ROBOTICS EDUCATION &
COMPETITION FOUNDATION

Presents:

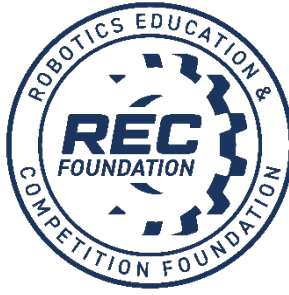**Mobile Robotics Technology
Game Manual**
Secondary Teams
2020-2021

Adapted from VEX Robotics Competition
Change Up Robot Skills Challenge

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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 Change Up 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 who are enrolled in a coherent sequence of courses or a career major that prepares the student for further education and/or employment related to technology, the health industry, trades or industry. Further, a high-school contestant must be earning credit toward a high-school diploma/certificate or its equivalent 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.

Note: Contestants must wear their official contest clothing to the contest orientation meeting. *This requirement may be waived by SkillsUSA for the 2020-21 season*.

THE GAME

A Primer

Matches are played on a 12 ft x 12 ft foam-mat, surrounded by a sheet-metal and polycarbonate perimeter. There are thirty (30) balls including fifteen (15) red balls and fifteen (15) blue balls. There are nine (9) goals initially loaded with the blue balls where teams must remove those blue balls and replace with the red balls within a two-minute (2:00) period.
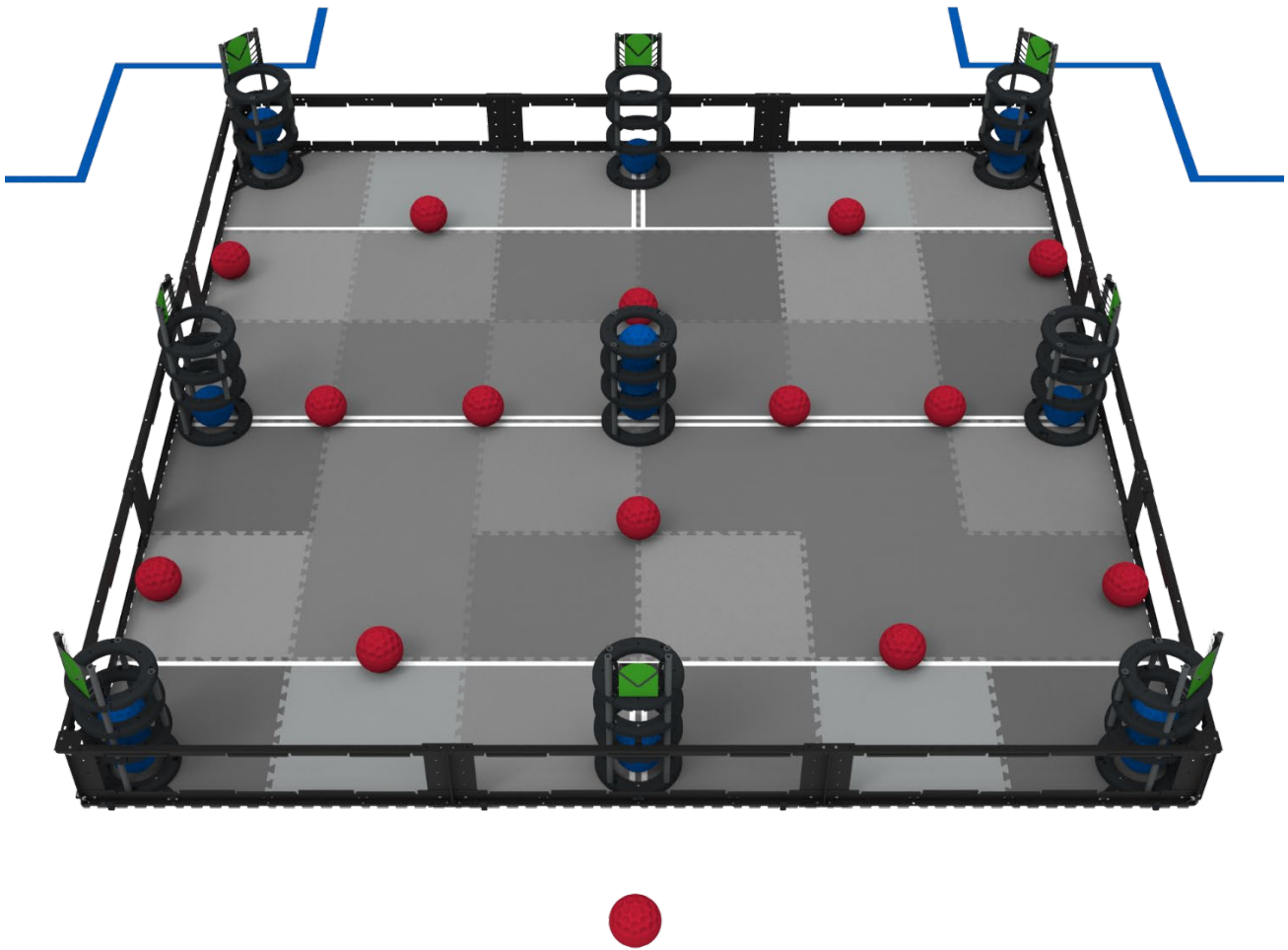
Figure 1: Initial setup configuration. Exact ball placement on the field will be reveled at the SkillsUSA NLSC Orientation Meeting.

Game Definitions

Adult – Anyone who is not a student.

Alliance Home Row – The three (3) Goals in each Alliance's Home Zone.
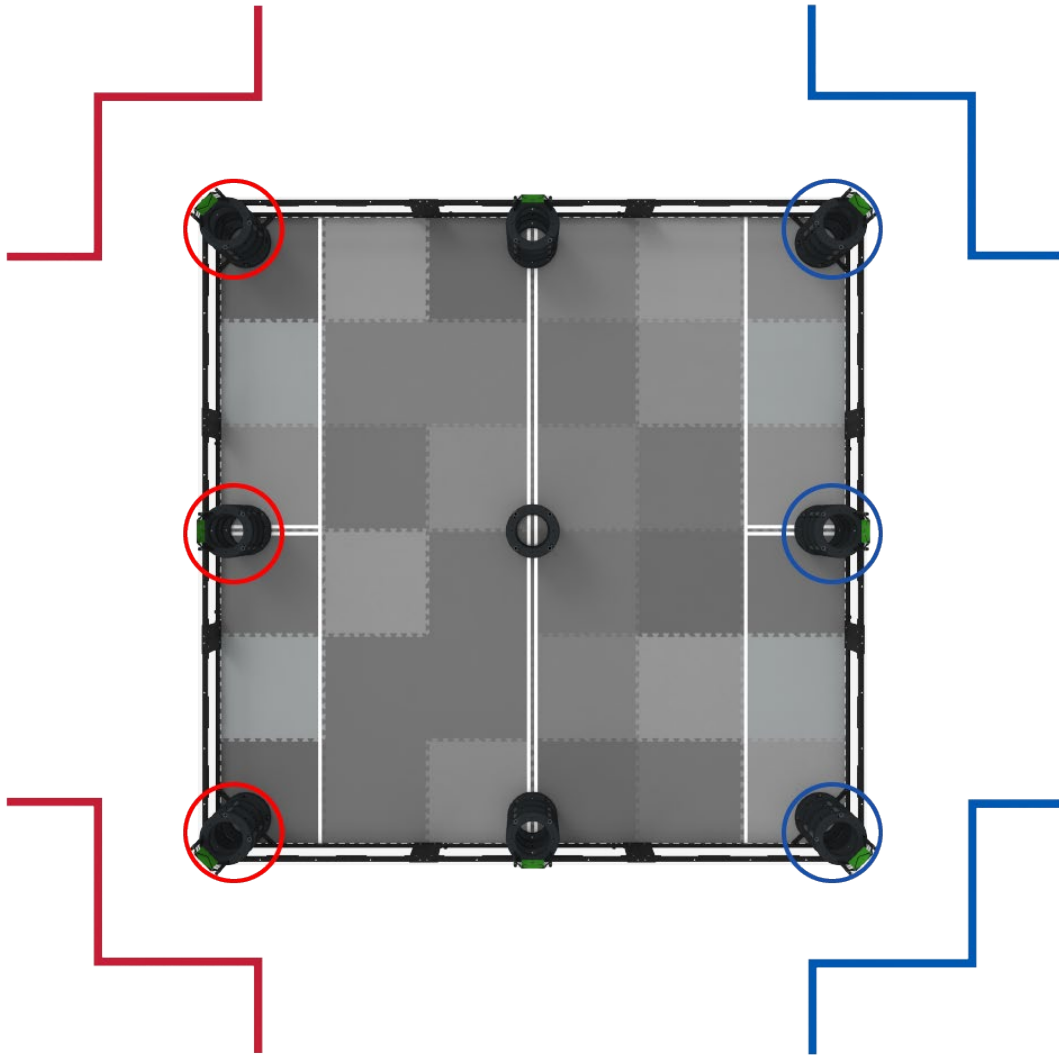
Figure 2: The Red Alliance's Home Row and Blue Alliance's Home Row. In Skills Matches, teams play on the Red Alliance, using the Red Alliance's Home Row.

Alliance Station – The designated region where the Drive Team Members must remain for the duration of the Match.
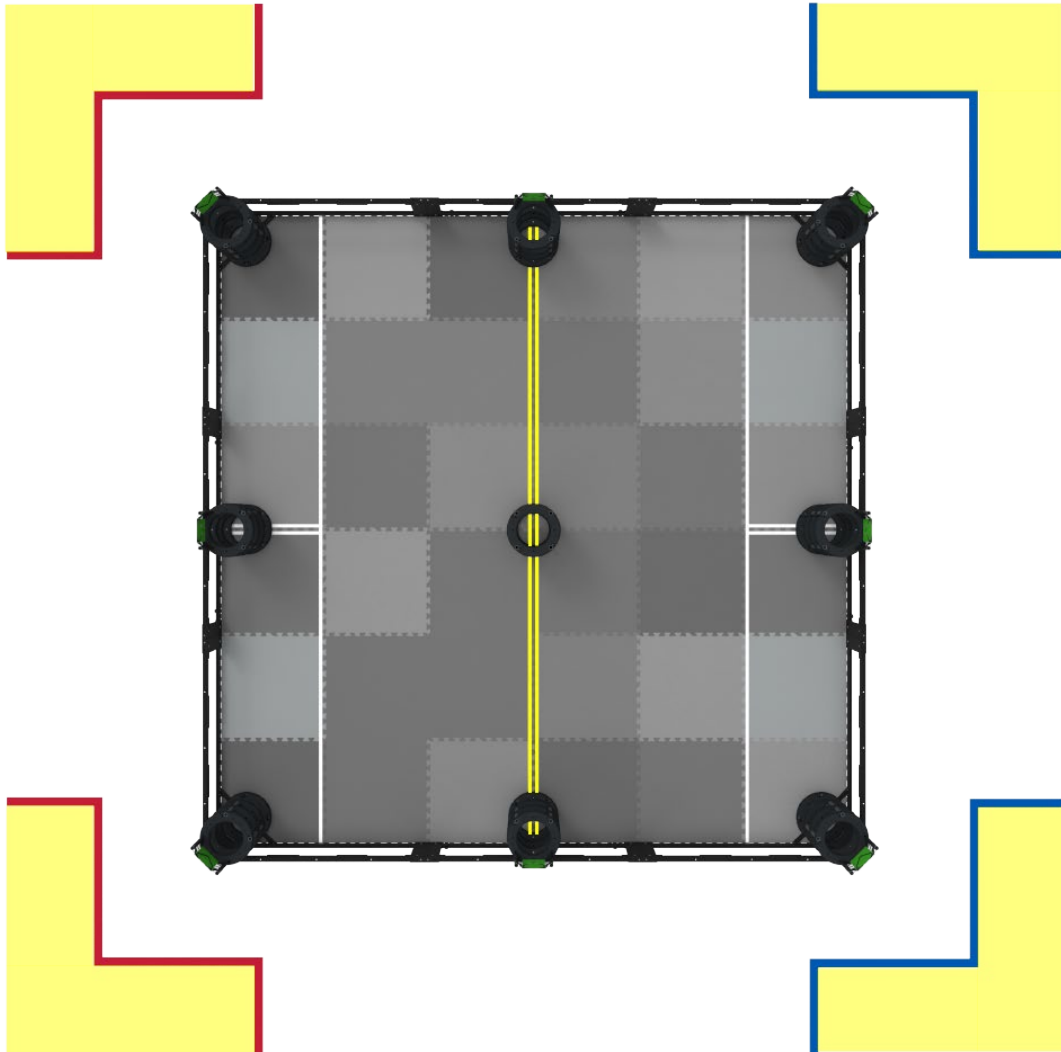
Figure 3: The Red Alliance Station and Blue Alliance Station. In Skills Matches, teams play on the Red Alliance, using the Red Alliance Station.

Ball – A hollow plastic spherical-shaped, dimpled object, with a diameter of 6.3" (160mm), that can be Scored in Goals.

Figure 4: A Red Ball.

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.

Connected Row – A Row where all three (3) Goals in the Row are Owned by the same Alliance.

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.

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.).

Goal - One of nine (9) cylinders in which Robots can Score and remove Scored Balls. The Goals are all 18.41" (467.6mm) tall and have an inside diameter of 7.02" (178.3mm). The Goal consists of four (4) retaining rings and four (4) PVC pipes. The outer edge of the ring is considered to be the outer edge of the Goal. The upper edge of the top ring is considered to be the upper edge of the Goal.

Figure 5: Close-up of a Goal, depicting the outer and upper edges of the Goal.

Home Zone – One of two (2) areas, one (1) for each Alliance Station, where Robots start the match and defines the location of the Alliance Home Row. The Home Zones are defined by the inner edges of the field perimeter and the outer edge of the tape line that runs across the field adjacent to the Alliance Stations, i.e., the tape line is part of the Home Zone. The Alliance Home Zone is closest to their Alliance Stations. The Home Zone refers to the foam field tiles; it is not a 3-dimensional volume.
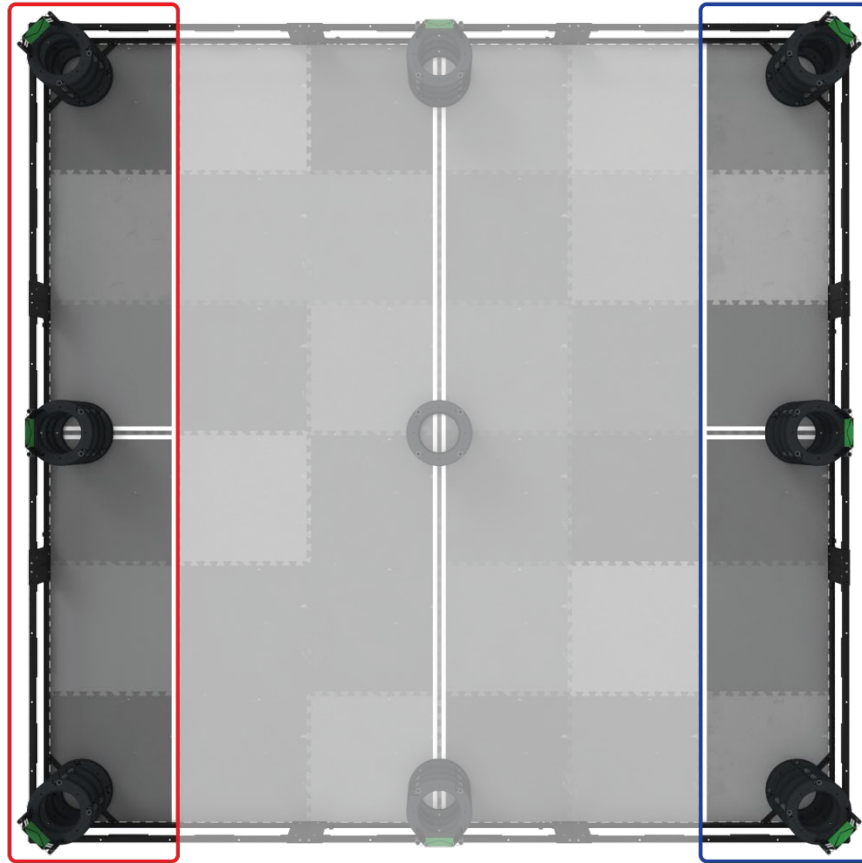
Figure 6: Top view of the field with the Home Zones highlighted.

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.

Owned - A Goal status. A Goal is considered Owned by an Alliance if its colored Ball is the vertically highest Scored Ball in that Goal.

Figure 7: This Goal is Owned by the blue Alliance, as the top-most Ball is completely within the upper edge of the Goal.

Figure 8: This Goal is owned by the Red Alliance, as the top-most Ball is not completely within the upper edge of the Goal. The Top red Ball is Scored because it is below the upper edge of the Goal.

Figure 9: This Goal is Owned by the blue Alliance, as the top-most Ball is not completely within the upper edge of the Goal. The two bottom-most Balls would both be considered Scored as they are partially within the outer edge of the Goal

Possession – A Robot is considered to be Possessing a Ball if a Ball is in an unscored position and the following criteria is met:

- The Robot is carrying, holding or controlling the movement of a Ball such that if the Robot changes direction, the Ball will move with the Robot. Pushing/plowing Balls is not considered Possession, however using concave portions of your Robot to control the movement of Balls is considered Possession

  Note: Balls that are Scored in Goals cannot be considered Possessed until the Robot removes the Ball from that Scored position and is carrying, holding, controlling, or blocking opposing Robots' access to that Ball.

Preload– The Ball, one (1) per Robot, that must be placed on the field such that it satisfies the conditions in <SG1> prior to the start of the Match.

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.

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

Row - Three (3) Goals that make up a straight line. There are a total of eight (8) Rows including two (2) Alliance Home Rows.
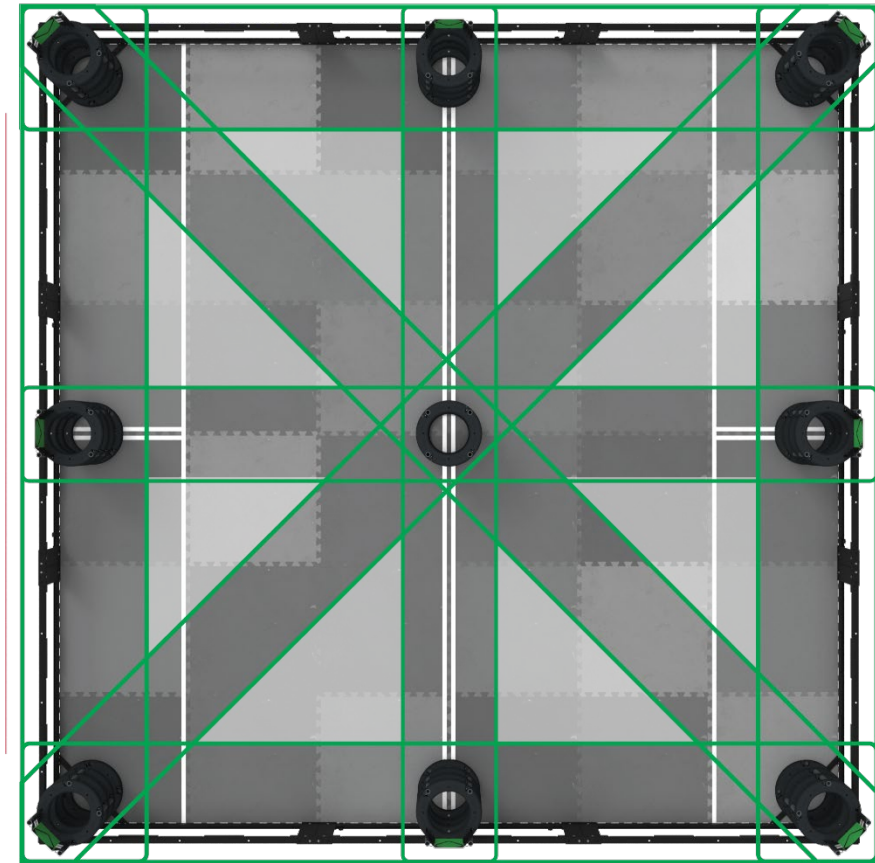
Figure 10: Top view of the field with the eight possible Connected Row options highlighted.

Scored - A Ball status. A Ball is considered Scored in a Goal if it is not touching a Robot of the same color as the Ball and meets all of the following criteria.

- The Ball is fully or partially within the outer edge of the Goal.
- The Ball is fully below the upper edge of the Goal.
- The Ball is not contacting the foam tiles outside of the Goal.

Note: In the act of removing a Ball from the bottom of a Goal with three Scored Balls inside, it is possible for the top Ball to momentarily break criteria 2 above. If this occurs at the end of the Match, this Ball should still be considered Scored. The intent of this note is to avoid unintended de-scoring via the top of the Goal. The intent is not to encourage Teams to seek unique scenarios that would not typically be considered Scored.

Student – Any eligible SkillsUSA member in High School. 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 only one (1) Robot on the Field.

- **Programming Skills Match** – An Autonomous period that is <mark>two minutes (2:00)</mark> long with only one (1) Robot on the Field.

Skills Stop Time – The time remaining in a Skills Match when a Team ends the Match early. If a Team does not end the Match early, they receive a default Skills Stop Time of 0.

a. The moment when the Match ends early is defined as the moment when the Robot is "disabled" by the field control system. See the "Skills Stop Time" section for more details.

b. If a V5 Robot Brain or Tournament Manager display is being used for field control, then the Skills Stop Time is the time shown on the display when the Match is ended early (i.e. in 1-second increments).

c. If a VEXnet Competition Switch is being used for field control, in conjunction with a manual timer that counts down to 0 with greater accuracy than 1-second increments, then the time shown on the timer should be rounded up to the nearest second.

- For example, if the Robot is disabled and the stopwatch shows 25.2 seconds, then the Skills Stop Time should be recorded as 26.

Team – Two Students make up a *Team*.

Scoring

- A Ball Scored in a Goal is worth one (1) point for the Alliance of the color of the Ball.
- A Connected Row is worth six (6) points for that Alliance.

Teams play for the Red Alliance, against the field who acts as the Blue Alliance. The Field is setup with Blue already scored with 63 points as shown below.

15 Blue Balls in Goals = 15 x 1 point each = 15

8 Completed Rows = 8 x 6 points each = 48

Total Blue Score = 15 + 48 = 63

Teams can reduce the Blue Alliance's score for points AND increase the Red Alliance's points. The Team's total score is calculated as follows:

Team's Skills Match Score = (Red Alliance Score) – (Blue Alliance Score) + 63

At the start of the Skills Match, the score would be calculated as follows:

Team's Skills Match Score = (0) – (63) + 63 = 0

The highest score possible is when the team completely flips the field from Blue to Red as follows:

Team's Skills Match Score = (63) – (0) + 63 = 126

Note: At NLSC, the Programming Skills Score will be capped at 50 points and the Driving Skills Score will be capped at 125 points. Teams are not expected to be able to program a 2-minute autonomous routine that can score all available points. Scores above 125 for Driving and 50 for Programming will be recorded as 125 and 50 points, respectively. Depending on the starting locations of Game Objects, the 63 points added in the calculator will be adjusted to whatever the starting score of the Blue alliance is when the locations of the starting positions is revealed at the Orientation Meeting.

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. Ball tolerances and weights may vary from nominal to ±0.10" and 10 grams respectively. Ball placement at the beginning of Matches may vary from nominal to ±1.5". The bottom opening of Goals between the lowest two rings has a dimensional tolerance of -0.0 / +0.5". Teams are encouraged to design their Robots accordingly.

> **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 Change Up Specific Game Rules

<SG1> Starting a Match. Prior to the start of each Match, the Robot must be placed such that it is:
   a. Contacting its Home Zone.
   b. Not contacting the gray foam field tiles outside of the Alliance's Home Zone.
   c. Not contacting any Balls other than the Preload.
   d. Not contacting another Robot.
   e. Contacting exactly one (1) Preload.
       i. The Preload must be contacting exactly one (1) Robot.
       ii. The Preload must be fully within the field perimeter.
       iii. The Preload must not be breaking the vertical projection of the Goal, i.e., the Preload must not be inside or above the Goal.

<SG2> N/A

<SG3> N/A

<SG4> N/A

<SG5> Balls may not be de-scored from the top of Goals. Balls that are Scored may not be lifted by any means such that the Ball goes above the top edge of the Goal.

It is expected that while removing Balls from the bottom of the Goal, this may cause the top Ball to momentarily go above the top edge of the Goal. This would not be a violation of this rule and is considered to be normal game play.

If the Match ends while a Robot is removing a Ball from the bottom of the Goal that contains three (3) Balls and the top Ball remains partially above the top edge of the Goal, that Ball will be considered Scored and no penalty to the Team will be assessed.

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.
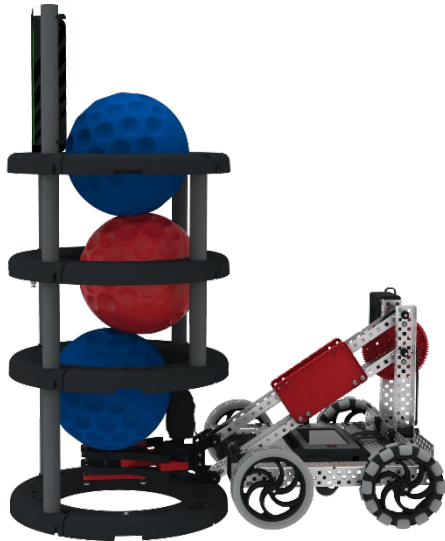
Figure 11: If this situation occurs at the end of a match, this goal would still be owned by the Blue Alliance and the top-most Ball would be scored even though it is not fully within the upper edge of the goal. No penalty should be assessed.

<SG6> Keep Game Objects in the field. Teams may not intentionally remove Game Objects from the field. While Game Objects may accidentally leave the field when attempting to Score, doing so intentionally or repeatedly would be a violation of this rule. Game Objects that leave the field during Match play, intentionally or unintentionally, will not be returned.

<SG7> N/A

<SG7> Possession is limited. Robots may not have greater-than-momentary Possession of more than three (3) Balls at once.

Robots that violate this rule must stop all Robot actions except for those actions that are attempting to remove the excess Ball.

Minor violations of this rule that are not Match Affecting will receive 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.

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> One Robot per Team. Only one (1) Robot will be allowed to compete per Team. Though it is expected that Teams will make changes to their Robot at the competition, a Team is limited to only one (1) Robot. 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 second Robot and are no longer legal.

1. Teams may not compete with one Robot while a second is being modified or assembled.
2. Teams may not switch back and forth between multiple Robots during a competition. This includes using different Robots for Driving Skills and Programming Skills.
3. 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 box. At the beginning of any Match, Robots must be smaller than 18" (457.2 mm) long by 18" (457.2 mm) wide by 18" (457.2 mm) 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 EDR system. Robots may be built ONLY using official VEX EDR 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 EDR 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. An unlimited amount of plastic 3D printed parts may be used on the Robot using PLA, PETG and/or ABS. These parts must be documented in the Engineering Notebook and explained why they are chosen including how they were printed.
Note: Using a 3D printer to make molds for casting or injection molding is not legal and not within the spirit of this rule.

<RE9> 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. For securing and retaining a VEXnet Key 2.0 to the VEX ARM® Cortex®-based Microcontroller. Using tape in this manner is highly recommended to ensure a robust connection.
6. In any other application that would be considered a "non-functional decoration" per <R12>.

<RE10> 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. Robots must use ONLY one (1) VEX EDR Microcontroller.
1. Examples of VEX EDR Microcontrollers are the VEX ARM® Cortex®-based Microcontroller (276- 2194) and the V5 Robot Brain (276-4810).
2. Any other microcontrollers or processing devices are not allowed. This includes microcontrollers that are part of other VEX product lines, such as VEXpro, VEX RCR, VEX IQ, or VEX Robotics by HEXBUG; it also includes devices that are unrelated to VEX, such as Raspberry Pi or Arduino devices.

<RE12> Robots use VEXnet. Robots must ONLY utilize the VEXnet system for all Robot communication.
1. VEX 75Mhz Crystal Radios are prohibited.
2. Electronics from the VEXpro, VEX RCR, VEXplorer, VEX IQ, or VEX Robotics by HEXBUG product line are prohibited.
3. Mixing and matching of VEXnet transmitters and receivers is prohibited. The VEXnet Joystick may only be used in conjunction with a VEX ARM® Cortex®-based Microcontroller. A VEXnet upgraded 75MHz Transmitter may only be used in conjunction with a PIC Microcontroller. A V5 Controller may only be used in conjunction with a V5 Robot Brain.
4. Teams are permitted to use the Bluetooth® capabilities of the V5 Robot Brain and/or V5 Controller in team pits or outside of Matches. However, VEXnet must be used for wireless communication during Matches.

<RE13> Robots use one control system. Robots may use either:
   Option 1: A VEX ARM® Cortex®-based Microcontroller, up to ten (10) 2-Wire Motors or VEX Servos (in any combination up to ten) and a legal VRC pneumatic system per <RE22>.
   Option 2: A VEX ARM® Cortex®-based Microcontroller, up to twelve (12) 2-Wire Motors or VEX Servos (in any combination up to 12) and no pneumatic components, excluding pneumatic tubing.

Option 3: A V5 Robot Brain, up to six (6) V5 Smart Motors, and a legal VRC pneumatic system per <RE22>.

Option 4: A V5 Robot Brain, up to eight (8) V5 Smart Motors, and no pneumatic components, excluding pneumatic tubing.

Option	Control System	Pneumatics	2-Wire Motors or Servos	Smart Motors
1	Cortex	Y	10	0
2	Cortex	N	12	0
3	V5	Y	0	6
4	V5	N	0	8

Table 1: The four combinations of control system, motors and pneumatics that are legal.

<RE14> One motor or Y cable per motor port. If using a VEX ARM® Cortex®-based Microcontroller, a maximum of one (1) VEX Y-cable can be used per Motor Port of the Microcontroller or Power Expander. (You cannot "Y off a Y" to have more than two (2) motors controlled by the same Motor Port.)

1. Teams using the VEX ARM® Cortex®-based Microcontroller may only power one (1) 2-wire Motor per each of the two 2-wire motor ports on the Microcontroller. It is illegal to "Y" off a 2-wire Motor Port.
2. Teams may not "Y" off of a Motor Controller 29 (276-2193).

<RE15> Electrical power comes from VEX batteries only. The only allowable source(s) of electrical power are as follows:

1. If using a VEX ARM® Cortex®-based Microcontroller, Robots may use (1) VEX 7.2V Robot Battery Pack of any type.
   a. Robots utilizing the VEX Power Expander may use a second VEX 7.2V Robot Battery of any type. Robots are permitted to use a maximum of one (1) VEX Power Expander.
   b. The only legal means for charging a VEX 7.2V Battery Pack is via one of the following VEX Battery Chargers: Smart Charger (276-1445); Smart Charger v2 (276-2519); 276-2221 (discontinued), 276-2235 (discontinued). All other chargers are strictly prohibited.
   c. Teams must connect a charged 9V backup battery to their VEXnet system using the VEXnet Backup Battery Holder (276-2243).
   d. VEXnet Joysticks must only be powered by AAA batteries.
2. If using a V5 Robot Brain, Robots may use (1) V5 Robot Battery (276-4811).
   a. There are no legal power expanders for the V5 Robot Battery.
   b. V5 Robot Batteries may only be charged by the V5 Robot Battery Charger (276-4812).
   c. V5 Wireless Controllers may only be powered by their internal rechargeable battery. Teams are permitted to have an external power source (such as a rechargeable battery pack) plugged into their V5 Controller during a Match, provided that this power source is connected safely and does not violate any other rules.

	VEX ARM® Cortex®-based Microcontroller			V5 Robot Brain		
Component	Legal Parts	Legal Chargers	Maximum Quantity	Legal Parts	Legal Chargers	Maximum Quantity
Robot Battery	276-1456 276-1491	276-1445 276-2519 276-2221 276-2235	1 (2 with Power Expander)	276-4811	276-4812	1
Power Expander	276-2271	N/A	1	None	None	0
Transmitter Battery	AAA Battery	Any safe AAA charger	6 (per transmitter)	276-4820 (internal)	Any safe Micro-USB cable	1 (per transmitter)
Transmitter Field Power	276-1701	N/A	1	None	None	0
Backup Battery	9V battery	N/A	1	None	None	0

Table 2: *The legal sources for electrical power.*

<RE16> One or two controllers per Robot. No more than two (2) VEX 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. i. Using sensor feedback to augment driver control (such as motor encoders or the Vision Sensor) is acceptable.
3. Teams may not "mix-and-match" wireless remote types, such as using a VEXnet Joystick and V5 Wireless Controller at the same time.

<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 EDR 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 on/off switch 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. Pneumatic devices may only be charged to a maximum of 100 psi. Teams may only use a maximum of two (2) legal VEX pneumatic air reservoirs on a Robot.

<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.
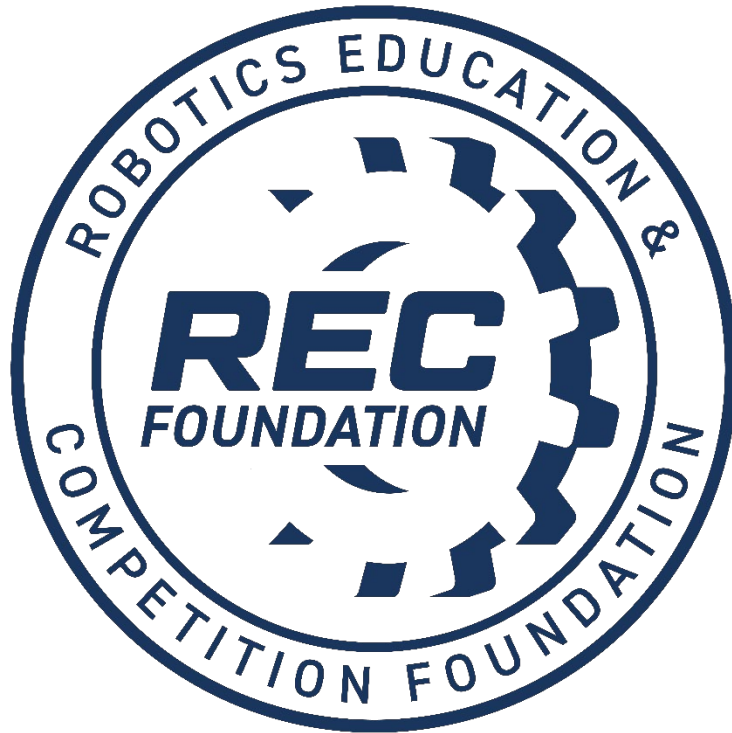
MOBILE ROBOTICS TECHNOLOGY APPENDIX

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 _____

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)

REC FOUNDATION

Team Number _____

Highest Score _____

Trial 1

Red Alliance Score

Red Balls   ____ x 1 = _____(a)

Red Rows   ____ x 6 = _____(b)

Red Alliance Score   (a + b) = _____(c)

Blue Alliance Score

Blue Balls   ____ x 1 = _____(d)

Blue Rows   ____ x 6 = _____(e)

Blue Alliance Score   (d + e) = _____(f)

(Red Alliance Score) – (Blue Alliance Score) + 63   = Trial 1 Score

_____ – _____ + 63   = [   ]
       (c)   **(f)**

Trial 2

Red Alliance Score

Red Balls   ____ x 1 = _____(a)

Red Rows   ____ x 6 = _____(b)

Red Alliance Score   (a + b) = _____(c)

Blue Alliance Score

Blue Balls   ____ x 1 = _____(d)

Blue Rows   ____ x 6 = _____(e)

Blue Alliance Score   (d + e) = _____(f)

(Red Alliance Score) – (Blue Alliance Score) + 63   = Trial 2 Score

_____ – _____ + 63   = [   ]
       (c)   **(f)**

Trial 3

Red Alliance Score

Red Balls   ____ x 1 = _____(a)

Red Rows   ____ x 6 = _____(b)

Red Alliance Score   (a + b) = _____(c)

Blue Alliance Score

Blue Balls   ____ x 1 = _____(d)

Blue Rows   ____ x 6 = _____(e)

Blue Alliance Score   (d + e) = _____(f)

(Red Alliance Score) – (Blue Alliance Score) + 63   = Trial 3 Score

_____ – _____ + 63   = [   ]
       (c)   **(f)**

Driving Skills Matches

REC FOUNDATION

Team Number _____

(2-minute matches)

Highest Score _____

Trial 1

Red Alliance Score

Red Balls	____ x 1 = _____(a)
Red Rows	____ x 6 = _____(b)
Red Alliance Score	(a + b) = _____(c)

Blue Alliance Score

Blue Balls	____ x 1 = _____(d)
Blue Rows	____ x 6 = _____(e)
Blue Alliance Score	(d + e) = _____(f)

(Red Alliance Score) – (Blue Alliance Score) + 63 = **Trial 1 Score**

_____ – _____ + 63 = [   ]
     (c)   **(f)**

Trial 2

Red Alliance Score

Red Balls	____ x 1 = _____(a)
Red Rows	____ x 6 = _____(b)
Red Alliance Score	(a + b) = _____(c)

Blue Alliance Score

Blue Balls	____ x 1 = _____(d)
Blue Rows	____ x 6 = _____(e)
Blue Alliance Score	(d + e) = _____(f)

(Red Alliance Score) – (Blue Alliance Score) + 63 = **Trial 2 Score**

_____ – _____ + 63 = [   ]
     (c)   **(f)**

Trial 3

Red Alliance Score

Red Balls	____ x 1 = _____(a)
Red Rows	____ x 6 = _____(b)
Red Alliance Score	(a + b) = _____(c)

Blue Alliance Score

Blue Balls	____ x 1 = _____(d)
Blue Rows	____ x 6 = _____(e)
Blue Alliance Score	(d + e) = _____(f)

(Red Alliance Score) – (Blue Alliance Score) + 63 = **Trial 3 Score**

_____ – _____ + 63 = [   ]
     (c)   **(f)**

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	50 x 4 = 200		4	
Highest Driving Skills Score	125 x 1 = 125		1	
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