In Self Storage Unit</i>	2			4.5.2.3a
<i>Freight Completely On Shipping Hub</i>	6			4.5.2.3b
<i>Auto Bonus: Pre-Load Freight Completely On randomized Level using Duck</i>	10			4.5.2.4
<i>Auto Bonus: Pre-Load Freight Completely On randomized Level using Team Shipping Element</i>	20			4.5.2.5
<i>Freight Completely In Storage Unit</i>		1		4.5.3.1a
<i>Freight On Alliance Shipping Hub – Level 1</i>		2		4.5.3.1b
<i>Freight On Alliance Shipping Hub – Level 2</i>		4		4.5.3.1b
<i>Freight On Alliance Shipping Hub – Level 3</i>		6		4.5.3.1b
<i>Duck or Team Shipping Element Delivered</i>			6	4.5.4.1
<i>Alliance Shipping Hub: Balanced</i>			10	4.5.4.2a
<i>Parking In Warehouse</i>			3	4.5.4.3a
<i>Parking Completely In Warehouse</i>			6	4.5.4.3b
<i>Capping: each Team Shipping Element</i>			15	4.5.4.4

### 4.8 Rule Summary

The following table shows the possible rule violations and their consequences. The table is a quick reference guide and not a substitute for a thorough understanding of the complete rule descriptions in section 4.6.

Rule #	Rule	Consequence	Warning Disable	Minor Penalty	Major Penalty	Card Issued
<b>Safety Rules</b>						
<S1>	Unsafe <i>Robot</i> or Damage to the <i>Playing Field Boundary</i> .	<i>Disable</i> if unsafe operation is likely to persist. Optional <i>Yellow Card</i> . Significant damage and/or delays may escalate to <i>Red Card</i> .	D*			
<S2>	Contact <i>Outside</i> the <i>Playing Field Boundary</i> .	<i>Major Penalty</i>	D*		1x	
<S3>	<i>Drive Team</i> missing safety gear.	<i>Warning</i> , <i>Match</i> cannot be played until issue is resolved	W			
<b>General Rules – Further definitions, no <i>Penalties</i> earned</b>						
<G1>	<i>Autonomous</i> to <i>Driver-Controlled Period</i> transition					
<G2>	Certifying the <i>Score</i> at <i>End of the Match</i>					
<G4>	<i>Scoring Elements Controlled</i> or <i>Possessed</i> are part of the <i>Robot</i> for <i>Robot</i> location					
<G5>	<i>Scoring Elements Controlled</i> or <i>Possessed</i> are part of the <i>Robot</i> for <i>Robot</i> location	Points are not earned for any <i>Scoring Elements</i> in a <i>Scoring Area</i> in contact with <i>Robots</i> of the corresponding <i>Alliance</i> .				
<G6>	<i>Scoring Elements</i> in two or more <i>Areas</i>					
<G7>	<i>Disabled Robot</i> eligibility					
<G8>	<i>Playing Field Tolerances</i>					
<G9>	<i>Match Replay</i>					
<G10>	<i>Inadvertent</i> and <i>Inconsequential</i>					
<b>General Rules – Pre-match <i>Penalties</i></b>						

Rule #	Rule	Consequence	Warning Disable	Minor Penalty	Major Penalty	Card Issued
<G12>	Measure, test, or adjust <i>Game Elements</i> . <i>Playing Field</i> inspection to determine <i>Score</i>	<i>Minor Penalty</i> for pre- <i>Match</i> or post- <i>Match</i> violations. <i>Major Penalty</i> if delay start of <i>Match</i> .		1x	1x	
<G14>	<i>Robot</i> starting volume.	<i>Match</i> cannot start until in compliance with starting volume.				
<G15>	<i>Robot</i> setup alignment devices/ <i>Match</i> Delay.	<i>Minor Penalty</i> for each offense.		1x		
<G16>b	<i>Drive Team</i> member(s) leaving the <i>Alliance Station</i> .	<i>Warning</i> for the first instance with any following instances resulting in a <i>Minor Penalty</i> .	W	1x		
<G17>	Delay caused by the removal of <i>Robots</i> from the <i>Playing Field</i> and <i>Game Elements</i> from <i>Robots</i> .	A <i>Minor Penalty</i> will be assessed.		1x		
<b>General Rules – Gameplay Penalties</b>						
<G18>	Starting Gameplay Early.	<i>Minor Penalty</i> with the option of a <i>Major Penalty</i> if the early start results in a competitive advantage for the <i>Team</i>		1x	1x*	
<G19>	Late <i>Start of the Autonomous Period</i> .	<i>Minor Penalty</i> with the option of a <i>Major Penalty</i> if the late start results in a competitive advantage for the <i>Team</i> .		1x	1x*	
<G20>	<i>Robot</i> is not <i>Parked</i> at the end of period.	<i>Minor Penalty</i> and the actions of the <i>Robot</i> that occur after the end of gameplay do not count towards the <i>Team's Score</i> . <i>Major Penalty</i> if the late stop results in a competitive advantage for the <i>Team</i> .		1x	1x*	

Rule #	Rule	Consequence	Warning Disable	Minor Penalty	Major Penalty	Card Issued
<G21>	Robot control during Autonomous Period / Early stopping of the Autonomous code.	Major Penalty. Achievements earned during that time result in zero Score.			1x	
<G22>	Drive Team contact with the Playing Field, Game Element, or Robot.	Warning for the first instance with any following instances resulting in a Minor Penalty. Optional Major Penalty if contact affects Scoring and/or gameplay.	W <sup>T</sup>	1x	1x	
<G23>	Drive Team Coach Driver Station control.	Warning for the first instance with any following instances resulting in a Major Penalty.	W <sup>T</sup>		1x	
<G24>	Robots deliberately detaching parts.	Minor Penalty per occurrence.		1x		
<G25>	Robots illegally grasping Game Elements.	Warning for the first instance with any following instances resulting in a Major Penalty.	W <sup>T</sup>		1x	
<G26>	Destruction, damage, tipping, etc.	Deliberate or chronic violations of this rule will receive a Major Penalty.			1x	
<G27>	Deliberately removing Game Elements from the Playing Field.	Minor Penalty per Game Element deliberately removed from the Playing Field.		1x		
<G29>	Illegal Use of Game Elements to ease or amplify Scoring.	Major Penalty will be assessed with any following instances resulting in a Yellow Card.			1x	YC
<b>Game-Specific Rules – Gameplay Penalties</b>						
<GS3>a	Relocate Alliance Shipping Hub	Major Penalty for each offense			1x	
<GS5>	Violating Warehouse Operations	Minor Penalty for each offense		1x		
<GS6>	Launching Scoring Elements	Minor Penalty for each offense		1x		
<GS7>a	Robots placing items on Carousel.	Minor Penalty for each offense		1x		
<GS7>b	Robot contact on top or bottom of Carousel.	Immediate Minor Penalty for each violation plus additional Minor Penalty every 5 seconds		1x+		

Rule #	Rule	Consequence	Warning Disable	Minor Penalty	Major Penalty	Card Issued
<GS7>c	Contact with Scoring Element while on Carousel.	Minor Penalty for each offense		1x		
<GS8>a	Herding Scoring Elements	Immediate Minor Penalty for each offense plus additional Minor Penalty every 5 seconds		1x+		
<GS8>b	Scoring while in Possession of excess quantity.	Major Penalty for each offense. May escalate to Yellow Cards			1x	YC
<GS9>a	Duck/ Team Shipping Element must touch floor before a Robot can Control it.	Minor Penalty for each offense		1x		
<GS9>b	Delivery only by Carousel	Major Penalty for each offense			1x	
<GS9>c	Placing Ducks/ Team Shipping Element on Carousel during Autonomous	Major Penalty for each offense			1x	
<GS9>d	Delivery only during Autonomous or End Game	Major Penalty for each offense			1x	
<GS9>e	Only one Duck / Team Shipping Element at a time.	Major Penalty for each offense			1x	
<GS9>f	Duck not loaded correctly	Major Penalty for each offense			1x	
<GS9>g	Drive Team touching the Duck while Carousel in motion	Major Penalty for each offense			1x	
<GS9>h	Drive Team touching Carousel when in motion	Major Penalty for each offense			1x	

Table Key	
W: Warning	1x: Penalty at single cost
D: Robot Disabled	1x+: Penalty at single cost every 5 seconds
DQ: Disqualification	2x: Penalty at double cost
	* Indicates optional

## Appendix A – Resources

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### Game Forum Q&A

<https://ftc-qa.firstinspires.org/>

Anyone may view questions and answers within the *FIRST*® Tech Challenge game Q&A forum without a password. To submit a new question, you must have a unique Q&A system user name and password for your team.

### Volunteer Forum

Volunteers can request access to role specific volunteer forums by emailing [FTCTrainingSupport@firstinspires.org](mailto:FTCTrainingSupport@firstinspires.org). You will receive access to the forum thread specific to your role.

### FIRST Tech Challenge Game Manuals

Part 1 and 2 - <https://www.firstinspires.org/resource-library/ftc/game-and-season-info>

### FIRST Headquarters Pre-Event Support

Phone: 603-666-3906

Mon – Fri

8:30am – 5:00pm

Email: [Firsttechchallenge@firstinspires.org](mailto:Firsttechchallenge@firstinspires.org)

### FIRST Websites

*FIRST* homepage – [www.firstinspires.org](http://www.firstinspires.org)

[FIRST Tech Challenge Page](#) – For everything *FIRST* Tech Challenge.

[FIRST Tech Challenge Volunteer Resources](#) – To access public volunteer manuals.

[FIRST Tech Challenge Event Schedule](#) – Find *FIRST* Tech Challenge events in your area.

### FIRST Tech Challenge Social Media

[FIRST Tech Challenge Twitter Feed](#) - If you are on Twitter, follow the *FIRST* Tech Challenge Twitter feed for news updates.

[FIRST Tech Challenge Facebook page](#) - If you are on Facebook, follow the *FIRST* Tech Challenge page for news updates.

[FIRST Tech Challenge YouTube Channel](#) – Contains training videos, game animations, news clips, and more.

[FIRST Tech Challenge Blog](#) – Weekly articles for the *FIRST* Tech Challenge community, including outstanding volunteer recognition!

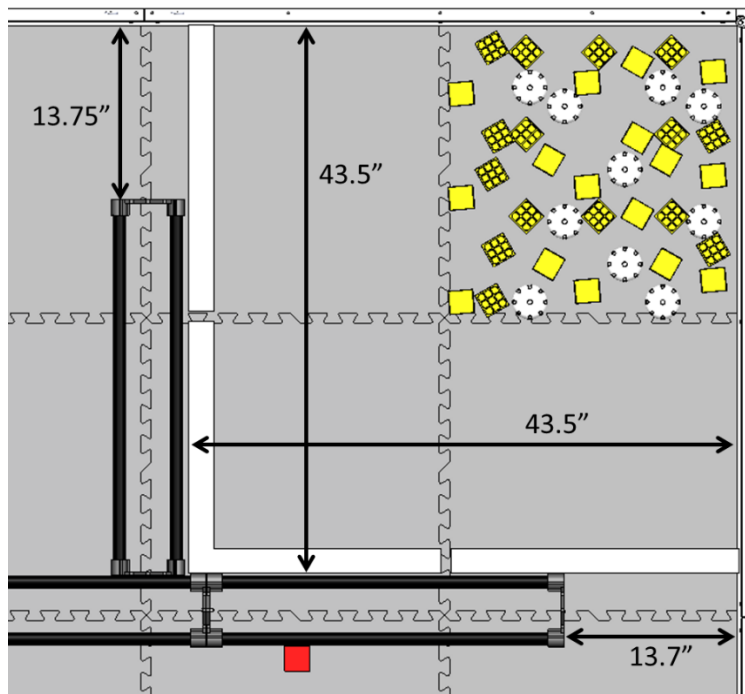
[FIRST Tech Challenge Team Email Blasts](#) – contain the most recent *FIRST* Tech Challenge news for teams.

### Feedback

We strive to create support materials that are the best they can be. If you have feedback about this manual, please email [firsttechchallenge@firstinspires.org](mailto:firsttechchallenge@firstinspires.org). Thank you!

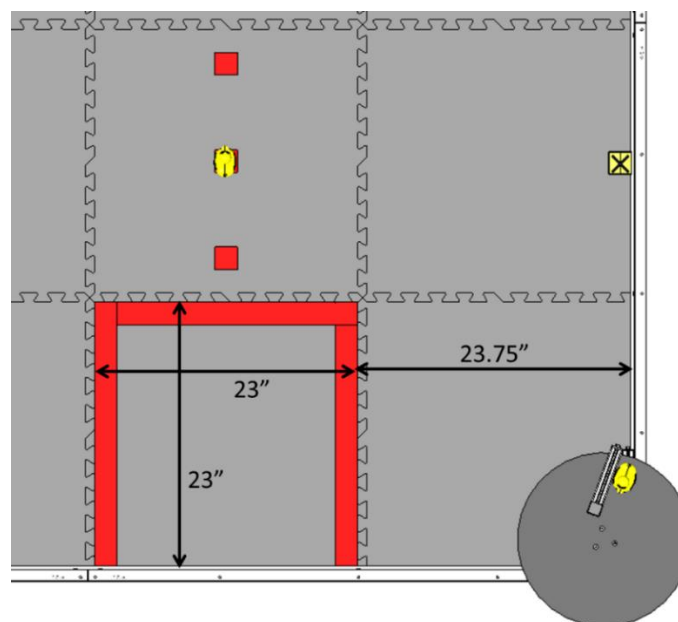


## Appendix B – Playing Field Details

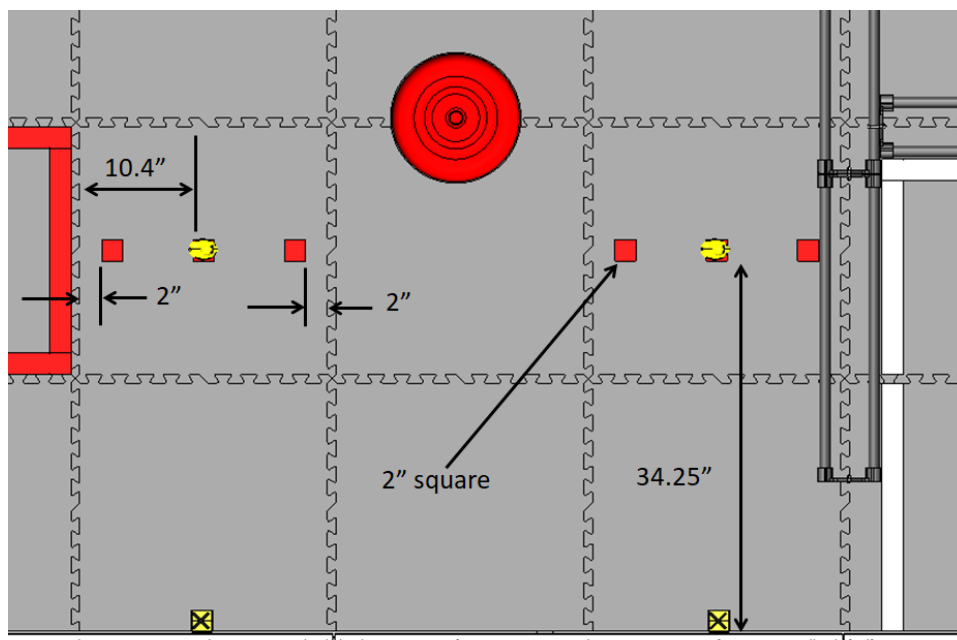
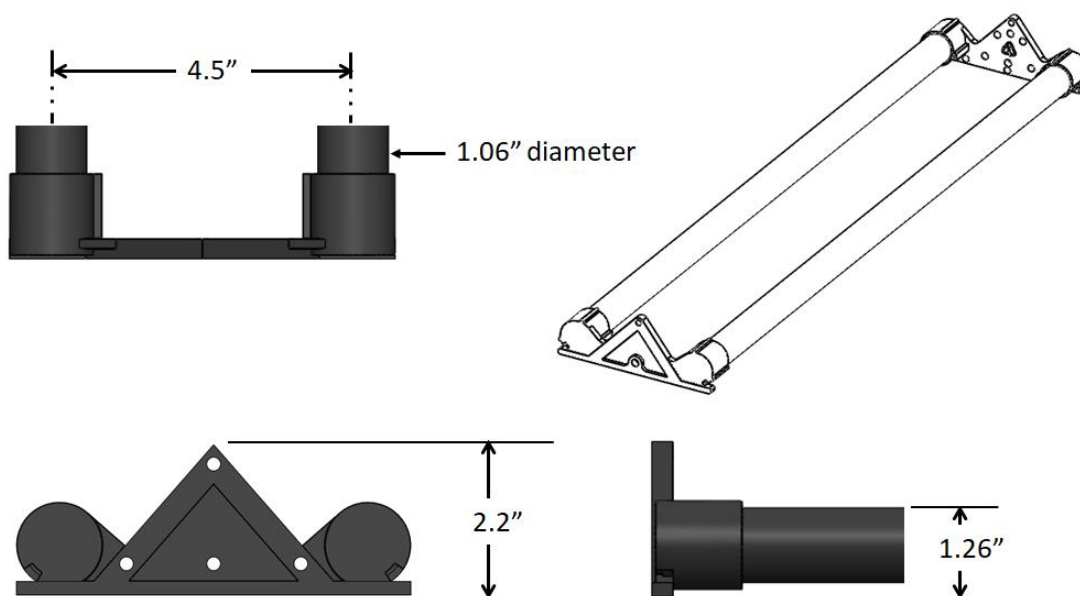


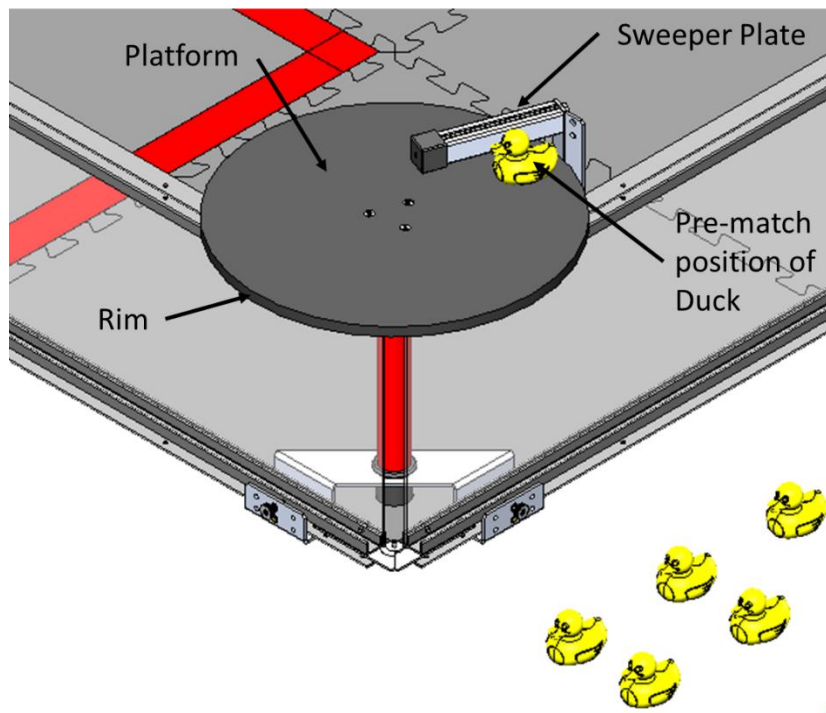
Note: Freight that is placed into the Warehouse during Pre-Match Setup will be placed Completely In the corner Tile.

### B-1 Warehouse

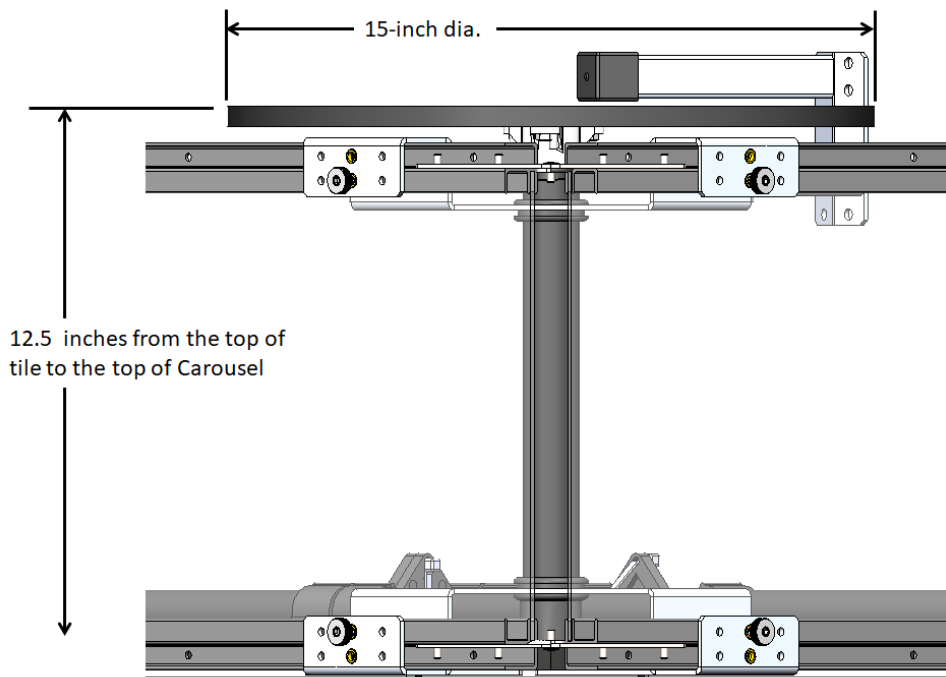


### B-2 Storage Unit

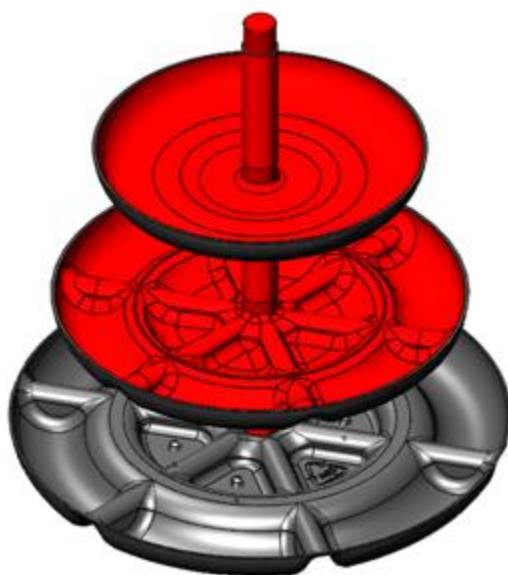
**B-3 Barcode Locations****B-4 Barrier**



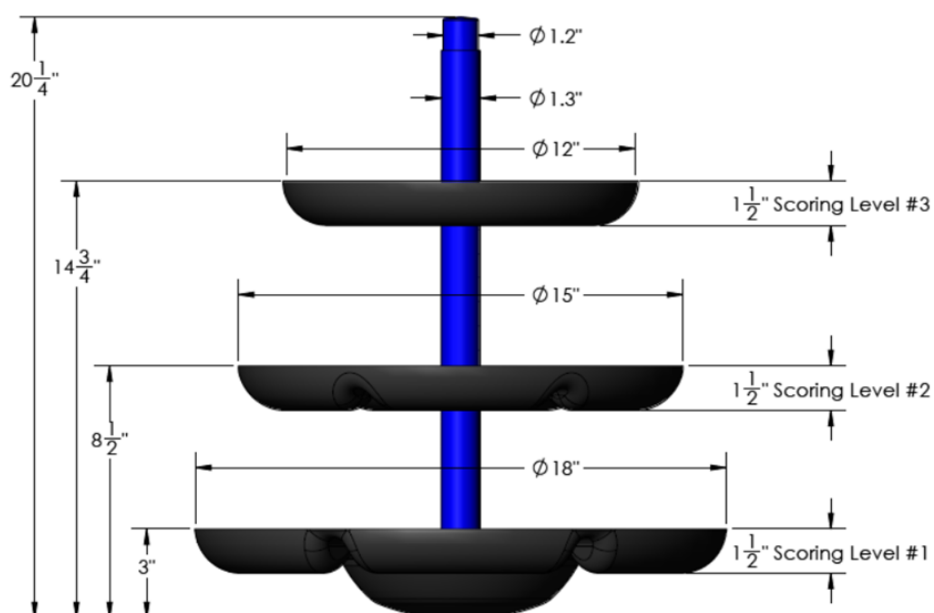
**B-5 Carousel**



**B-6 Carousel**



**B-7 Alliance Shipping Hub**

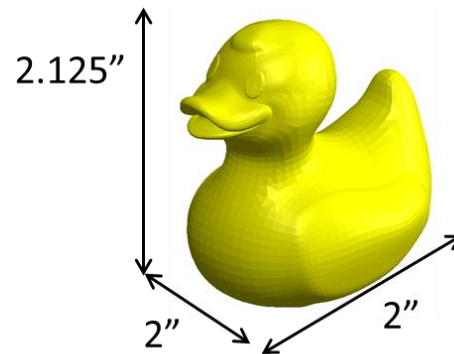


**B-8 Alliance Shipping Hub**

## Appendix C – Scoring Elements

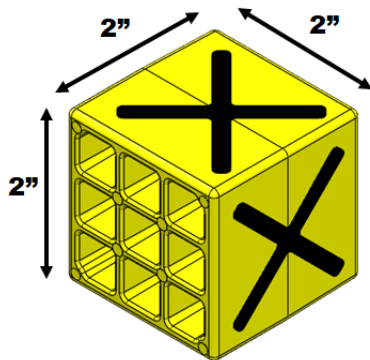


Cargo  
2.75" Diameter

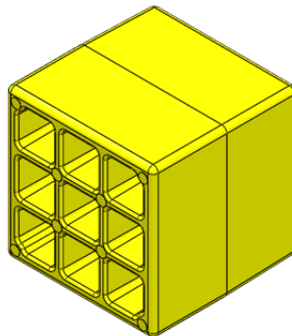


Duck

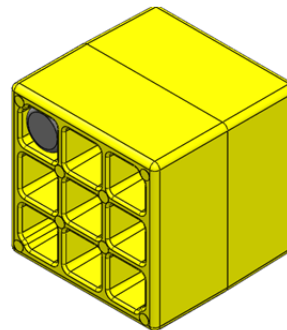
### C-1 Freight



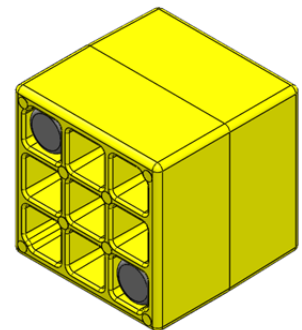
Pre-Load Box



Light Box

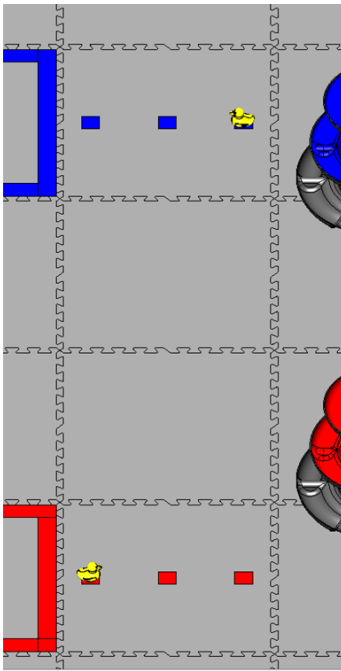


Medium Box

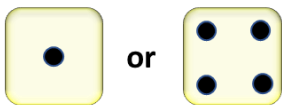


Heavy Box

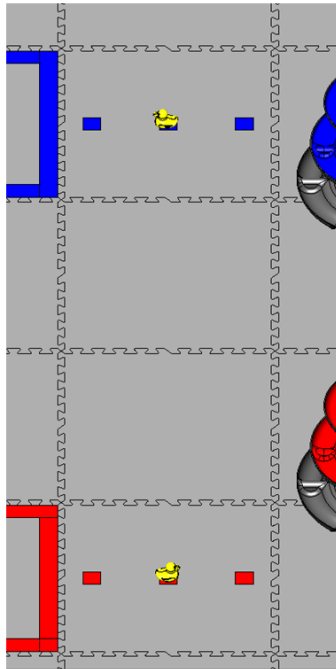
## Appendix D – Randomization



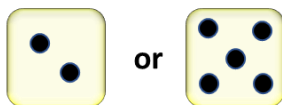
**Scoring Level 1**



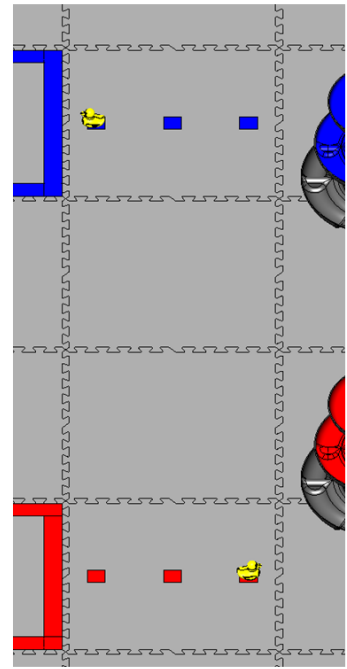
**Dice Roll**



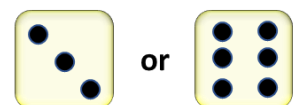
**Scoring Level 2**



**Dice Roll**



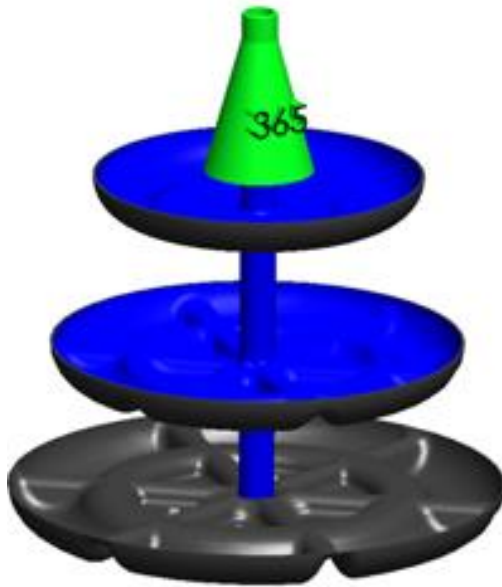
**Scoring Level 3**



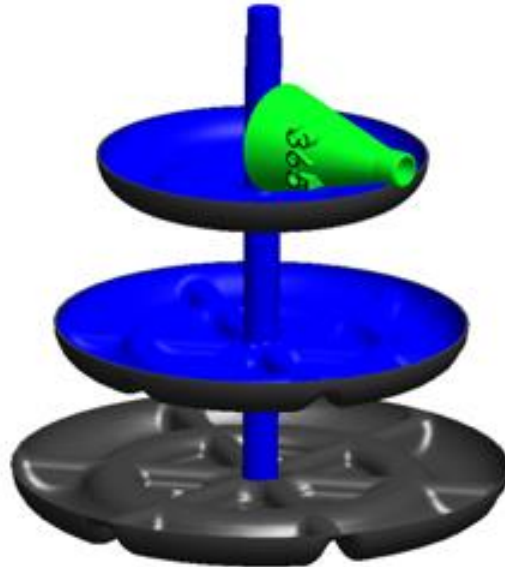
**Dice Roll**

**D-1 Orientation of the *Duck* is as shown.**

## Appendix E – Scoring Examples

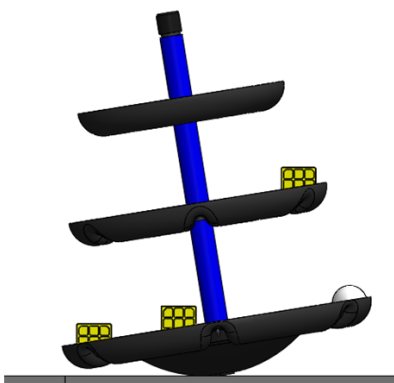


One (1) Team Shipping  
Element Scored



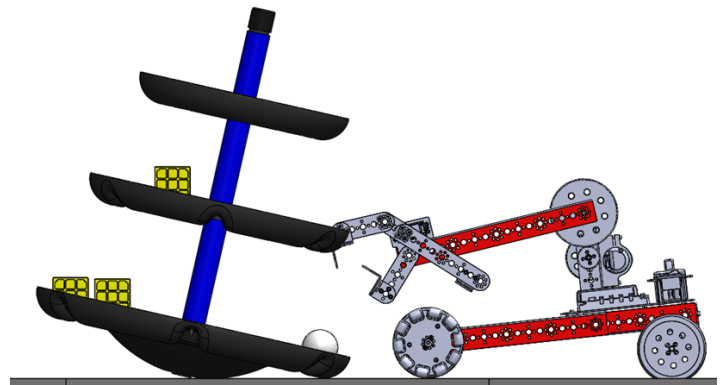
Zero (0) Team Shipping  
Elements Scored

### E-1 Team Shipping Element Scoring



*Balanced*

The rim of the Hub is not in contact with the floor

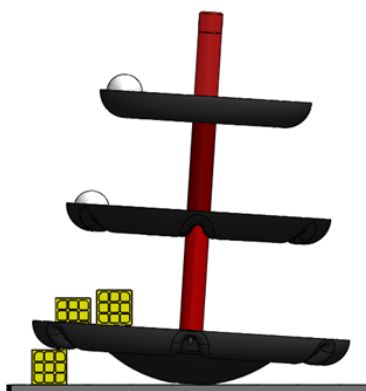


*Balanced*

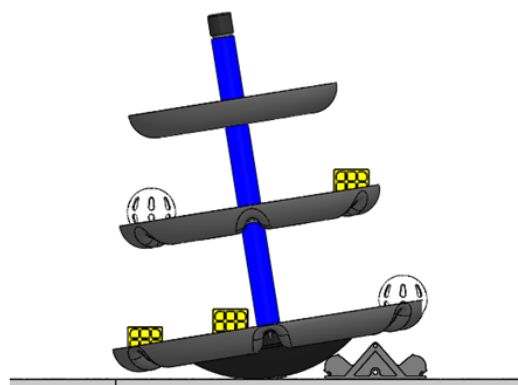
Robot in contact with opposing Alliance's Hub

### E-2 *Balanced*

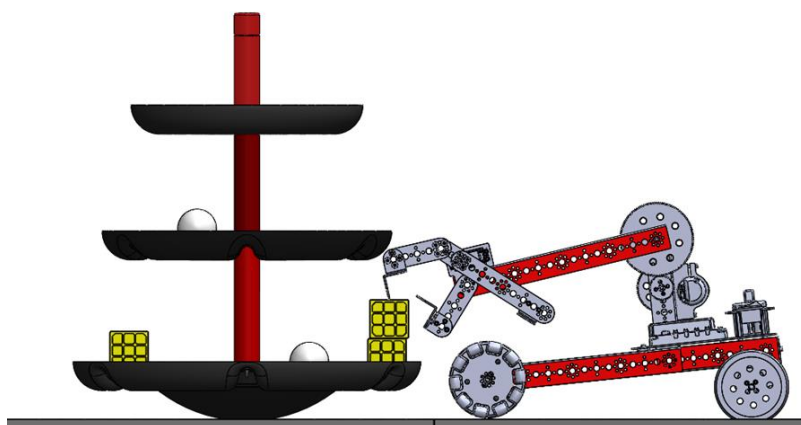




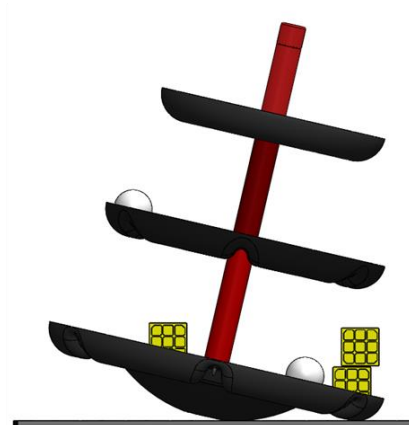
*Unbalanced*  
Hub is in Contact with Unscored Freight



*Unbalanced*  
Hub is in contact with the Barrier



*Unbalanced*  
Robot in contact with its own Shipping Hub



*Unbalanced*  
The rim of the Hub is in contact with the floor

### E-3 Unbalanced

## Appendix F – Navigation Images

Field built with blue  
*Alliance* components



**Image 1**  
Blue Alliance Wall

Field built with red  
*Alliance* components



**Image 4**  
Red Alliance Wall



**Image 2**  
Audience Wall  
Blue Side



**Image 3**  
Audience Wall  
Red Side

Image 1 - The center of the image is on the *Playing Field Wall* closest to the blue *Alliance Station* and is aligned to the center of the fourth *Tile* in from the *Playing Field Wall* closest to the audience.

Image 2 - The center of the image is on the *Playing Field Wall* closest to the *Audience* and is aligned to the center of the second *Tile* in from the blue *Alliance Station*.

Image 3 - The center of the image is on the *Playing Field Wall* closest to the *Audience* and is aligned to the center of the second *Tile* in from the red *Alliance Station*.

Image 4 - The center of the image is on the *Playing Field Wall* closest to the red *Alliance Station* and is aligned to the center of the fourth *Tile* in from the *Playing Field Wall* closest to the audience.

**Do not print the images from this manual for practice purposes, as they are not to the same scale as *Teams* will see in actual competition. Please refer to the [website](#) for printable versions of these images.**