ROBOTICS EDUCATION &
COMPETITION FOUNDATION

Presents:

Mobile Robotics Technology
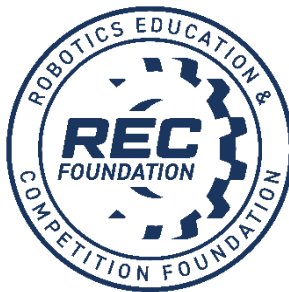**Game Manual**
Post-Secondary Teams
2021-2022

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OVERVIEW

Students who participate in Mobile Robotics Technology engage in the Engineering Process and demonstrate their ability to keep and maintain an engineering notebook. Students will be judged based on their robot in design, construction, and programming, along with the quality of their notebook, and their ability to communicate their design process to the judges. Students will show the result of their preparation by performing tasks in both autonomous and driver control functions. The game that will be played is an adaptation of the VRC Tipping Point Robot Skills Challenge. Students can participate in both VRC and SkillsUSA using the same robot and engineering notebook. The key difference is that SkillsUSA focuses on the ability of students to create a robot that performs exceptionally at a given task, whereas VRC is a teamwork-based program that focuses on collaborating with other teams along with game strategy in a tournament structure of competition. Students in SkillsUSA should focus on designing, building and programming a robot to perform well, knowing that there are no other robots on the field that may help their robot or might get in the way.

ELIGIBILITY

Open to a team of two active SkillsUSA members enrolled in a coherent series of courses or a career major that prepares them for further education and/or employment related to technology, the health industry, trades or industry. College/postsecondary contestants must be earning credit toward a postsecondary degree/certificate during the school year immediately preceding the National Leadership and Skills Conference.

CLOTHING REQUIREMENT

Class E: Contest specific – Business Casual

For men: Official SkillsUSA white polo shirt, black dress slacks, black socks, black leather shoes.

For women: Official SkillsUSA white polo shirt with black dress skirt (knee-length) or black slacks; black socks or black or skin-tone seamless hose; black leather dress shoes. These regulations refer to clothing items that are pictured and described at: www.skillsusastore.org. If you have questions about clothing or other logo items, call (800) 401-1560 or (703) 956-3723.

THE GAME

A Primer

VEX Robotics Competition Tipping Point is played on a 12'x12' square field configured as seen below.

In this challenge, Teams will compete in two-minute (2:00) long Matches in an effort to score as many points as possible. These Matches consist of Driving Skills Matches, which will be entirely driver controlled, and Programming Skills Matches, which will be autonomous with limited human interaction. Teams will be ranked based on their combined score in the two types of Matches.

The VEX GPS code strip will be installed on the field for both types of Matches.

The object of the game is to attain a higher score than the opposing teams by Scoring Rings, moving Mobile Goals to Alliance Home Zones, and by Elevating on Platforms at the end of a Match.
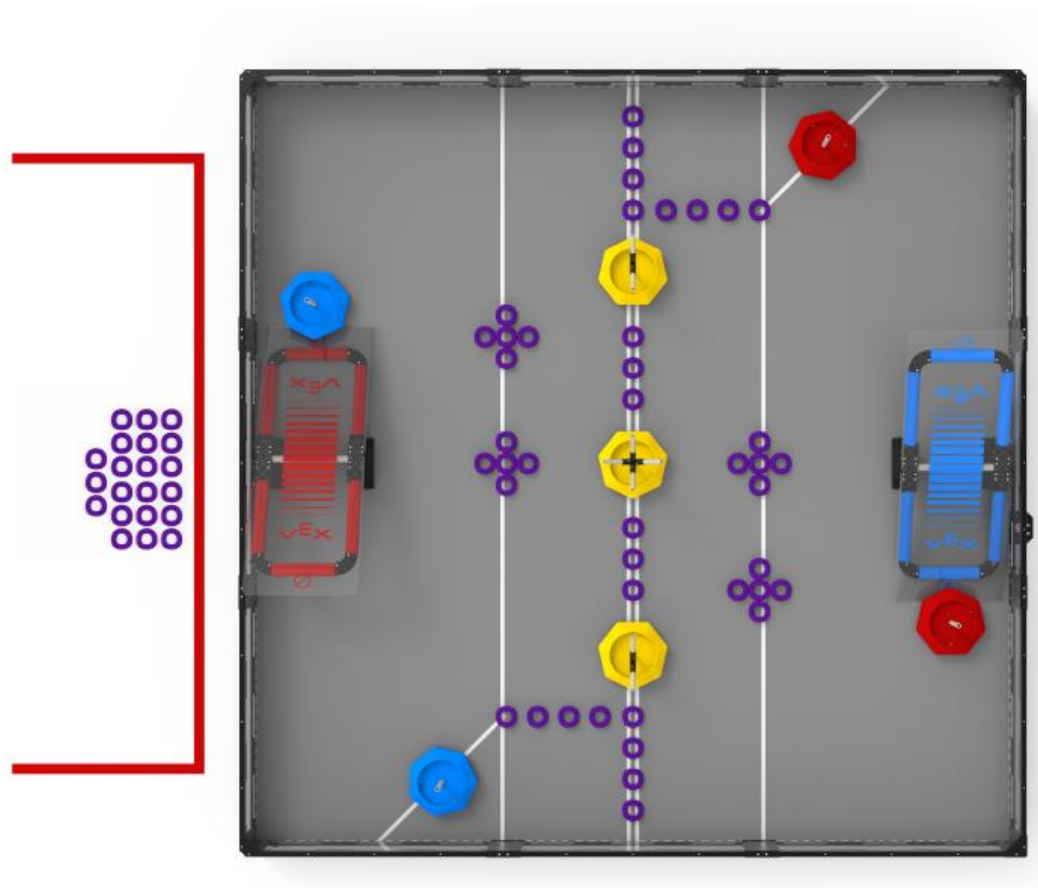

Figure 1: Initial setup configuration. Exact ball placement on the field will be reveled at the SkillsUSA NLSC Orientation Meeting.

Game Definitions

Adult – Anyone who is not a student.

Alliance Home Zone - One of two (2) areas of gray foam tiles, one (1) for each Alliance, where Robots begin the Match and defines the location where Mobile Goals can be Scored. Red Mobile Goals are Scored in the Red Alliance Home Zone, Blue Mobile Goals are Scored in the Blue Alliance Home Zone, and Neutral Mobile Goals can be scored in either the Red or Blue Alliance Home Zone.

- The Alliance Home Zones are defined by the inner edges of the playing field walls and the designated white tape lines.
- The tape is considered to be part of the Alliance Home Zone.
- The Alliance Home Zones are a 3-dimensional volume, defined by the infinite upward projection from the foam tiles inside of the Alliance Home Zone boundaries.
- The Platforms are considered part of their respective Alliance Home Zone.
- Teams play as a neutral Alliance and score for both Red and Blue, but will start the match in the Red Alliance Home Zone.
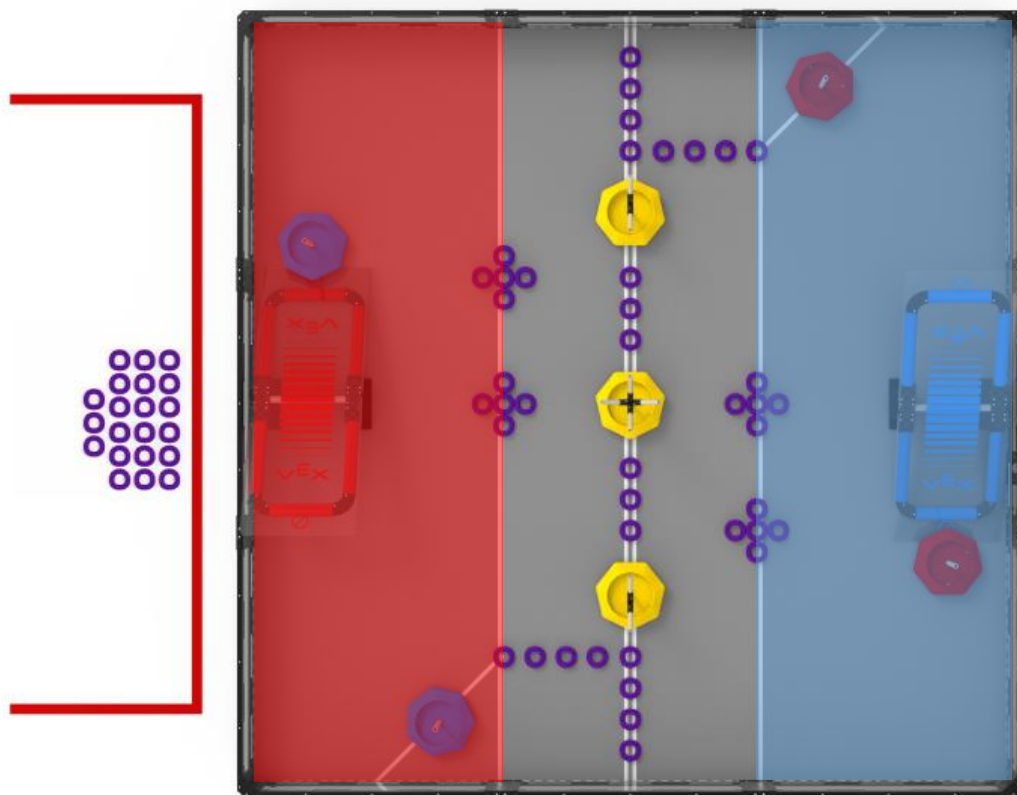
Alliance Station – The designated region where the Drive Team Members must remain for the duration of the Match.
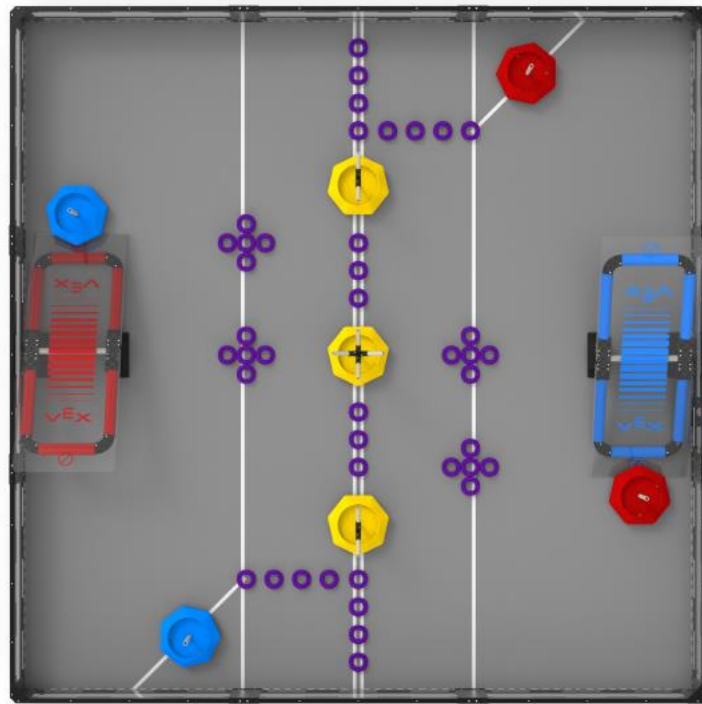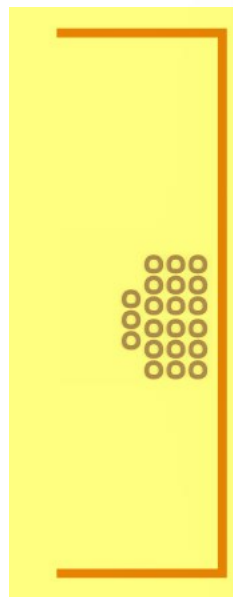
Balanced - A Platform state. A Platform is considered Balanced if all of the following criteria are met at the end of a Match:

1. The Platform is roughly parallel to the field.
2. Both flat surfaces of the Platform hinges are contacting the Platform base, as shown below.
3. Robots and / or Scoring Objects contacting the Platform in their Alliance Home Zone are not also contacting any other Field Elements, such as foam field tiles or the field perimeter.
    a. For the purposes of this definition, contact is considered "transitive" through Scoring Objects. For example, as shown below, contact with a Mobile Goal that is resting on top of the field perimeter would not satisfy the definition of Balanced.
    b. As stated in rule <G18>, a Match ends once all Robots, Field Elements, and Scoring Objects have come to rest, including Platforms.
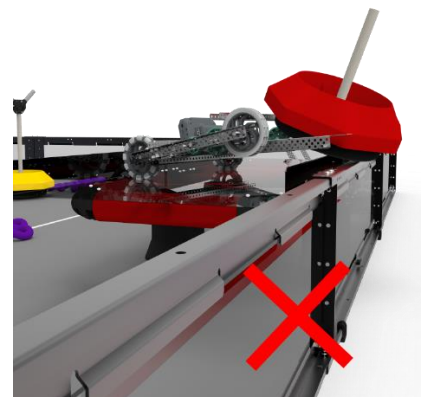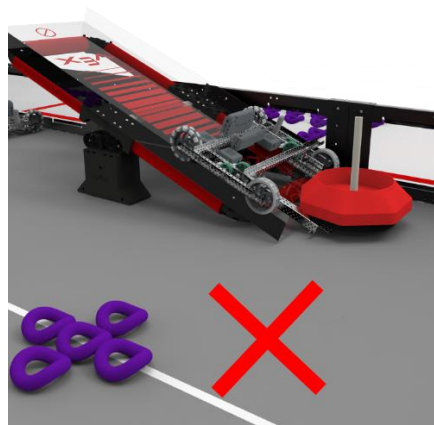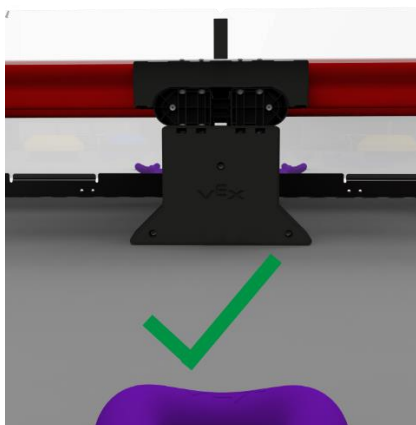
Builder – The Student(s) on the Team who assemble(s) the Robot. An Adult cannot be the Builder on a Team. Adult are permitted to teach the Builder associated concepts but may never be working on the Robot without the Builder present and actively participating.

Designer – The Student(s) on the Team who design(s) the Robot to be built for competition. An Adult cannot be the Designer on a Team. Adults are permitted to teach the Designer associated concepts but may never be working on the design of the Robot without the Designer present and actively participating.

Disablement – A penalty applied to a Team for a rule violation. A Team that is Disabled is not allowed to operate their Robot for the remainder of the Match, and the Drive Team Members will be asked to place their controller(s) on the ground.

Disqualification – A penalty applied to a Team for a rule violation. Teams that are disqualified in a match receive a score of zero for the match.

Drive Team Member(s) – A Student who stands in the Alliance Station during a match. Only Drive Team Members are permitted to stand in the Alliance Station and allowed to touch the controls during the Match or interact with the Robot. Adults are not allowed to be Drive Team Members.

Elevated - A Robot and / or Mobile Goal state. A Robot or Mobile Goal is considered Elevated if all of the following criteria are met at the end of a Match:

1. The Robot or Mobile Goal is contacting their Alliance Platform.
2. The Platform meets the definition of Balanced.
3. The Robot or Mobile Goal is not contacting any other Field Element, such as the foam field tiles or the field perimeter.
   a. For the purposes of this definition, contact is considered "transitive" through other Robots and Scoring Objects. For example, as shown in Figure 10, contact with a Mobile Goal that is contacting a field tile would not satisfy the definition of Elevated.
   b. For the purposes of this definition, any Mobile Goals that are in Possession of an Elevated Robot are also considered Elevated. See below for more information
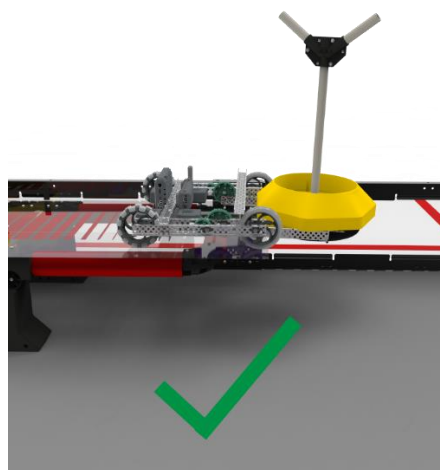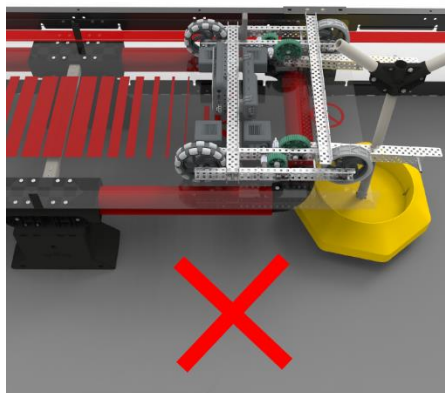
**Field Element** – The foam field tiles, field perimeter, white tape, Goal, and all supporting structures or accessories (such as driver station posts, field monitors, etc.).

Match Affecting – A rule violation status determined by the head referee. A rule violation is Match Affecting if it changes the winning and losing Alliances in the Match. Multiple rule violations within a Match can cumulatively become Match Affecting.

Match Load Rings - The eighteen (18) Rings, nine (9) per Alliance, that begin the Match in an Alliance Station and may be introduced during the Match.

Mobile Goal - One of the seven (7) large Scoring Objects made up of a Mobile Goal Base and Mobile Goal Branch(es). All Mobile Goals have a maximal base diameter of 13" (330.2mm).

- **Alliance Mobile Goal** - The two (2) red and two (2) blue Mobile Goals which begin each Match in their respective Alliance Home Zones and have only one Mobile Goal Branch. Alliance Mobile Goals weigh approximately 1,520 grams.
- **Neutral Mobile Goal** - The three (3) yellow Mobile Goals which begin each Match in the Neutral Zone and have two (2) or four (4) Mobile Goal Branches. The 2-branch Mobile Goal weighs approximately 1,560 grams, and the 4-branch Mobile Goal weighs approximately 1,810 grams.
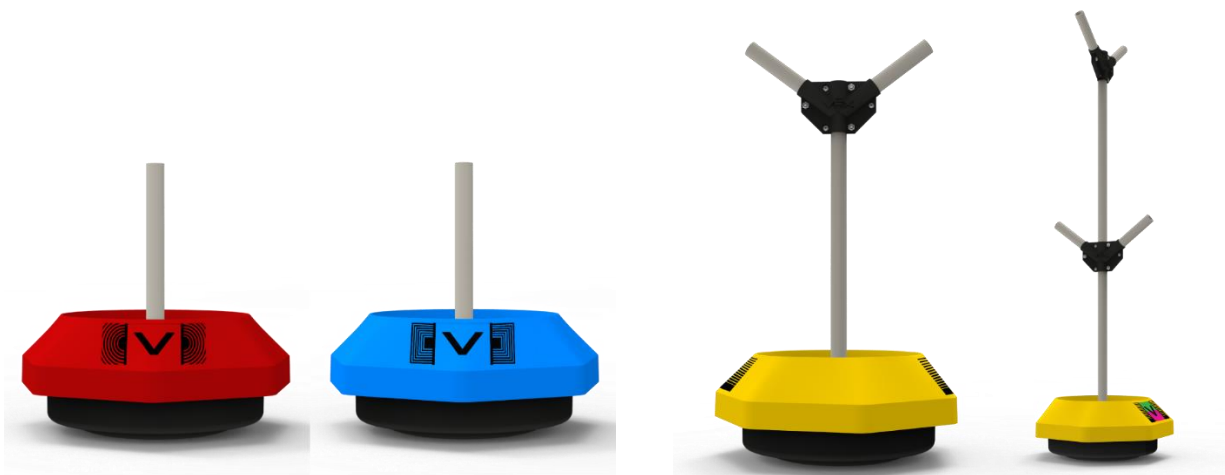
Mobile Goal Base - The 7-sided plastic bottom of a Mobile Goal with a maximal diameter of 13" (330.2mm). Rings may be Scored in the "bowl" of a Mobile Goal Base for points. Both the yellow, blue, or red "upper" portion, and the black "lower" portion, are considered parts of the Mobile Goal Base.

Mobile Goal Branch - The gray PVC pipes, 0.84" (21.3mm) in diameter, that extend vertically out of a Mobile Goal Base. Rings may be Scored on Mobile Goal Branches for points.
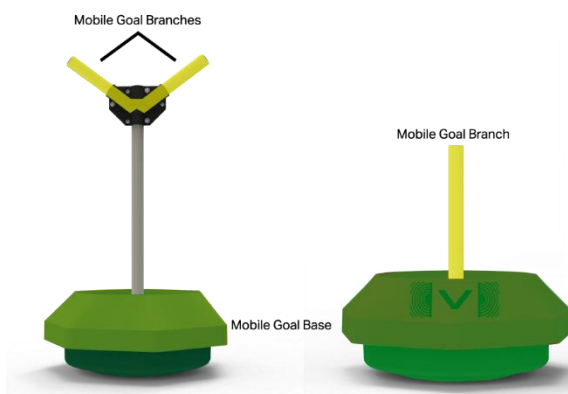
Neutral Zone - The area of the field in which all three Neutral Mobile Goals begin.

- The Neutral Zone is bounded by the inner edges of the playing field walls, and the single tape lines which run the length of the field.
- The Neutral Zone is defined as the gray foam tiles themselves; it is not a 3-dimensional volume
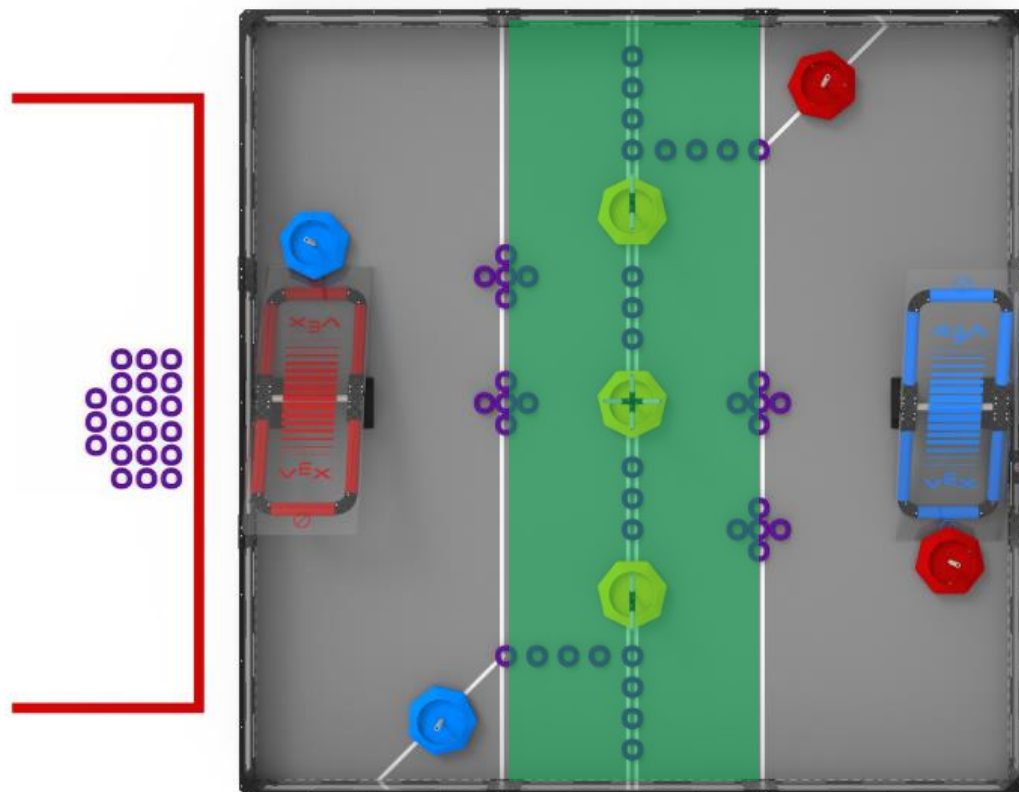
Platform - The 53.0" x 20.1" (1,346.2mm x 511mm) hinged polycarbonate device and the attached red or blue PVC pipes (highlighted below in Figure 17), located in each Alliance Home Zone, that sits 9.5" (241.5mm) high off of the ground when Balanced. The Platform is attached to a double hinge that allows it to tip towards the field in either direction.
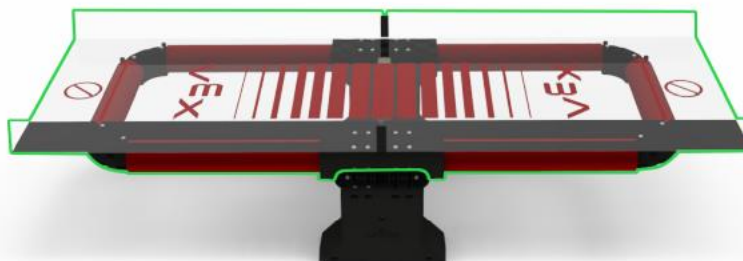
Preload– The Rings, (3) per Robot, placed prior to the start of each Match. If used, these Rings must be placed such that they satisfy the conditions in <SG1>.

Programmer – The Student(s) on the Team who write(s) the computer code that is downloaded onto the Robot. An Adult cannot be the Programmer on a Team. Adults are permitted to teach the Programmer associated concepts but may never be working on the code that goes on the Robot without the Programmer present and actively participating.

Ring - One of seventy-two (72) small Scoring Objects. Rings have a maximal outer diameter of 4.125" (104.8mm) and a minimal inner diameter of 2" (50.8mm).

Robot – A machine that has passed inspection, designed to execute one or more tasks autonomously and/or by remote control from a human operator.

Scored - A Ring, Mobile Goal, Robot, and / or Platform State. See the "Scoring" section for more details.

Scoring Object - A Ring or Mobile Goal.

Student – Any eligible SkillsUSA member in Post-Secondary education. Students are the individuals who design, build, repair, and program the *Robot* with minimal *Adult* assistance.

Skills Match – A Driving Skills Match or Programming Skills Match.

- **Driving Skills Match** – A Driver Controlled period that is two minutes (2:00) long with the team's two (2) Robots on the Field.
- **Programming Skills Match** – An Autonomous period that is two minutes (2:00) long with the team's two (2) Robot on the Field.

Team – Two Students make up a *Team*.
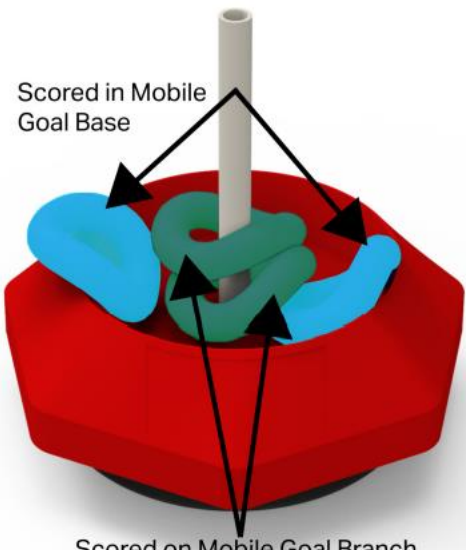
Scoring
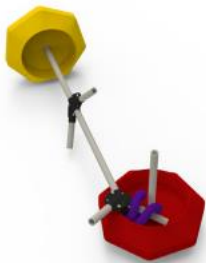
Ring on / in a *Scored* Mobile Goal	*Mobile Goal* High Branch	10 Points
	Any other *Mobile Goal Branch*	3 Points
	Mobile Goal Base	1 Point
Neutral Mobile Goal	Either *Alliance's* Home Zone	20 Points
	Elevated on a *Balanced Platform*	40 Points
Alliance Mobile Goal	Correct *Alliance's* Home Zone	20 Points
	Elevated on correct *Alliance's Balanced Platform*	40 Points
Robot	*Elevated* on correct *Alliance's Balanced Platform*	30 Points
Alliance	Wins *Autonomous Bonus*	6 Points

	Each *Ring* which is *Scored* on a *Neutral Mobile Goal* High Branch is worth ten (10) points.
	Each *Ring* which is *Scored* on any other *Mobile Goal Branch* is worth three (3) points.
	Each *Ring* which is *Scored* in a *Mobile Goal Base* is worth one (1) point.

	Each *Mobile Goal* that is *Scored* in an *Alliance Home Zone* is worth twenty (20) points for that *Alliance*.
	That *Alliance* also receives the points for any *Rings* which are *Scored* on or in that *Mobile Goal*.
	Each *Robot* which is *Elevated* on an *Alliance's Balanced Platform* is worth thirty (30) points for that *Alliance*.
	Each *Mobile Goal* which is *Elevated* on an *Alliance's Balanced Platform* is worth forty (40) points for that *Alliance*.

Scoring Details

1. *Rings* can be *Scored* in *Mobile Goal Bases*, or on *Mobile Goal Branches*. In order to be considered *Scored* in either position, a *Ring* must first meet the following prerequisite criteria:
   - Not contacting a *Robot* of the same color *Alliance* for which the *Rings* would receive points
   - Not contacting any *Field Elements*, such as gray foam field tiles, the *Platform*, or the field perimeter
   - Not contacting any *Rings* which are not considered *Scored* (i.e. *Rings* which are contacting a *Robot* or a *Field Element*)

2a. To be considered *Scored* in a *Mobile Goal Base*, a *Ring* must:
   - Meet the prerequisite definition of *Scored* in Note 1
   - Be contacting either
     - The colored portion of a *Mobile Goal Base*, or
     - Another *Ring* which is considered *Scored* in a *Mobile Goal Base*

2b. To be considered *Scored* on a *Mobile Goal Branch*, a *Ring* must:
   - Meet the prerequisite definition of *Scored* in Note 1
   - Also be "encircling" a *Mobile Goal Branch*
   - In this context, "encircling" means that any part of the *Mobile Goal Branch* is at least partially within the volume defined by the outer edges of the *Ring*

2c. *Rings* may only count for points once, i.e. in one *Mobile Goal Base* or on one *Mobile Goal Branch*.
   - If a *Ring* meets the definitions of *Scored* for multiple point values on the same *Mobile Goal*, the highest point value should be used.
   - Both of the blue *Rings* in the figure to the left would be considered *Scored* in the *Mobile Goal Base*
   - Both of the green *Rings* in the figure to the left would be considered *Scored* on the *Mobile Goal Branch*

2d. In the event that a *Ring* meets the definition of *Scored* for more than one *Mobile Goal*, such as in the figure to the left, the *Ring* will not count for any points.
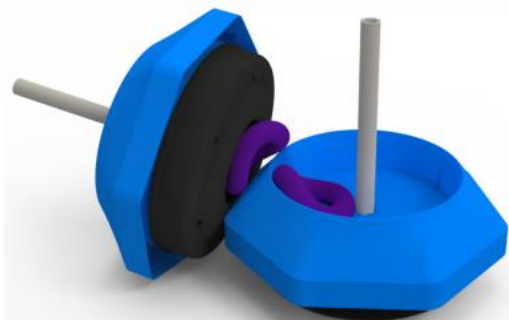
Scoring Figure 1: Both Rings would be considered Scored, as neither Ring is contacting a Robot, Field Element or Ring that is not considered Scored. Both are contacting the colored portion of a Mobile Goal Base, and only meet the definition of Scored for one Mobile Goal.
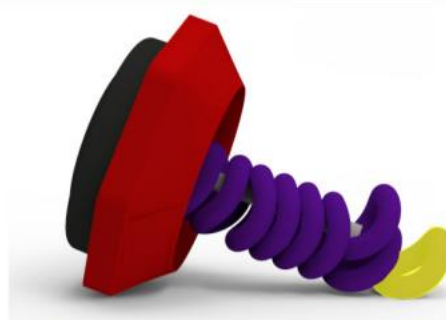
Scoring Figure 2: None of the Rings in this image would be considered Scored. The highlighted Ring is contacting the floor, causing it to not be Scored. The next Ring is contacting the highlighted Ring, therefore causing it to not be Scored, and so on.

Scoring Figure 3: All three highlighted Rings would be considered Scored. None of the other Rings would count as Scored, for the same reasons listed in Scoring Figure 2.
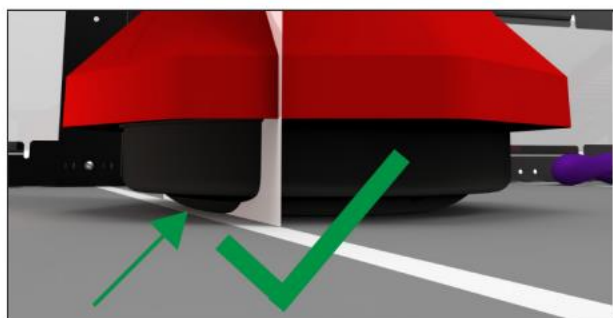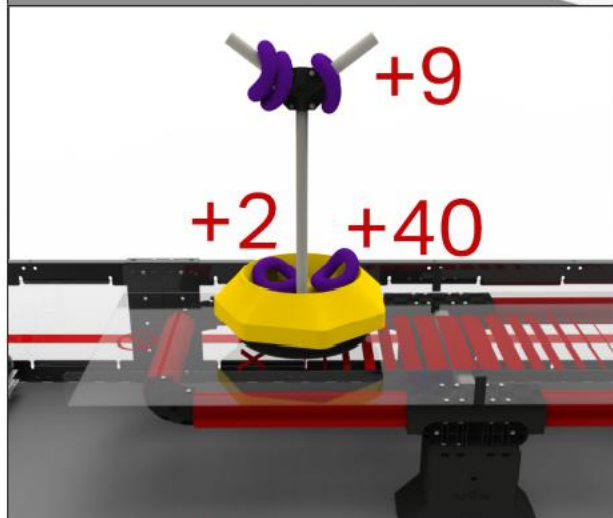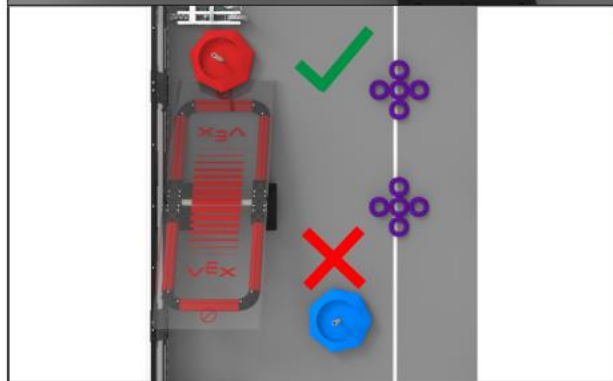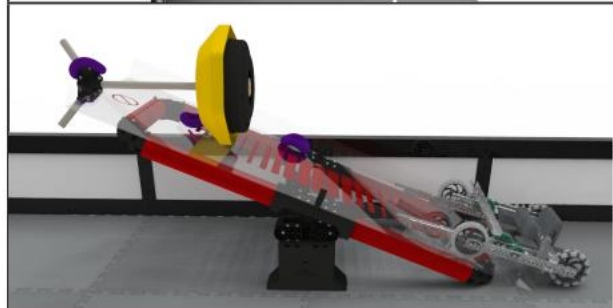
Scoring Figure 4: All of these Rings would be considered Scored, as they are all fully or partially encircling the Mobile Goal Branch.
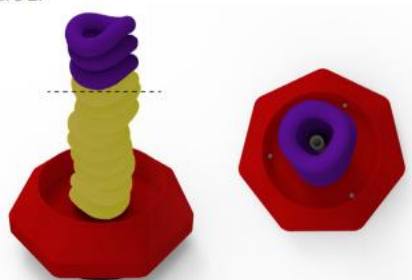
Scoring Figure 5: Only the highlighted Rings would be considered Scored, as they are the only ones fully or partially encircling the Mobile Goal Branch.

Note: In Scoring Figure 5, none of the rings would count as scored if they ended in that configuration, because a ring that touches a non-scored ring is not counted as scored. The figure is meant to show which rings are encircling the post and would be scored if they were the only ones present.

3. A *Mobile Goal* is considered *Scored* in an *Alliance Home Zone* if, at the end of the *Match*, any part of the *Mobile Goal Base* is at least partially within the *Alliance Home Zone* (i.e. "breaking the plane" of the Zone).

4. *Rings* which are *Scored* on or in an *Elevated Mobile Goal* count for points for the *Alliance* who is *Elevating* the *Mobile Goal*.
   a. An *Elevated Mobile Goal* does not also receive points for being *Scored* in an *Alliance Home Zone*.

   The example shown here would be worth 51 points for the Red *Alliance*.
   - Forty (40) points for the *Elevated Mobile Goal*
   - Two (2) points for the two (2) *Scored Rings* in the *Mobile Goal Base*
   - Nine (9) points for the three (3) *Scored Rings* on the *Mobile Goal Branches*

5. *Alliance Mobile Goals* only count for points when *Scored* in the same color *Alliance Home Zone*. *Alliance Mobile Goals* which end the *Match* anywhere other than their corresponding *Alliance Home Zone* or *Platform* are not worth any points for either *Alliance*.
   a. *Rings* which are *Scored* on / in an *Alliance Mobile Goal* are worth points for that color *Alliance*, regardless of where the *Alliance Mobile Goal* ends the *Match*.

6. Contact with foam tiles, *Platforms*, and / or *Robots* does not affect whether a *Mobile Goal* is considered *Scored*. Contact is only relevant when determining whether a *Mobile Goal* is *Elevated* (see the definition of *Elevated* for more information). In this particular example, the *Mobile Goal* would not be considered *Elevated*, but would still be considered as *Scored*.

Safety Rules

<S1> Be safe out there. If at any time the Robot operation or Team actions are deemed unsafe or have damaged any Field Elements or Game Objects, the offending Team may be Disabled and/or Disqualified at the discretion of the Head Referee. The Robot will require re-inspection before it may again take the field.

<S2> Stay inside the field. If a Robot is completely out-of-bounds (outside the playing field), it will be Disabled for the remainder of the Match.

> **Note:** The intent is NOT to penalize Robots for having mechanisms that inadvertently cross the field perimeter during normal game play.

<S3> Wear safety glasses. All Drive Team Members must wear safety glasses or glasses with side shields while in the Alliance Stations during Matches and while in the pit area when handling a robot. Safety glasses do not need to be worn when writing the computer code or working on the Engineering Notebook.

General Game Rules

<G1> Treat everyone with respect. All Teams are expected to conduct themselves in a respectful and professional manner while competing in VEX Robotics Competition events including Mobile Robotics Technology. If a Team or any of its members (Students or any adults associated with the Team) are disrespectful or uncivil to event staff, volunteers, or fellow competitors, they may be Disqualified from a current or upcoming Match. Team conduct pertaining to <G1> may also impact a team's eligibility for judged awards. Repeated or extreme violations of <G1> could result in a Team being Disqualified from an entire event, depending on the severity of the situation.

This rule exists alongside the REC Foundation Code of Conduct. Violation of the Code of Conduct can be considered a violation of <G1> and can result in Disqualification from a current Match, an upcoming Match, an entire event, or (in extreme cases) an entire competition season. The Code of Conduct can be found at https://www.roboticseducation.org/competition-teams/vex-roboticscompetition/ .

<G2> VRC is a student-centered program. Adults may assist Students in urgent situations when preparing for events, but adults should never work on or program a Robot without Students on that Team being present and actively participating. Students should be prepared to demonstrate an active understanding of their Robot's construction and programming to judges or event staff. During the competitive events, Adults may not touch or program the Robot for any reason.

<G3> Use common sense. When reading and applying the various rules in this document, please remember that common sense always applies in VEX Robotics Competitions including the Mobile Robotics Technology Competition.

<G4> Robots begin the Match in the starting volume. At the beginning of a Match, each Robot must be smaller than a volume of 18" (457.2 mm) long by 18" (457.2 mm) wide by 18" (457.2 mm) tall. Using Field Elements, such as the field perimeter wall, to maintain starting size is only acceptable if the Robot would still satisfy the constraints of <RE4> and pass inspection without the Field Element. Robots in violation of this limit will be removed from the field prior to the start of the Match, at the Head Referee's discretion.

<G5> Keep your Robots together. Robots may not intentionally detach parts during the Match or leave mechanisms on the field.

Minor violations of this rule that do not affect the Match will result in a warning. Match Affecting offenses will result in a Disqualification. Teams that receive multiple warnings may also receive a Disqualification at the Head Referee's discretion. Multiple intentional infractions may result in Disqualification for the entire competition.

<G6> Drive your own Robot. Each Team shall include up to two (2) Drive Team Members. No Drive Team Member may fulfill this role for more than one Team in a given competition season.

<G7> Only Drivers, and only in the Alliance Station. During a Match, each Team may have up to two (2) Drive Team Members in their Alliance Station and all Drive Team Members must remain in their Alliance Station for the duration of the Match. Drive Team Members are not allowed to use any sort of communication devices while in the Alliance Station. Devices with communication features turned off (e.g., a phone in airplane mode) are allowed.

> **Note 1:** Drive Team Members are the only Team members that are allowed to be in the Alliance Station during a Match. Violations will result in a Disqualification for that Match.

> **Note 2:** During a Match, Robots may be operated only by the Drive Team Members and/or by software running on the Robot's control system. Violations or refusal will result in a Disqualification for that Match.

<G8> N/A

<G9> Hands out of the field. Drive Team Members may only touch the Team's controls at specified times during a Match. Drive Team Members are prohibited from making intentional contact with any Game Object, Field Element, or Robot during a Match.

Drive Team Members are not permitted to break the plane of the field perimeter at any time during the Match.

Minor violations of these rules that do not affect the Match will result in a warning. Match Affecting offenses will result in a Disqualification. Teams that receive multiple warnings may also receive a Disqualification at the Head Referee's discretion.

> **Note:** Any concerns regarding the Ball(s) starting positions should be raised with the Head Referee prior to the Match; Team members may never adjust the Balls or Field Elements themselves.

<G10> Autonomous means "no humans". During the Programming Challenge Match, Drive Team Members are not permitted to interact with the Robot in any way, directly or indirectly. This could include, but is not limited to:

- Activating any controls on their VEXnet Joysticks or V5 Controllers.
- Unplugging or disconnecting from the field in any way.
- Triggering sensors (including the Vision Sensor) in any way, even without touching them.

Violations of this rule would result in a Disqualification.

<G11> N/A

<G12> N/A

<G13> N/A

<G14> N/A

<G15> N/A

<G16> Don't clamp your Robot to the field. Robots may not intentionally grasp, grapple or attach to any Field Elements. Strategies with mechanisms that react against multiple sides of a Field Element in an effort to latch or clamp onto said Field Element are prohibited. The intent of this rule is to prevent Teams from both unintentionally damaging the field and/or from anchoring themselves to the field.

Minor violations of this rule that do not affect the Match will result in a warning. Match Affecting offenses will result in a Disqualification. Teams that receive multiple warnings may also receive a Disqualification at the Head Referee's discretion.

<G17> Let go of Game Objects after the Match. Robots must be designed to permit easy removal of Game Objects from any mechanism without requiring the Robot to have power after a Match.

<G18> It's not over until it's over. Scores will be calculated for all Matches immediately after the Match, once all Game Objects, Field Elements, and Robots on the field come to rest.

<G19> Be prepared for minor field variance. Field Element tolerances may vary from nominal by ±1.0", unless otherwise specified. Ring weights may vary from nominal to ±5 grams. Mobile Goal weights may vary from nominal to ±65 grams respectively. Teams are encouraged to design their Robots accordingly.

- Scoring Object placement at the beginning of Matches may vary from nominal to ±1.5".
- The rotation of Scoring Objects may vary from nominal to ±20°. Rings should always be oriented such that the "raised" portions are parallel to the Platforms. Mobile Goals should always be oriented such that the vision target found on the "point" of the heptagon Base resembles as shown below. (Red and Blue Mobile Goals are reversed in the diagram)
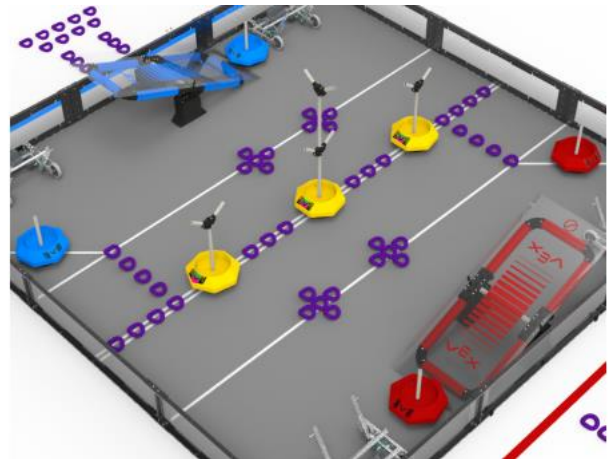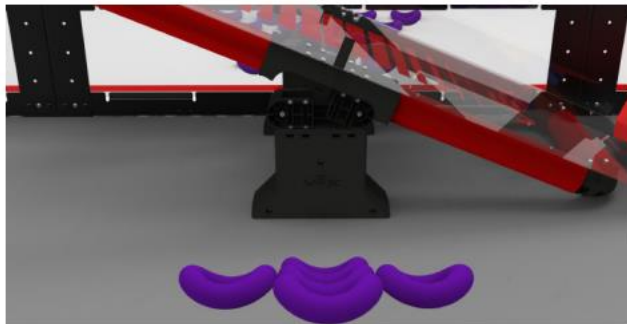
> **Note:** The field perimeter should always be resting upon the Field Perimeter Rubber Feet, regardless of whether or not the tabs have been cut from the foam field tiles.

<G20> Replays are allowed, but rare. Replays are at the discretion of the Event Partner and Head Referee and will only be issued in the most extreme circumstances.

<G21> N/A

<G22> N/A

VRC Tipping Point Specific Game Rules

<SG1>Starting a Match. Prior to the start of each Match, the two Robots must be placed such that they are:

- Contacting at least one (1) of the gray foam field tiles directly in front of their Alliance Station, i.e. the row of gray foam field tiles that contains their Alliance's Platform.
- Not contacting any other gray foam field tiles, i.e. those in contact with the white tape lines that define the Alliance Home Zone.
- Not contacting any Scoring Objects other than the Preloads.
- Not contacting another Robot.
- Not contacting the Platform.
- Contacting no more than three (3) Preloads.
  - No Preloads may be contacting more than one (1) Robot.
  - All Preloads must be fully within the field perimeter.
  - All Preloads must not be in any positions that would be considered Scored if the Robot were not present.
  - If a Team does not wish to use their six (6) Preloads at the start of the Match, they may be used as Match Load Rings at any point during the Match.
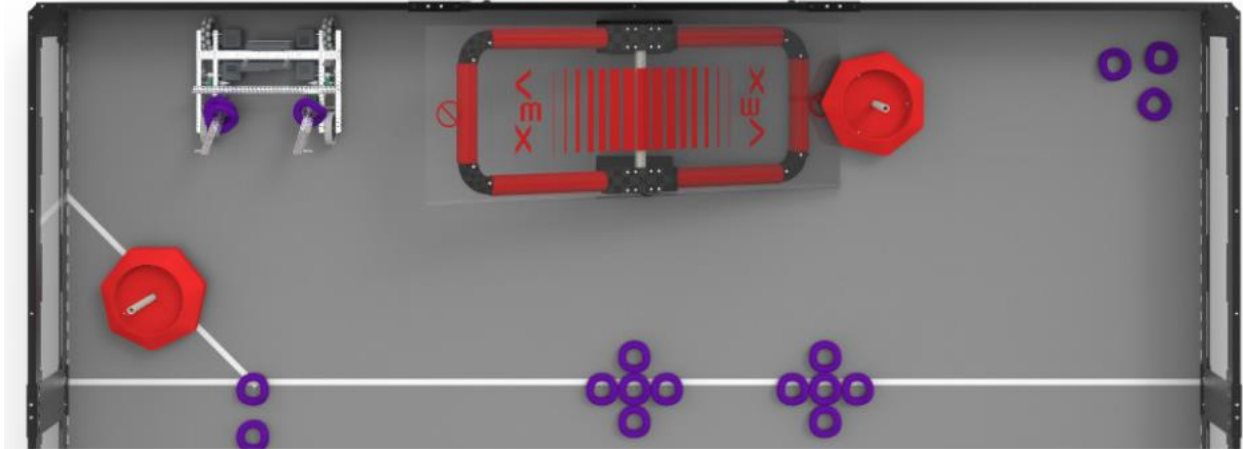
<SG2> Robot expansion is limited once the Match begins. At the beginning of a Match, each Robot must be smaller than a volume of 18" (457.2 mm) long by 18" (457.2 mm) wide by 18" (457.2 mm) tall. Once the Match begins, Robots may expand, but no horizontal dimension can exceed 36" (914.4 mm) at any point during the Match.

<SG3> N/A

<SG4> N/A

<SG5> N/A

<SG6> N/A

<SG7> N/A

<SG7> N/A

<SG8> Each Alliance may introduce their Match Load Rings at any point during the Match. This action must abide by the following criteria:

a. Match Load Rings must be gently placed onto one of the gray foam tiles directly in front of the Alliance Station, i.e. the tiles coincident with the field perimeter wall..

b. Match Load Rings may not be placed into a Scored position on a Mobile Goal.

c. Match Load Rings may not be placed such that they are contacting a Robot (from either Alliance) while still in contact with a Drive Team Member.

d. Match Load Rings must be gently placed directly onto the foam tile. "Throwing", "rolling", or otherwise imparting energy upon the Rings such that they leave the intended tile, or violate one of the other points in this rule, is not permitted.

e. Match Load Rings may only be introduced during the Autonomous Period or the Driver Controlled Period, i.e. they may not be introduced during the pause between the two periods, or prior to the Match.

f. It is expected that Drive Team Members may momentarily break the plane of the field perimeter while legally introducing Match Load Rings. This action should be kept as brief as possible, and Teams from both Alliances should be very mindful of when Match Load Rings are being entered into the field.

> i. Any human contact with Robots from either Alliance during this interaction may be considered a violation.

Note: There is no requirement for Alliances to introduce their Match Load Rings if they do not wish to do so.
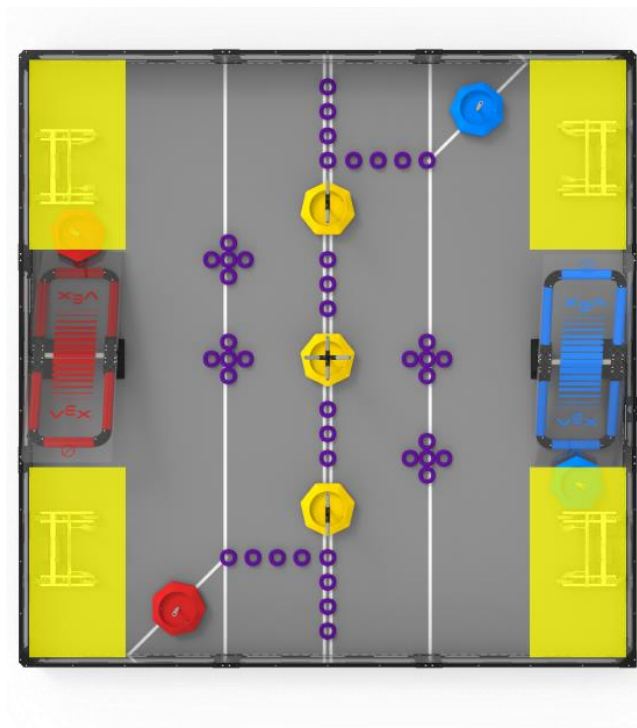
Rules Specific only to SkillsUSA

<SkillsUSA1> **This manual will be updated for NLSC**. Rules in this manual are subject to change for NLSC and will be announced when teams arrive at the Championship for the Orientation Meeting. Teams should be prepared for the following changes which may or may not occur. No other rules will be changed.

1. The starting position of all Game Objects.
2. The starting position of the Robot.

<SkillsUSA2> **No Power Tools.** Teams may not use power tools in the competition or pit areas. Hand tools are the only acceptable means of cutting and bending materials.

ROBOT EQUIPMENT

Competitors will be required to purchase their own robot kits for competition. All equipment found in the VEX EDR product line found here is permitted with the following limits.

<RE1> **Two Robots per Team.** Only two (2) Robots will be allowed to compete per Team. Though it is expected that Teams will make changes to their Robots at the competition, a Team is limited to only two (2) Robots. As such, a legal Robot has the following subsystems:

Subsystem 1: Mobile robotic base including wheels, tracks, legs, or any other mechanism that allows the robot to navigate the majority of the flat playing field surface.

Subsystem 2: Power and control system that includes a legal VEX battery, a legal VEX control system, and associated motors for the mobile robotic base.

Subsystem 3: Additional mechanisms (and associated motors) that allow manipulation of game objects or navigation of field obstacles.

Given the above definitions, a minimum Robot for use must consist of 1 and 2 above. Thus, if you are swapping out an entire subsystem of either item 1 or 2, you have now created a third Robot and are no longer legal.

1. Teams may not compete with two Robots while additional Robots are being modified or assembled.
2. Teams may not switch back and forth between multiple Robots during a competition and must remain with their two Robots. This includes using a different pair of Robots for Driving Skills and Programming Skills.

Multiple Teams may not use the same Robot. Once a Robot has competed under a given team number at an event, it is "their" Robot - no other Teams may compete with it for the duration of the competition season.

<RE2> **Robots must pass inspection.** Every Robot will be required to pass a full inspection before being cleared to compete. This inspection will ensure that all robot rules and regulations are met. Initial inspections will take place during the Orientation meeting.

<RE3> **Robots must be safe.** Mechanisms and components that could potentially damage playing field components such as the field perimeter or Field Elements are not permitted.

<RE4> Robots must fit in a sizing volume. At the beginning of any Match, one Robot must be smaller than a volume of 24" long by 24" wide by 24" tall. The second Robot must be smaller than a volume of 15" long by 15" wide by 15" tall.

1. Robots may expand beyond their starting size constraints after the start of a Match.
2. Any restraints used to maintain starting size (i.e. zip ties, rubber bands, etc.) MUST remain attached to the Robot for the duration of the Match.

<RE5> Robots are built from the VEX V5 system. Robots may be built ONLY using official VEX V5 components, unless otherwise specifically noted within these rules. Teams are responsible for providing documentation proving a part's legality in the event of a question. Examples of documentation include receipts, part numbers, official VEX websites, or other printed documentation.

<RE6> VEX products come from VEX Robotics or VEX Robotics Resellers. Official VEX products are ONLY available from VEX Robotics & official VEX Resellers. To determine whether a product is "official" or not, consult www.vexrobotics.com. A complete list of authorized VEX Resellers can be found at www. vexrobotics.com/find-a-reseller.

<RE7> Certain non-VEX V5 components are allowed. Robots are allowed the following additional "non-VEX" components:

1. Any material strictly used as a color filter or a color marker for a VEX Light Sensor.
2. Any non-aerosol based grease or lubricating compound, when used in extreme moderation on surfaces and locations that do NOT contact the playing field walls, foam field surface, Game Objects, or other Robots.
3. Anti-static compound, when used in extreme moderation (i.e. such that it does not leave residue on playing field walls, the foam field surface, Game Objects, or other Robots).
4. Hot glue when used to secure cable connections
5. An unlimited amount of 1/8" (or local metric equivalent), braided, nylon rope
6. Commercially available items used solely for bundling or wrapping of 2-wire, 3-wire, 4-wire, or V5 Smart Cables, and pneumatic tubing are allowed. These items must solely be used for the purposes of cable protection, organization, or management. This includes but is not limited to electrical tape, cable carrier, cable track, etc. It is up to inspectors to determine whether a component is serving a function beyond protecting and managing cables.

<RE8> 3D Printed Parts and Fabrication is allowed. Teams are allowed to fabricate their own unique components for each of their Robots from the following additional raw materials. These parts may be fabricated using techniques that may otherwise be prohibited in VRC, such as welding, brazing, casting, forging, hot/cold rolling, tempering, or gluing.

a. An unlimited amount of non-shattering plastic from the following list: polycarbonate, acetal monopolymer (Delrin), acetal copolymer (Acetron GP), POM (acetal), ABS, PEEK, PET, PETG, HDPE, LDPE, Nylon (all grades), Polypropylene, FEP.
b. An unlimited amount of silicone, polyurethane, or other rubber.
c. An unlimited amount of composite materials, such as G10 (Garolite), FR-4, or carbon fiber.
d. An unlimited number of plastic 3D printed parts.
e. An unlimited amount of steel, aluminum, brass & bronze.
f. An unlimited amount of wood.

<RE9> Any Fabricated Parts must be accompanied by documentation that demonstrates the Team's design and construction process for that Fabricated Part.

> a. The minimum acceptable form of documentation is an engineering drawing with multiple views for the part in question. These drawings may be included in a Team's Engineering Notebook, or in a standalone appendix to the Engineering Notebook.
> b. Any Fabricated Parts must have been physically fabricated by Team members. For example, parts that have been ordered by the Team to be 3D printed by a third-party would be prohibited.
> c. Teams will be required to provide this documentation to inspectors, Head Referees, or judges at any time. Failure to provide acceptable documentation will result in the part being deemed illegal for use.

<RE10> Teams may use commercially-available springs on their Robots. For the purposes of this rule, a "spring" is any device used for storing and releasing elastic potential energy. Examples include, but are not limited to:

> a. Compression, tension, torsion, constant force, or conical springs made from spring steel.
> b. Springs made from elastic thread or rubber, such as surgical tubing, bungee cords, or stretchable braided rope.
> c. Closed-loop (pneumatic) gas shocks.

<RE11> Teams may use any commercially available fastener on their Robot. Examples of fasteners may include (but are not limited to) screws, nuts, washers, rivets, hinges, pins, rod ends, threaded rods, or hose clamps.

> a. To be considered a legal "fastener" in the context of this rule, the primary function of the part must be to join or fasten together two otherwise legal parts. For example, a pre-fabricated wheel would not be considered a "fastener", even though it may also technically serve the purpose of bridging the connection between tread and a shaft.

<RE12> A limited amount of tape is allowed. Robots may use a small amount of tape when used for the following purposes:

> 1. For the sole purpose of securing any connection between the ends of two (2) VEX cables.
> 2. For labeling wires and motors.
> 3. For covering the back of License Plates (i.e. the "wrong color").
> 4. For the purposes of preventing leaks on the threaded portions of pneumatic fittings. This is the only acceptable use of Teflon tape.
> 5. In any other application that would be considered a "non-functional decoration" per <R12>.

<RE13> Certain non-VEX screws, nuts, and washers are allowed. Robots may use any commercially available #4, #6, #8, M3, M3.5, or M4 screw up to 2" (50.8mm) long (nominal), and any commercially available nut, washer, and/or spacer (up to 2" / 50.8mm long) to fit these screws.

<RE11> Robots have one microcontroller. Each Robot must utilize exactly one (1) V5 Robot Brain microcontroller and exactly one (1) V5 Robot Radio connected to a V5 Controller. No other types of VEX microcontrollers or wireless communication protocols are permitted.

<RE12> Robot Motors. There is no restriction on the number of V5 Smart Motors that Robots may use. No other motors, servos, or actuators are permitted, including those sold by VEX (e.g. the 2-Wire 393 Motor).

> **Note 1**: Pneumatic actuators are permitted within the guidelines of .

> **Note 2**: Any device which is powered by any non-V5 motor, such as an external fan for cooling electronics, would be considered a violation of this rule.

<RE13> Robot Sensors. There is no restriction on sensors and other additional electronics that Robots may use for sensing and processing, except as follows:

a. Sensors and electronics MUST be connected to the V5 Robot Brain via any of the externally accessible ports (i.e. without any modification to the microcontroller). A sensor may be connected to a processing unit which then connects to the V5 Robot Brain.
b. Sensors and electronics CANNOT directly electrically interface with VEX motors.
c. The additional sensors and electronics may only receive power from any of the following:
    i. Directly from the V5 Robot Brain via any externally accessible port.
    ii. From an additional lithium ion, lithium iron or nickel metal hydride battery pack (only one (1) additional battery can be used for sensor/processing power). Battery pack must operate at a maximum of 12 volts nominal.
d. Only the V5 Battery can power the V5 Brain.

<RE14> Robot Communication. No radio communication is allowed between Robots. However, other non-radio forms of communication are permitted (i.e., IR, ultrasonic, etc.).

<RE16> One controller per Robot. No more than one (1) VEX V5 wireless remotes may control a single Robot during the tournament.

1. No modification of these transmitters is allowed of ANY kind.
2. No other methods of controlling the Robot (light, sound, etc.) are permissible.
    a. Using sensor feedback to augment driver control (such as motor encoders or the Vision Sensor) is acceptable.

<RE17> No modifications to electronic components are allowed. Motors (including the internal PTC or Smart Motor firmware), microcontrollers (including V5 Robot Brain firmware), extension cords, sensors, controllers, battery packs, reservoirs, solenoids, pneumatic cylinders, and any other electrical component or pneumatics component of the VEX EDR platform may NOT be altered from their original state in ANY way.

1. External wires on VEX electrical components may be repaired by soldering, using twist/crimp connectors, electrical tape or shrink tubing such that the original functionality / length is not modified in any way. Wire used in repairs must be identical to VEX wire. Teams may make these repairs at their own risk; incorrect wiring may have undesired results.
2. Teams are advised to use the latest official VEXos firmware updates, found at www.vexedr.com. Custom firmware modifications are not permitted.
3. Teams may change or replace the gears in the "2-Wire 393" or "2-Wire 269" motors with the corresponding official VEX Replacement Gears
4. Teams may change or replace the gear cartridge in the V5 Smart Motor with other official replacement gear cartridges

<RE18> Most modifications and repairs to non-electrical components are allowed. Physical modifications such as bending or cutting are permitted and may be done to legal VEX Robotics Competition metal structure or plastic components.

1. Physical modifications to electrical components such as a legal microcontroller or radio is prohibited unless otherwise explicitly permitted, per <RE17>.
2. Internal or external mechanical repairs of VEX Limit and Bumper switches are permitted. Modifying the metal arm on the Limit Switch is permitted. Using components from these devices in other applications is prohibited.
3. Metallurgical modifications that change fundamental material properties, such as heat treating, are not permitted.
4. Teams may cut pneumatic tubing to a desired length.
5. Teams are permitted to fuse/melt the end of the 1/8" nylon rope to prevent fraying.
6. Welding, soldering, brazing, gluing, or attaching in any way that is not provided within the VEX V5 platform is NOT permitted.
7. Mechanical fasteners may be secured using Loctite or a similar thread-locking product. This may ONLY be used for securing hardware, such as screws and nuts.

<RE19> Custom V5 Smart Cables are allowed. Teams must use official V5 Smart Cable Stock but may use commodity 4P4C connectors and 4P4C crimping tools. Teams who create custom cables acknowledge that incorrect wiring may have undesired results.

<RE20> Keep the power switch accessible. The Robot display must be accessible without moving or lifting the Robot. The microcontroller lights and/or screen should also be visible by competition personnel to assist in diagnosing Robot problems.

<RE21> Robots are ready when they are at the field. Teams must bring their Robots to the field prepared to play. Teams who use VEX pneumatics must have their systems charged before they place the Robot on the field.

<RE22> Pneumatics are limited to pressure only. Teams may utilize an unlimited amount of the following commercially available pneumatic components: Cylinders, actuators, valves, gauges, storage tanks, regulators, manifolds, and solenoids.

a. Pneumatic devices may only be charged to a maximum of 100 psi.
b. Compressors or any other forms of "on-Robot" charging are not permitted.
c. All commercial components must be rated for 100 psi or higher. Teams should be prepared to provide documentation that verifies these ratings to inspectors if requested.
d. Components must not be modified from their original state, other than the following exceptions:
   i. Cutting pneumatic tubing or wiring to length, assembling components using pre-existing threads, brackets, or fittings, or minor cosmetic labels.

<RE23> Programing using any language. Teams may program the robots in any programming language that suits their needs. Teams will not be judged on which language is chosen, but rather, will be judged on how the robot performs. Some programming options can be found here.

DESIGN PROCESS

Judges must use the Design Rubric to evaluate the teams' design process. A record of all teams submitting notebooks shall be kept by the Judge Advisor. Notebooks shall be collected during the orientation meeting and brought to the Judges' room for evaluation. The Rubric comes in two (2) pages. The first page is for the Engineering Notebook, and the second page is for the Design Interview.

Engineering Notebooks

The Engineering Notebook is a way for teams to document how the VEX Robotics Competition experience has helped them to better understand the engineering design process while also practicing a variety of critical life skills including project management, time management, brainstorming, and teamwork. Bound notebooks are preferred by Judges and are given a 3-point bonus on the Design Rubric.

Each notebook is created through a concerted effort by a team to document their design decisions.

Engineering is an iterative process whereby students recognize and define a problem, brainstorm and work through various stages of the design process, test their designs, continue to improve their designs, and continue the process until a solution has been identified. During this process, students will come across obstacles, encounter instances of success and failure, and learn many lessons. It is this iterative process that students should document in their Engineering Notebook.

The Engineering Notebook is an opportunity to document everything a team does throughout the design process. Students should include a number of items in their Engineering Notebook including:

- A table of contents
- Team meeting notes as they relate to the design process
- Design concepts, sketches and pictures
- Notes from competitions regarding observations that should be considered in the next iteration of their design
- Programming improvements or significant modifications
- CAD drawings of their Robot and/or specific elements of their Robot.
- Team members' observations and thoughts on their design
- Team organization practices as they relate to their design process
- Other documentation that a team finds useful as related to their robot's design

The team should also document their project management practices including their use of personnel, financial, and time resources.

A bound quad-ruled notebook is the preferred format. The team number should be on the cover. The notebook should never be edited. Pages should never be removed from the notebook even if they contain errors. The notebook should be written in ink with errors crossed out using a single line. Pages should be numbered, and entries should be dated in chronological order with each page signed or initialed by the students. Additional materials such as examples of computer code or CAD drawings should be glued or taped into the notebook.

The question of what is a 'bound' Engineering Notebook often arises. To be considered bound, a notebook must have been bound prior to any entries being made in it.

Judges will not accept electronic notebooks on laptops, thumb drives, or cloud-based servers.

Design Interview

All teams will be interviewed by Judges who will ask them questions about their robot and design process. Teams should bring their robot with them to the interview. Judges will fill out page 2 of the Design Rubric and give teams a score based on the responses of the team members. Teams are not to prepare a slide presentation such as Power Point for this interview and should be prepared to talk about their robot without any written notes such as cards or written outlines.

Appendix A contains the Design Award Rubric and Design Interview Rubric.

Programming Interview

All teams will be interviewed by Judges who will ask questions about the coding and programming process. Teams should bring their robot, laptop and programming cable with them to the interview. Judges will use the following interview process rubric to determine the knowledge of the programmer and quality of the written code.

Appendix B contains the Programming Interview questions.

Appendix C contains the Programming Interview Scorecard.

Safety Points

All teams are expected to be safe in the competition area. Students will start with 65-points in Safety and will be deducted 10-points for every instance of a safety violation. The minimum score is zero.

Students will be notified immediately upon each instance of a safety violation. Examples of Safety violations are as follows.

- General horseplay (running, throwing objects, pushing others)
- Not wearing shoes (except when walking on foam tiles)
- Not wearing safety glasses while working on Robot
- Not wearing safety glasses while standing in the Alliance Station
- Using teeth as a tool (other than eating)
- Leaving equipment in aisles (creating trip hazards)

TEAM RANKING

Teams will be given a total score based on the Professional Development Test, Engineering Notebook (Page 1 of the Design Rubric), CAD drawings, the Design Interview (Page 2 of the Design Rubric), the Programming Interview, the team's highest Programming Skills Score, the team's highest Driving Skills Score, and the Team's Safety Score. Teams are ranked by the sum of their weighted scores in these categories.

All teams will be given the same number of Robot Skills Matches to be determined by the Competition Organizer. At SkillsUSA NLSC, each team will get three (3) chances for Programming Skills and three (3) chances for Driving Skills. Only the highest Programming Skills score and the highest Driving Skills score will be used to determine rankings.

In the case of ties, the tie will be broken by looking at the following in order.

1. Engineering Notebook Score
2. Team's highest Programming Skills Score
3. Team's highest Driving Skills Score

Appendix F contains the Mobile Robotics Technology Overall Scorecard.
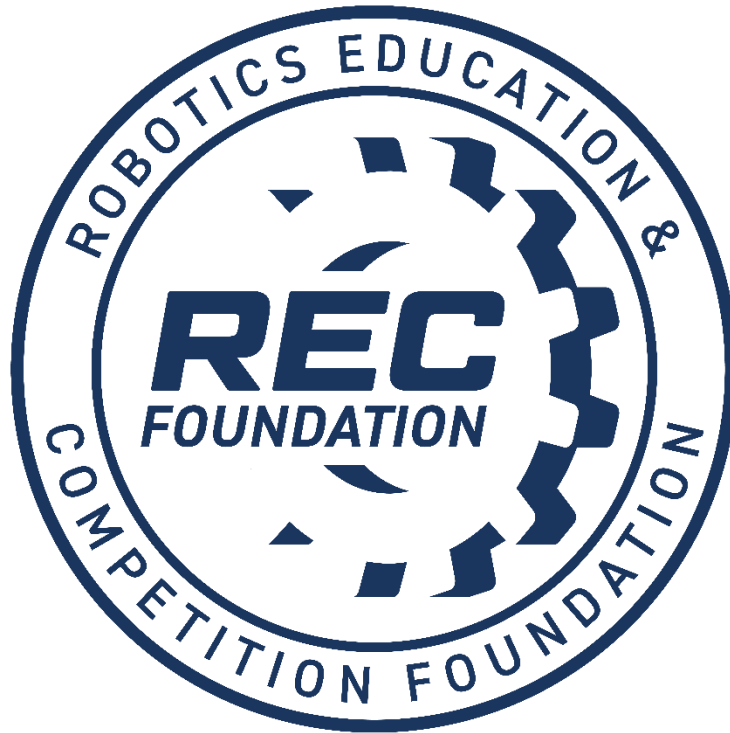
MOBILE ROBOTICS TECHNOLOGY APPENDIX

Design Award Rubric – Page 1 *Engineering Notebook Review*

Directions: Write the points in each row for the criterion that best describes the performance of the Engineering Notebook on each topic. Total the points.

Team Number _____

	Topic	Criteria			Points
		Expert (4-5 points)	Proficient (2-3 points)	Emerging (0-1 points)	
Engineering Design Process	Identify game and robot design challenges and goals	Identifies the game challenge or robot design challenge in detail at the start of each design process cycle with words and pictures. States the goals for accomplishing the challenge.	Identifies the challenge at the start of each design cycle. Lacking details in words, pictures, or goals.	Does not identify the challenge at the start of each design cycle.	
	Brainstorm and diagram or prototype solutions	Lists three or more possible solutions to the challenge with labeled diagrams. Citations provided for ideas that came from outside sources such as online videos or other teams.	Lists one or two possible solutions to the challenge. No citations provided for ideas that came from outside sources.	Does not list any solutions to the challenge.	
	Select the best solution and plan	Explains why the solution was selected through testing and/or a decision matrix. Fully describes the plan to implement the solution.	Explains why the solution was selected. Mentions the plan.	Does not explain why the solution was selected or does not mention the plan.	
	Build and program the solution	Records the steps to build and program the solution. Includes enough detail that the reader could recreate the solution following the steps in the Notebook.	Records the key steps to build and program the solution. Lacks sufficient detail to recreate the solution.	Does not record the key steps to build and program the solution.	
	Test solution	Records all the steps to test the solution, including test results.	Records the key steps to test the solution.	Does not record the steps to test the solution.	
	Repeat design process	Shows that the design process is repeated multiple times to improve performance on an individual design goal or overall robot or game performance.	Shows that the design process is not often repeated for individual design goals or overall robot or game performance.	Does not show that the design process is repeated.	
Usefulness and repeatability		Records the entire design and development process in such great clarity and detail that the reader could recreate the project's history and build the current robot from the notebook.	Records the design and development process completely but lacks sufficient detail to fully recreate the entire project or robot.	Does not record the design and development process or lacks sufficient detail to understand the design process.	
Record of team and project management		Provides a complete record of team and project assignments; notes from team meetings including goals, decisions, and accomplishments; name or initials of author; each page numbered and dated. Design cycles are easily identified. Includes Table of Contents and/or Index so anyone can easily locate needed information.	Records most of the information listed at the left. Organized so that team members can locate most of the needed information.	Does not record most of the information listed at the left. Not organized; needed information difficult to locate.	
Notebook construction		Five (5) points if notebook is bound. Notebook must have been bound before any entries were made in it.	Zero points for any other notebook construction.	Zero points for any other notebook construction.	

Describe a few of the best features of the Engineering Notebook:

Total points for Engineering Notebook:

CAD Drawings

(Keep separate from Engineering Notebook Score)

1 point = Made an attempt to have a CAD drawing, but it is not accurate

2-3 points = Have basic elements of CAD drawings

4-5 points = Have detailed CAD drawings for entire Robot including some early iterations of design

CAD Score_____

Design Award Rubric – Page 2 *Team Interview with Judges*

Directions: Write the points in each row for the criterion that best describes the team's performance on each topic during interview. Total the points below.

Team Number _____

REC FOUNDATION

Topic	Criteria			Points
	Expert (4-5 points)	Proficient (2-3 points)	Emerging (0-1 points)	
Design process and Engineering Notebook	Students clearly explain all aspects of the design process and how they recorded their use of the design process in the Notebook.	Students can explain most aspects of the design process and how they recorded their use of the process.	Students can explain only limited aspects of the design process and how they recorded their use of the process.	
Game strategies and robot designs	Students can describe three or more game strategies and robot designs that were considered; students can fully explain how and why the current game strategy and robot design were chosen.	Students can describe two game strategies and robot designs that were considered; students can explain how and why the current game strategy or robot design were chosen.	Students can describe only their current game strategy and design, or they cannot explain how and why the current game strategy or robot design were chosen.	
Project and team management	Students can explain how team progress was tracked against an overall project timeline, and how students were assigned to tasks based on their skills and availability; students can explain management of material resources.	Students can explain how team progress was monitored, or how students were assigned to tasks, or management of material resources.	Students cannot explain how team progress was monitored or how students were assigned to tasks or how material resources were managed.	
Teamwork and communication	Students can explain how multiple team members contributed to the robot design and game strategy. All students answer questions independently.	Students can explain how most team members contributed to the robot design and game strategy. Students support each other as needed to answer questions.	Only one team member answered questions or contributed to the robot design process.	
Respect and courtesy	Students answer respectfully and courteously. Students make sure each team member contributes. Students wait to speak until others have finished.	Students answer respectfully and courteously. Some students attempt to contribute but are interrupted by other students.	Students do not answer respectfully and courteously. Students interrupt each other or the Judges.	

Describe a few of the best features of the team interview:

			Total points for Design Interview (30 Max):	

Professional Dress

(Add this to the Design Interview Score)

As the students walk into the interview, check to see if their shirts are fully tucked in.

Add 5 points if BOTH students have their shirts fully tucked in.

Professional Dress Score_____

(5 or 0)

Mobile Robotics Programming Interview Questions

This interview is comprised of 3 sections. For each section please read all instructions and questions before assessing the team.

Please pay attention to the students' Professional Dress as they walk into the interview. There is a point value evaluation on the Programming Interview Scorecard for this category.

Section 1: General Programming Information (Maximum 15 pts)

For this section you will be asking the team general information about their program. This section will make sure teams have come prepared for their interview.

1. Did the team bring a laptop with their code?

No (0 pts)		Yes (5 pts)	

2. Did the team bring their robot?

No (0 pts)		Yes (5 pts)	

3. Ask the team, what programming software are they using. Does it match the code that was brought to the interview?

No (0 pts)		Yes (5 pts)	

Section 2: Program Design and Fluency (Maximum 60 pts)

In this section you will ask the team to walk you through their code. Ask the team to start at the very beginning and explain the program until the robot stops. Read all questions beforehand because you will need to assess the program after the walk through is complete. The following questions are for the judge and should not be asked to the team.

4. Did the program include comments?

1 pt	2 pt	5 pt	9 pt	10 pt
Program did not contain comments.	Program contained comments but lacked in depth. The comments were only useful for the programmer.			Program contained in depth comments for their entire code base. Comments were articulate and meaningful.

5. Did the program use variables instead of hard coding numbers? (e.g., when they set the speed of the motor, is it a number or a variable)?

1 pt	2 pt	5 pt	9 pt	10 pt
Program did not include any variables.	Program contained a mix of variables and hard coded values. Variable may not be organized.			The program used variables for all or most opportunities. Variables were organized and named in a meaningful way.

6. Did the program contain advanced programing structures like loops and if else statements?

1 pt	2 pt	5 pt	9 pt	10 pt
Program did not contain any loops or if else statements.	The program only had a few loops or if/else structure. Some parts of the code were reused in loops but others were programed linearly.			The program contained many loops and if/else structures.

7. Did the program contain functions that were used throughout their code?

1 pt	2 pt	5 pt	9 pt	10 pt
Program did not contain any functions.	The program used some functions but missed opportunities to make a function.			The program had multiple functions and was used to reuse code wherever possible in their program.

8. Is the code formatted in an organized manner?

1 pt	2 pt	5 pt	9 pt	10 pt
Program did not follow any kind of format. Code was not properly indented or spaced in a neat fashion.	Most or some of the code was formatted. There are areas where code could have been formatted a little better.			The entire code base is formatted and spaced.

9. How did the team conduct the walkthrough of their code?

1 pt	2 pt	5 pt	9 pt	10 pt
The team showed zero or minimal knowledge of their program. They were not able to articulate what their program does or where it starts.	Team was able to walk you through the program. Students read the comments verbatim and were not able to explain more than what was already written in the program. The team was unsure about how some of the code worked in some sections.			The team was able to explain all parts of their program. The team used proper terminology when talking about their program. The team was able to explain their code without having to read the comments verbatim.

Section 3: Smart Programming (Maximum 15 pts)

In this section you will be asking the team specific questions about their program. The judge will assess the team on how well they answer each question.

10. Ask the team how many sensors are on their robot that they programed.

1 pt	2 pt	3 pt	4 pt	5 pt
Team uses one or less sensors on their robot.	The team uses a moderate amount of sensors (2 - 3).			Team used a large amount of sensors (4+).

11. Find a sensor on the team's robot or one they mentioned in the question above. An example could be an Encoder in the Smart Motor. Ask the team to show you where in their code that they use this sensor. Is the team able to explain and show you how they used the sensor?

1 pt	2 pt	5 pt	9 pt	10 pt
Team did not use any sensors or could not find how they used the sensor in their code.	The team struggled to find where they used the sensor in their code, and/or was only able to explain how they used the sensor by reading comments in that section. The team did not fully understand what data was being collected by the sensor and how it was used by the program.			Teams were able to quickly find the sensor in their program. They were able to explain in great detail how the program uses the data from the sensor.

Team Number _____

Total Score _____

_____ 1. Laptop (5)

_____ 2. Robot (5)

_____ 3. Software Match (5)

_____ 4. Comments (10)

_____ 5. Variables (10)

_____ 6. Programming Structure (10)

_____ 7. Functions (10)

_____ 8. Format (10)

_____ 9. Walkthrough (10)

_____ 10. Number of Sensors (5)

_____ 11. Code for Sensor (10)

_____ **Subtotal (90)**

_____ Professional Dress: 5 points per student if shirt is fully tucked in as they walk into interview. (10)

_____ **Total Score: Copy this number to the top of sheet (100)**

Programming Skills Matches

(2-minute matches)

Team Number _____

Highest Score _____

Trial 1

Rings Scored in / on

High Branches ____ x 10 = _____(a)

Standard Branches ____ x 3 = _____(b)

Goal Bases ____ x 1 = _____(c)

Number of Mobile Goals in

Correct Home Zones ____ x 20 = _____(d)

Elevated ____ x 40 = _____(e)

Robot Elevated ____ x 30 = _____(f)

Trial 1 Score:

Trial 2

Rings Scored in / on

High Branches ____ x 10 = _____(a)

Standard Branches ____ x 3 = _____(b)

Goal Bases ____ x 1 = _____(c)

Number of Mobile Goals in

Correct Home Zones ____ x 20 = _____(d)

Elevated ____ x 40 = _____(e)

Robot Elevated ____ x 30 = _____(f)

Trial 2 Score:

Trial 3

Rings Scored in / on

High Branches ____ x 10 = _____(a)

Standard Branches ____ x 3 = _____(b)

Goal Bases ____ x 1 = _____(c)

Number of Mobile Goals in

Correct Home Zones ____ x 20 = _____(d)

Elevated ____ x 40 = _____(e)

Robot Elevated ____ x 30 = _____(f)

Trial 3 Score:

Driving Skills Matches

(2-minute matches)

REC FOUNDATION

Team Number _____

Highest Score _____

Trial 1

Rings Scored in / on			**Number of Mobile Goals in**		
High Branches	____ x 10 = _____(a)		Correct Home Zones	____ x 20 = _____(d)	
Standard Branches	____ x 3 = _____(b)		Elevated	____ x 40 = _____(e)	
Goal Bases	____ x 1 = _____(c)		Robot Elevated	____ x 30 = _____(f)	

Trial 1 Score:

Trial 2

Rings Scored in / on			**Number of Mobile Goals in**		
High Branches	____ x 10 = _____(a)		Correct Home Zones	____ x 20 = _____(d)	
Standard Branches	____ x 3 = _____(b)		Elevated	____ x 40 = _____(e)	
Goal Bases	____ x 1 = _____(c)		Robot Elevated	____ x 30 = _____(f)	

Trial 2 Score:

Trial 3

Rings Scored in / on			**Number of Mobile Goals in**		
High Branches	____ x 10 = _____(a)		Correct Home Zones	____ x 20 = _____(d)	
Standard Branches	____ x 3 = _____(b)		Elevated	____ x 40 = _____(e)	
Goal Bases	____ x 1 = _____(c)		Robot Elevated	____ x 30 = _____(f)	

Trial 3 Score:

Team Number _____

Mobile Robotics Technology Overall Scorecard

Scoring Category	Max Score (Raw x Weight)	Raw Score	Weight	Total Score
Professional Development Test	25 x 1 = 25		1	
Engineering Notebook	45 x 4 = 180		4	
CAD Drawings	5 x 5 = 25		5	
Design Interview	30 x 6 = 180		6	
Programming Interview	100 x 2 = 200		2	
Highest Programming Skills Score	TBD		TBD	
Highest Driving Skills Score	TBD		TBD	
Safety Points	65 x 1 = 90		1	
Total Points	**1000**	**N/A**	**N/A**	

Used for tiebreaking purposes only:

_____ Engineering Notebook Score

_____ Team's highest Programming Skills Score

_____ Team's highest Driving Skills Score