Mobile Robotics Technology

2022-23 Game Manual for Middle School Teams

Presented by: Competition Pros Inc.

Adapted from: VEX IQ Competition Slapshot

In Partnership with: VEX Robotics and REC Foundation

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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 VEX IQ Challenge (VIQC) Slapshot Robot Skills Challenge. Students can participate in both VIQC 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 VIQC 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 may be interested in pursuing coursework in a career and technical education engineering program or a program that integrates robotics, engineering orpre-engineering techniques as an integral component of the instructional program.

CLOTHING REQUIREMENT

Class E: Contest specific – Business Casual

Official SkillsUSA white polo shirt

Black dress slacks or black dress skirt (knee-length minimum)

Black closed-toe dress shoes

Note: Wearing socks or hose is no longer required. If worn, socks must be black dress socks and hose must be either black or skin-tone and seamless/nonpattern.

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) 501-2183.

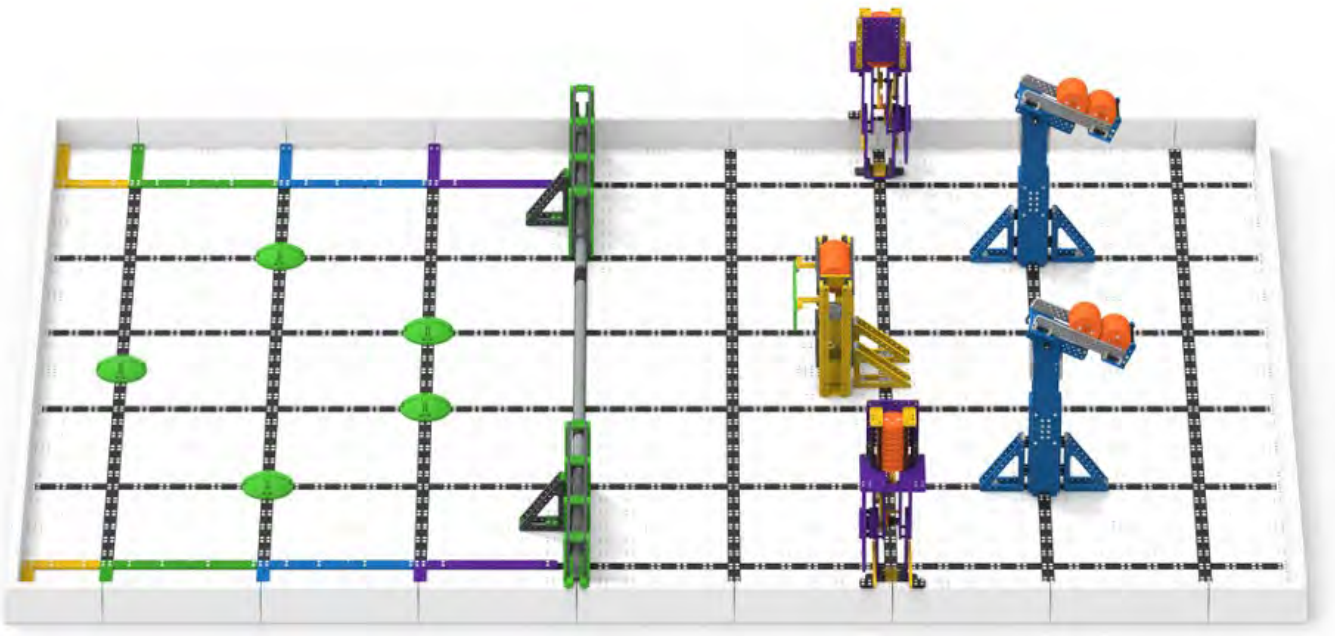
THE GAME

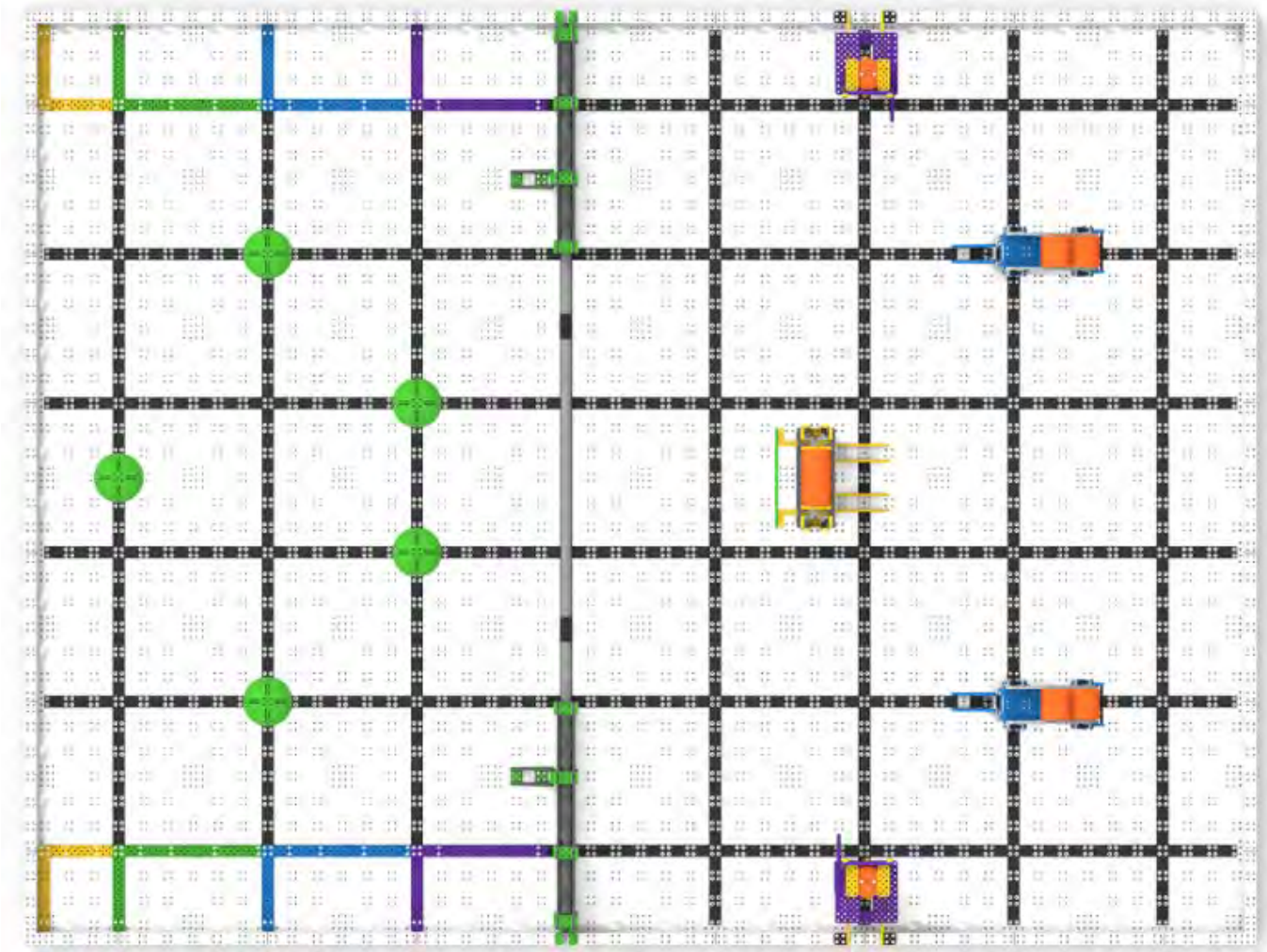
A Primer

VEX IQ Competition (VIQC) Slapshot is played on a 6’ x 8’ rectangular Field, set up as illustrated in the figures throughout this manual.

The object of the game is to score points by Removing Discs from Dispensers, by placing Discs into Goal Zones, and by getting Contact Bonuses at the end of the Match.

Teams compete in Robot Skills Challenge Matches, where one (1) Robot tries to score as many points as possible.





General Definitions

Adult - Anyone who is not a Student.

Alliance - A pre-assigned grouping of two (2) Teams that are paired together during a given Teamwork Match.

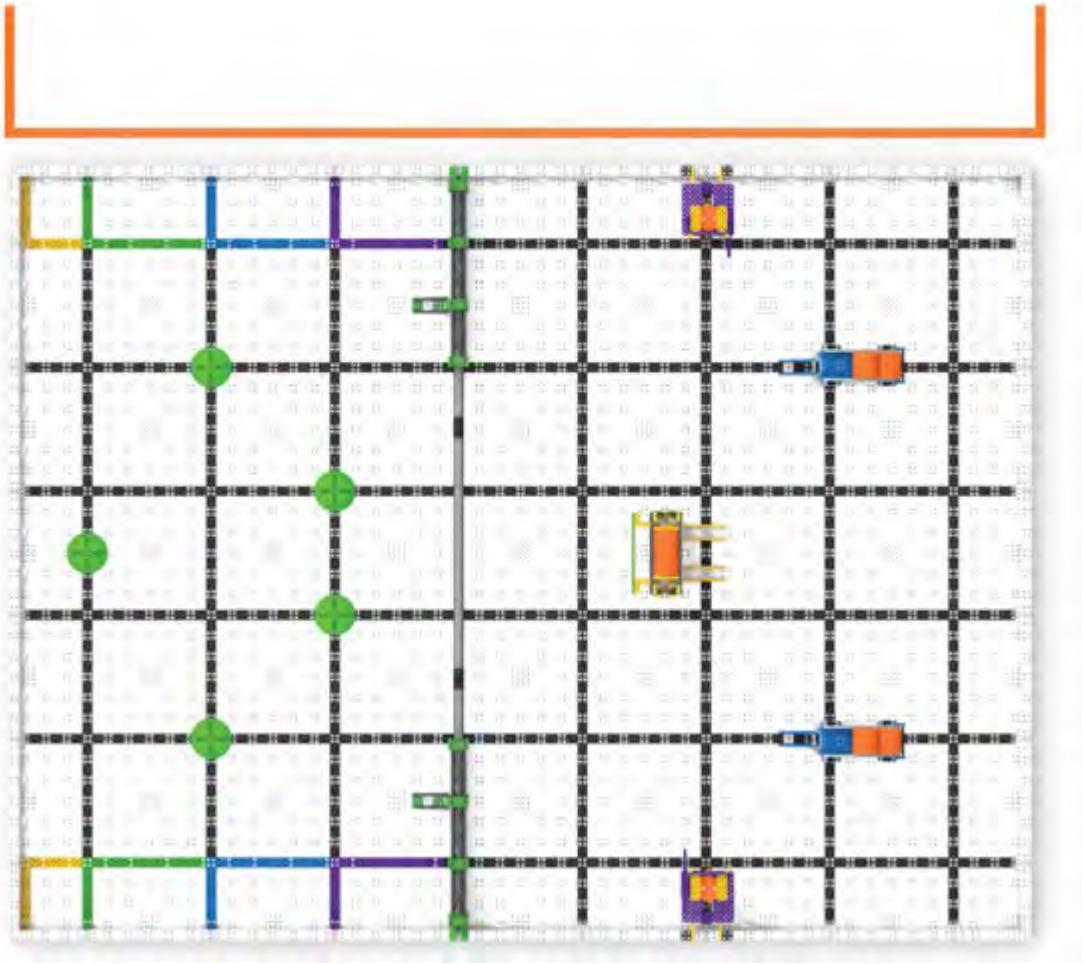
Alliance Score - Points scored in a Teamwork Match that are awarded to both Teams.

Disablement - A penalty applied to a Team for a rule violation. During Disablement, a Team is no longer allowed to operate their Robot, and the Drivers will be asked to place their Controller on the ground. A Disablement is not the same as a Disqualification.

Disqualification - A penalty applied to a Team for a rule violation (see <T12> for more details). If a Team is Disqualified in a Match, the Head Referee will notify the Team of their violation at the end of the Match. At the Head Referee's discretion, repeated violations and / or Disqualifications for a single Team may lead to its Disqualification for the entire event.

Driver - A Student Team member who stands in the Driver Station and is responsible for operating and controlling the Team's Robot. Up to two Team members per Team may fulfill this role in a given Match (see <G6>).

Driver Station - The region behind the Field, where the Drivers must remain during their Match unless legally interacting with their Robot.



Field - The entire playing Field, being six (6) field tiles wide by eight (8) field tiles long (totalling forty-eight (48) field tiles), including the Field Perimeter.

Field Element - All elements that make up the Field, including the Field Perimeter, Floor, PVC pipes, and any VEX IQ parts attached to any of the above.

Field Perimeter - The outer part of the Field, made up of four (4) outside corners and twenty-four (24) straight sections.

Floor - The interior flat part of the playing Field, made up of the forty-eight (48) field tiles that are within the Field Perimeter.

Game Design Committee (GDC) - The creators of VIQC Slapshot, and authors of this Game Manual.

License Plate - A physical component on the Robot that has the Team's VEX IQ Competition number displayed. The License Plate must have a length and height of 3.5" x 1.5" (88.9mm x 38.1mm) and must not exceed a width of 0.25" (6.35mm) per <R4>.

Match - A set time period during which Teams play a defined version of Slapshot to earn points. See Section 3.

- **Autonomous Period -** A time period during which Robots operate and react only to sensor inputs and to commands pre-programmed by the Students into the Robot control system.
- **Driver Controlled Period** - A time period during which Drivers operate their Robot.

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

Student - Students are the individuals who design, build, repair, and program the Robot with minimal Adult assistance.

Team- Two Students make up a Team.

- **Builder -** The Student(s) on the team who assemble(s) the Robot. An Adult cannot be a Builder on a Team. Adults are permitted to teach the Builder(s) associated concepts, but may never work on the Robot without the Builder(s) 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 a Designer on a Team. Adults are permitted to teach the Designer(s) associated concepts, but may never work on the design of the Robot without the Designer(s) present and actively participating.
- **Programmer -** The Student(s) on the Team who write(s) the computer code that is downloaded onto the Robot. An Adult cannot be a Programmer on a Team. Adults are permitted to teach the Programmer(s) associated concepts, but may never work on the code that goes on the Robot without the Programmer(s) present and actively participating.

Violation - The act of breaking a rule in the Game Manual.

- **Minor Violation -** A Violation which does not result in a Disqualification.
    - Accidental, momentary, or otherwise non-Score Affecting Violations are usually Minor Violations.
    - Minor Violations usually result in a verbal warning from the Head Referee during the Match, which should serve to inform the Team that a rule is being Violated before it escalates to a Major Violation.
- **Major Violation** - A Violation which results in a Disqualification.
    - Unless otherwise noted in a rule, all Score Affecting Violations are Major Violations.
    - If noted in the rule, egregious or intentional Violations may also be Major Violations.
    - Multiple Minor Violations within a Match or tournament may escalate to a Major Violation, at the Head Referee's discretion.

- **Score Affecting -** A Violation which improves a Team's or an Alliance's score at the end of a Match.
    - Multiple Violations within a Match can cumulatively become Score Affecting.
    - When evaluating if a Violation was Score Affecting, Head Referees will focus primarily on any Robot actions that were directly related to the Violation.
    - Determining whether a Violation was Score Affecting can only be done once the Match is complete and the scores have been calculated.

  Some rules include Violation Notes in a red italicized text to denote special circumstances or provide additional clarifications. If no Violation Notes are found in a given rule, then it should be assumed that the above "default" definitions apply.

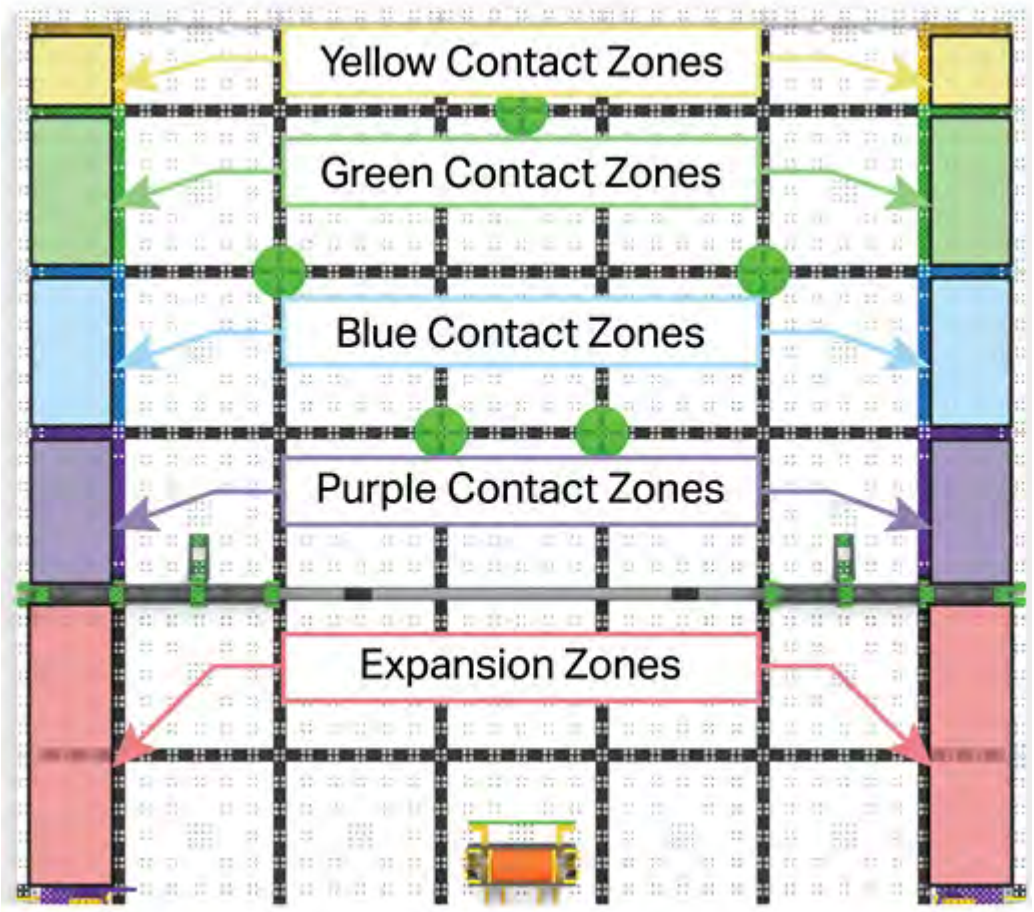
  To determine whether a Violation may have been Score Affecting, check whether the Violation directly contributed to increasing the score of the Match. If it did not increase the Alliance's score, then the Violation was not Score Affecting, and it was very likely a Minor Violation.

Game-Specific Definitions

Contact Bonus - A point bonus achieved at the end of a Match. See <SC4> for more details.

Contact Zone - One of the regions of the Field, as shown in Figure 5, where Teams can receive the Contact Bonus.

- Contact Zones are bordered by the Field Perimeter, the Fence, and / or VEX IQ beams. These bordering elements are not considered part of their respective Contact Zones.
- Contact Zones are defined as the Floor itself; they are not infinitely vertical volumes.

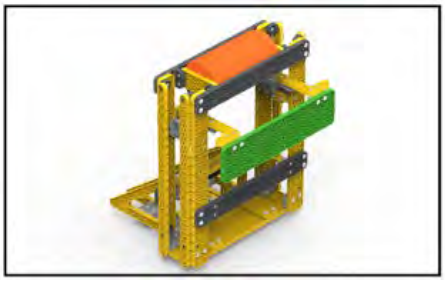


Disc - An orange, plastic, roughly cylindrical object with the following approximate dimensions:

- Diameter: 2.5 Inches (63.5 mm)
- Height: 0.5 Inches (12.7 mm)
- Weight: 0.02 lbs (10 grams)

Dispenser - A structure built out of VEX IQ parts which contains Discs at the beginning of the Match. Robots can interact with Dispensers to Remove Discs for points. There are five (5) Dispensers total:

- One yellow Dispenser, containing nine (9) Discs
- Two blue Dispensers, containing ten (10) Discs each
- Two purple Dispensers, containing eight (8) Discs each

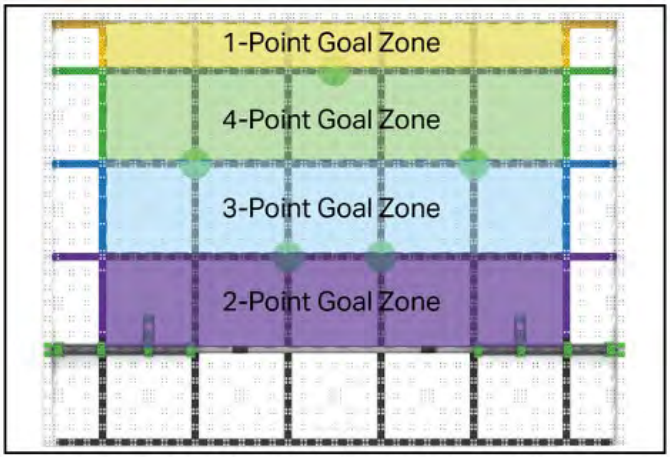


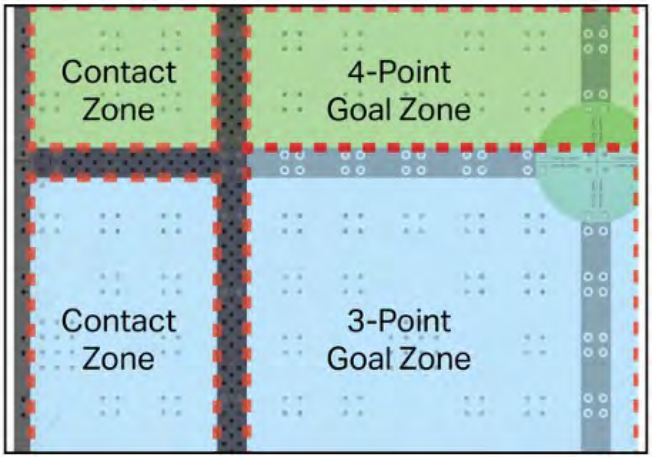
Expansion Zone - One of the regions of the Floor, as shown in Figure 5, where Robots can expand horizontally beyond the 11” x 19” limit. See rule <G13>.

Fence - The gray PVC pipe, and all supporting structures built out of VEX IQ parts, which spans the entire width of the Field.

Fence Line - The black line on the Floor which runs immediately underneath and parallel to the Fence. The Fence Line borders the 2-Point Goal Zone, the Purple Contact Zones, and the purple VEX IQ parts bordering the Purple Contact Zones.

Goal Zone - One of the regions of the Field, as shown in Figure 9, in which Discs can earn points. Goal Zones are defined as infinitely vertical 3-dimensional projections of these regions of the Floor; they are not just the Floor itself.





Removed - A Disc status. A Disc is considered Removed from a Dispenser if it meets the following criteria:

- It is one of the 45 Discs which begin the Match in Dispensers
- It ends the Match having moved from its original position such that it is no longer fully supported by its Dispenser (i.e., its Dispenser has been “triggered” by a Robot).

Scored - A Disc status. See the Scoring section for more information.

Scoring

Each *Disc Scored* in a *Goal Zone*	The point value corresponding to that *Goal Zone*
Each *Disc Removed* from a *Dispenser*	1 point
Each *Robot* that achieves the *Contact Bonus*	Additional 1 point per *Disc* that is *Scored* in the corresponding *Goal Zone*

Scoring Detail

<SC1> All Scoring statuses are evaluated immediately after the Match ends, once all Discs, Field Elements, and Robots on the Field come to rest

a) Referees and other event staff are not allowed to review any videos or pictures from the Match, per <T1b>.
b) If there is a concern regarding the score of a Match, only the Drivers from that Match, not an Adult, may share their questions with the Head Referee.
c) This rule's intent is for Driver inputs and Robot motion to cease at the end of the Match. A pre-programmed routine which causes Robot motion to continue after the end of the Match would violate the spirit of this rule. Any Scoring which takes place after the Match due to Robots continuing to move will not count.

<SC2> Each Disc that is Scored in a Goal Zone is worth the point value corresponding to that Goal Zone. For example, all Discs which are Scored in the 3-Point Goal Zone are worth three (3) points each.

To be considered Scored, a Disc must meet the following criteria:

1) The Disc is not contacting a Robot.
2) The Disc is at least partially within a Goal Zone.
3) The Disc is not contacting a Contact Zone.

If a Disc meets all of the above criteria, and is partially within two Goal Zones, then it is considered Scored in the Goal Zone farthest from the Fence.

<SC3> Disc Scoring examples, per the criteria listed in <SC2>. In these figures, each labeled Disc is highlighted to indicate which Goal Zone it is scored in.

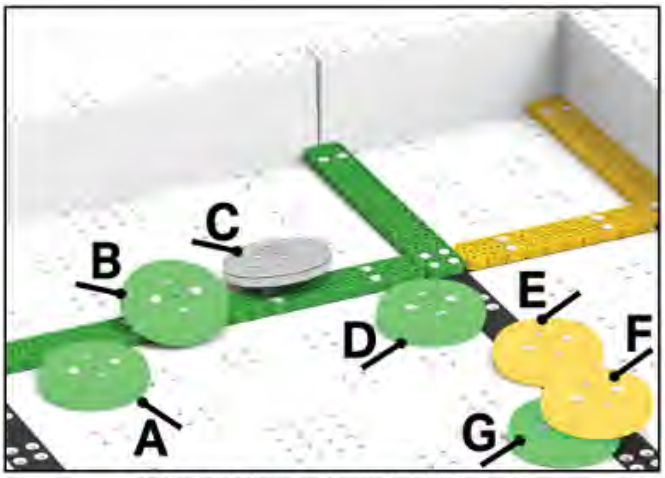


Figure 11: *Scoring Example 1 (side view)*

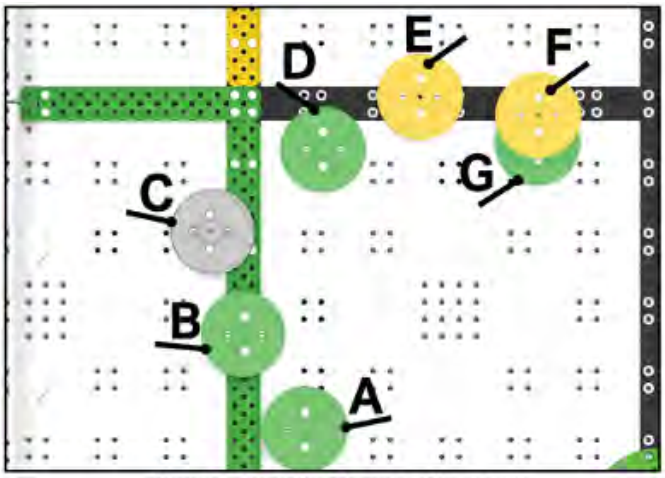
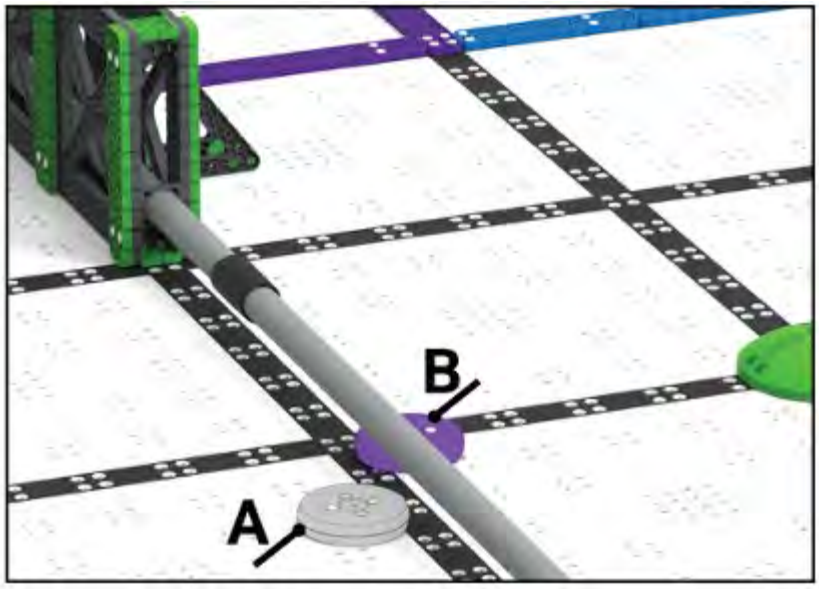


Figure 12: *Scoring Example 1 (top view)*

Disc	Score Value	Explanation
A	4 Points	• Fully within the 4-Point *Goal Zone*
B	4 Points	• Partially within the 4-Point *Goal Zone* • Resting on top of the border of the *Contact Zone* is irrelevant, because the *Disc* is not contacting the *Contact Zone* itself
C	0 Points	• Contact with the *Contact Zone* overrides any other statuses
D	4 Points	• Fully within the 4-Point *Goal Zone* • Contact with the black line is irrelevant, because the black line is still considered part of the 4-Point *Goal Zone*
E	1 Point	• Partially within both the 4-Point and 1-Point *Goal Zones* (i.e., it has "broken the plane" and entered into the 1-Point *Goal Zone*) • The 1-Point *Goal Zone* is further from the *Fence*
F	1 Point	• Partially within the 1-Point *Goal Zone* • Being fully supported by *Disc* G is not relevant; the *Goal Zones* are infinitely vertical volumes, so this *Disc* has "broken the plane" and entered the 1-Point *Goal Zone*
G	4 Points	• Fully within the 4-Point *Goal Zone* • Contact with *Disc* F is not relevant



Disc	Score Value	Explanation
A	0 Points	• Not partially within any *Goal Zone* (i.e., it has not "broken the plane" and entered the 2-Point *Goal Zone*)
B	2 Points	• Partially within the 2-Point *Goal Zone*

<SC4> A Robot achieves a Contact Bonus if any part of the Robot is contacting the Floor inside of a Contact Zone. The Contact Bonus is worth a number of points equal to the number of Discs which are Scored in the Contact Zone's corresponding Goal Zone.

For example, if a Robot is contacting the Purple Contact Zone, and there are five (5) Discs Scored in the 2-Point Goal Zone, then that Robot receives a Contact Bonus of five (5) points.

Note: If a single Robot is contacting the Floor in multiple Contact Zones, then it is not eligible for any Contact Bonuses.

Note 2: Contact Bonuses are awarded separately per Robot, and are added together.

<SC5> Each Disc that is Removed from a Dispenser receives one point. The recommended way to determine how many Discs have been Removed is to look at how many Discs are in a given Dispenser at the end of a Match, and subtract it from the starting quantity for that Dispenser.

For example, if a purple Dispenser ends the Match with 2 Discs left, then it should be reasonably assumed that 6 Discs were Removed from it.

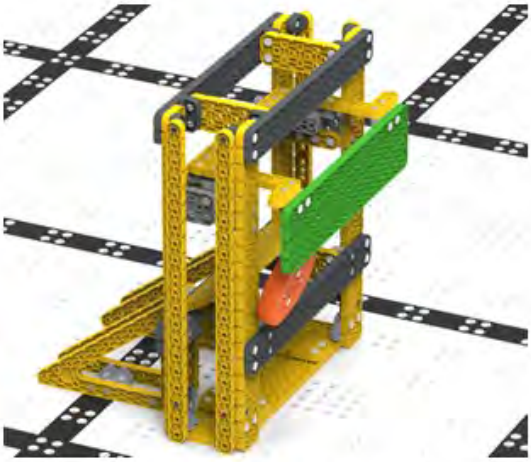


Figure 14: *An example of a Disc that should still be considered as Removed.*

Figure 15: *An example of a Disc that should not be considered as Removed.*

Safety Rules

<S1> Stay safe, don't damage the Field. If, at any time, the Robot operation or Team actions are deemed unsafe or have damaged any Field Elements or Scoring Objects, the offending team may be *Disabled* and/or *Disqualified* at the *Head Referee*'s discretion. The *Robot* will require re-inspection before it may again take the *Field*.

<S2> Health & Safety Guidelines. Some events may establish additional Health & Safety guidelines beyond the scope of this Game Manual. These guidelines will be communicated to all Teams in advance. All Teams (including Students or any Adults associated with the Team) must abide by these guidelines as written. Violation of an event-specific Health & Safety rule may be considered a violation of <G1> and/or the REC Foundation Code of Conduct.

General Game Rules

<G1> Treat everyone with respect. All Students and adults associated with a Team are expected to conduct themselves in a respectful and positive manner while participating in the VEX IQ Challenge. If Team members are disrespectful or uncivil to staff, volunteers, or fellow Teams at an event, the Team may be Disqualified from their current or upcoming Match. Judges may also consider team conduct and ethics when determining awards.

In all aspects of the VEX IQ Challenge program, the Students make the decisions and do the work with adult mentorship. The VEX community prides itself on being a positive learning environment where no one is bullied, harassed, or berated. Teams avoid placing unnecessary stress upon Students and/or event volunteers; instead, challenging situations are viewed as teachable moments to model positive behaviors and good sportsmanship.

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 http://link.roboticseducation.org/recf_codeofconduct.

<G2> VEX IQ is a student-centered program. Adults may assist Students in urgent situations, 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.

Some amount of adult mentorship, teaching, and/or guidance is an expected and encouraged facet of the VEX IQ Challenge. No one is born an expert in robotics! However, obstacles should always be viewed as teaching opportunities, not tasks for an adult to solve without Students present and actively participating. Violation of this rule could be considered a violation of <G1> and/or the REC Foundation Code of Conduct.

During the hours of competition, Adults may not assist Students in any way, including offering advice on how to program, build or drive the Robot.

<G3> Use common sense. When reading and applying the various rules in this document, please remember that common sense always applies in the VEX IQ Challenge.

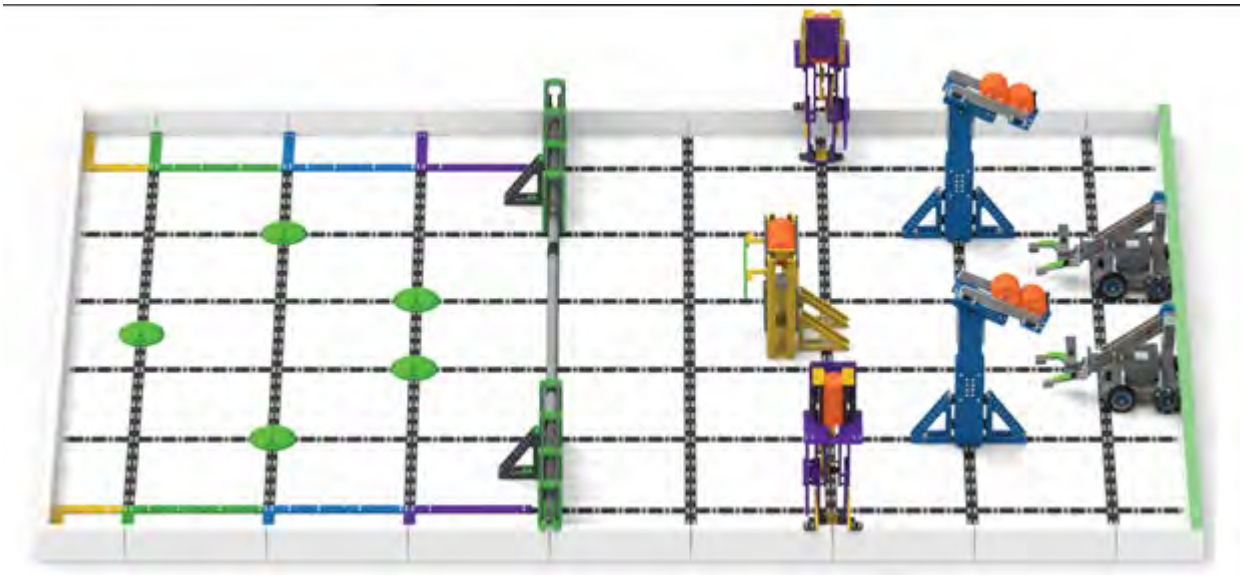
<G4> N/A

<G5> Pre-match setup. At the beginning of a Match, the Robot must meet the following criteria:

1) Not contacting any Discs, other Field Elements, or other Robots.
2) Fit within an 11" x 19" x 15" (279mm x 483mm x 381mm) volume, as checked during inspection per <R5>.
3) Contacting the inner wall of the Field Perimeter that is furthest from the Fence. See the green highlight on Figure 16.

Violation Notes: Any Violations of this rule will result in the Robot being removed from the Field prior to the start of the Match; rules <R3d> and <T17> will apply until the situation is corrected. The Team will not receive a Disqualification, but they will not be permitted to play in the Match.

Note: There are no specific starting positions, as long as the above criteria are met. Head Referees may ask Teams to temporarily move their Robot between two of the black lines on the field for a size check, but there is no requirement for them to start the Match in that location once the size has been verified.



<G6> Drivers switch Controllers midway through the Match.

a. In a given *Match*, only two (2) *Drivers* may be in the *Driver Station* per *Team*. No *Driver* shall operate a *Robot* for more than sixty-five seconds (1:05). The two *Drivers* must switch their controller between fifty-five seconds (0:55) and sixty-five seconds (1:05) remaining in the *Match*. The second *Driver* may not touch his/her *Team*'s controls until the controller is passed to him/her. Once the controller is passed, the first *Driver* may no longer touch his/her *Team*'s controls.
b. For the 2020-2021 season, *Teams* may elect to have one *Driver* in the *Driver Station*, instead of two. If only one *Driver* is present in the *Driver Station*, they may drive for the full *Match*, and a controller switch is not required. It is at the *Team's* discretion whether they wish to have one *Driver* or two. If two *Drivers* are present in the *Driver Station*, the controller switch rules in <G7a> would then apply.
c. *Drivers* are the only *Team* members that are allowed to be in the *Driver Station*. No *Adults* are permitted in the *Driver Station*.

Violations of this rule will result in a warning for minor offenses that do not affect the *Match*. Score affecting offenses will result in a *Disqualification*. *Teams* who receive multiple warnings may also receive a *Disqualification* at the *Head Referee's* discretion.

<G7> Drivers drive your Robot and stay in the Driver Station. During a Match, Robots may only be operated by that Team's Drivers. Drivers must remain in their Driver Station, except when legally interacting with their Robot as per <G16>. Drivers are not allowed to use any communication devices during their Match. Devices with communication features turned off (e.g. a phone in airplane mode) are allowed.

<G8> Hands out of the Field. Drivers are prohibited from making intentional contact with any Field Element, Ball, or Robot during a Match, except for the allowances in <G17> and/or <RSC7>.

Violations of this rule will result in a warning for minor offenses that do not affect the Match. Score affecting offenses will result in a Disqualification. Teams who receive multiple warnings may also receive a Disqualification at the Head Referee's discretion.

> **Note**: Accidental contact may result in a warning, Disqualification, or Disablement at the Head Referee's discretion.

<G9> Keep Discs in the Field. Balls that leave the Field during a Match will not be returned. "Leaving the Field" means that a Ball is outside of the vertical projection of the Field Perimeter and no longer in contact with the Field, Field Elements, other Balls, or Robots.

<G10> Keep your Robot together. Robots may not intentionally detach parts or leave mechanisms on the Field during any Match. If an intentionally detached component or mechanism affects gameplay, the Team may be Disqualified at the Head Referee's discretion.

> **Note**: Parts that become unintentionally detached from the Robot are no longer considered to be part of the Robot and can be either left on the Field or collected by a Driver (utilizing <G17>).

<G11> Don't damage the Field. Robot interactions which damage the Field or any Field Element are prohibited. For the purpose of this rule, "damage" is defined as anything which requires repair in order to begin the next Match.

Specific examples include, but are not limited to:

- A Dispenser detaching from the Floor
- VEX IQ parts detaching from a Dispenser structure
- The PVC pipe detaching from the Fence

Note: The purple Dispenser is designed to spin counter-clockwise. Intentionally attempting to rotate the purple Dispenser mechanism in the wrong direction (clockwise) creates a significant risk of Field Element damage, and is strictly prohibited.

Violation Notes: In most cases, Field damage is accidental and does not impact the final score, and should therefore only be considered a Minor Violation / formal warning.

However, any Field damage which results in Discs becoming Removed is inherently Score Affecting. Therefore, if the Head Referee determines that this damage was accidental, they may choose to issue a Match Replay, per <T19>, in lieu of a Major Violation.

Egregious, intentional, or repeated accidental / Minor Violations may escalate to a Major Violation at the Head Referee's discretion.

<G12> Handling the Robot mid-match is allowed under certain circumstances. If a Robot goes completely outside the playing Field, gets stuck, tips over, or otherwise requires assistance, the Team's Drivers may retrieve & reset the Robot. To do so, they must:

1) Signal the Head Referee by placing their VEX IQ Controller on the ground.
2) Any Disc being controlled by the Robot while being handled must be removed from the Field.
    a. In the context of this rule, "controlled" implies that the Robot was manipulating the Disc, and not simply touching it. For example, if the Disc moves with the Robot either vertically or while turning, then the Robot is "controlling" the Disc.
3) The Robot must be placed back into a legal position that meets the criteria listed in <G5> (i.e., contacting the Field Perimeter, not contacting any Discs, etc.).

If the Driver cannot reach a Robot in the center of the Field, they may ask the Head Referee to pick up the Robot and hand it to the Driver for placement according to the conditions above.

Violation Notes: This rule is intended so Teams can fix damaged Robots or help get their Robots "out of trouble." It is not intended for Teams to use as part of a strategy to gain an advantage during a Match, including via moving Balls per parts c and d above. If a Head Referee sees Teams strategically exploiting this rule, they may be Disqualified from said Match.

<G13> Horizontal expansion is limited during a Match. Robots may only expand horizontally beyond the 11" x 19" starting dimension limit if they are contacting the Expansion Zone.

Note: There are no restrictions on vertical expansion.

<G14> Don't cross the Fence Line until Contact. Robots may only extend over the Fence Line and "break the plane" of the 3-dimensional area of the 2-Point Goal Zone if they are contacting the Expansion Zone.

<G15> Discs that have crossed the Fence Line are "off limits". Robots may not contact any Discs which have fully crossed the Fence Line, regardless of whether the Robot is contacting an Expansion Zone or not.

Note: This rule is not transitive through Discs. For example, if Robot B pushed Disc H into Disc F without "breaking the plane" of the 2-Point Goal Zone, this would not be considered a violation.

Violation Notes: The intent of rules <G14> and <G15> are to prevent Robots from interacting with Discs which have already crossed the Fence Line.

<G16> Discs go under the Fence, not over it. Discs may only be Scored in Goal Zone by passing them underneath the gray PVC pipe. Robot actions such as “dumping,” “placing,” or “throwing” Discs over the Fence are strictly prohibited, and will result in a Disqualification.

Note: Discs which incidentally bounce over the Fence upon being Removed from a Dispenser are not considered a violation of this rule.

Violation Notes: Since this rule is inherently Score Affecting, all Violations will be considered Major Violations.

Robot Skills Challenge Specific Rules

<RSC1> N/A

<RSC2> N/A

<RSC3> N/A

<RSC4> N/A

<RSC5> Handling the Robot mid-match is allowed during Programming Skills Matches. A Team may handle their Robot as many times as desired during a Programming Skills Match.

a) Upon handling the Robot, it must be immediately brought back to any legal starting position.
    a. Drivers may reset or adjust the Robot as desired from this position, including pressing buttons on the Robot Brain or activating sensors.
b) Any Discs being controlled by the Robot while being handled must be removed from the Field. “Controlled” requires that the Robot was manipulating the Disc and not simply touching it (e.g., if the Disc moves with the Robot either vertically or while turning, the Robot is controlling the Disc).
c) Any Discs in the new starting position must be removed from the Field for the remainder of the Match.
d) During a Programming Skills Match, Drivers may move freely around the Field, and are not restricted to the Driver Station when not handling their Robot.
    a. The remainder of <G7>, which states that Drivers are not allowed to use any communication devices during their Match, still applies.
    b. An intent of this exception is to permit Drivers who wish to “stage” Robot handling during a Programming Skills Match to do so without excessive running back and forth to the Driver Station..

<RSC6> Starting a Programming Skills Match. Drivers must start a Robot’s Programming Skills Match routine by pressing a button on the Robot Brain or manually activating a sensor. Because there is no VEX IQ Controller handoff, only one (1) Driver is required for Programming Skills Matches (although Teams may still have two (2) if desired). Pressing a button on the VEX IQ Controller to begin the Programming Skills Match routine is not permitted.

ROBOT EQUIPMENT

General Robot Rules

<R1> One Robot per Team. Only one (1) Robot will be allowed to participate per Team in the Jr. Mobile Robotics Technology Competition. Though it is expected that Teams will make changes to their Robot at the event, a Team is limited to only one (1) Robot, and a given Robot may only be used by (1) Team. The VEX IQ system is intended to be a mobile robotics design platform. As such, a VEX IQ Challenge Robot, for the purposes of the VEX IQ Challenge, has the following subsystems:

Subsystem 1: Mobile robotic base including wheels, tracks, 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 VEX IQ legal battery, a VEX IQ control system, and associated Smart Motors for the mobile robotic base.

Subsystem 3: Additional mechanisms (and associated Smart Motors) that allow manipulation of Balls or navigation of Field obstacles.

Given the above definitions, a minimum Robot for use in Robot Skills Challenges must consist of subsystem 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.

a. Teams may not participate with one Robot while a second is being modified or assembled.
b. Teams may not switch between multiple Robots. This includes using different Robots for Robot Skills Challenge Matches.
c. Multiple Teams may not use the same Robot during a competition or season. 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.
d. Robots which have not passed inspection (i.e. who are in violation of one or more Robot rules) will not be permitted to play in any Matches until they have done so.
e. If a Robot has passed inspection but is later found to be in violation of a Robot rule during a Match, then they will be Disqualified from that Match and <R2d> will apply until the violation is remedied and the Team is re-inspected.

<R2> Robots must be a representation of the skill level of the Team. The *Robot* must be designed, built and programmed by members of the *Team*. *Adults* are permitted to mentor and teach design, building and programming skills to the *Students* on the *Team*, but may not design, build or program that team's *Robot*.

<R3> Robots must pass inspection. The Team's Robot must pass inspection before being allowed to participate in any Matches. Noncompliance with any Robot design or construction rule may result in Disqualification of the Robot at an event.

a. If significant changes are made to a Robot, it must be re-inspected before it will be allowed to participate in a Match.
b. If a Robot has multiple functional configurations, all possible configurations must be inspected before being used in competition.
c. Teams may be requested to submit to random inspections by event personnel during the event. Refusal to submit will result in Disqualification.
d. Referees or inspectors may decide that a Robot is in violation of the rules. In this case, the Team in violation will be Disqualified and the Robot will be barred from the Field until it passes re-inspection.

<R4> N/A

<R5> Starting Configuration. At the start of each Match, the Robot must be able to satisfy the following constraints:

a. Only be contacting the Floor and/or the Field Perimeter.
b. Fit within an 11" x 19" (279.4mm x 482.6mm) area, bounded by the Starting Position.
c. Be no taller than 15" from the Floor.

<R6> The starting configuration will be inspected. The starting configuration of a Robot at the beginning of a Match must be the same as the Robot configuration that was inspected for compliance, and within the maximum allowed size.

a. Teams using more than one Robot configuration at the beginning of Matches must tell the inspector(s) and have the Robot inspected in its largest configuration(s).
b. A Team may NOT have its Robot inspected in one configuration and then place it in an uninspected configuration at the start of a Match.

<R7> VEX IQ product line. Robots may be built ONLY from official robotic components from the VEX IQ product line.

a. Official VEX IQ products are ONLY available from VEX Robotics & official VEX Resellers. To determine whether a product is "official" or not, consult www.vexiq.com.
b. If an inspector or other event official questions whether something is an official VEX IQ component, the Team will be required to provide documentation to an Inspector that proves the component's source. Such types of documentation could include receipts, part numbers, or other printed documentation.
c. Only the VEX IQ components specifically designed for use in Robot construction are allowed. Using additional components outside their typical purpose is against the intent of the rule (i.e. please don't try using VEX IQ apparel, team or event support materials, packaging, Field Elements, or other non-robot products on a VEX IQ Challenge Robot).
d. Products from the VEX V5, Cortex, or VEXpro product line cannot be used for Robot construction. Products from the V5 product line that are also cross-listed as part of the VEX IQ product line are legal. A "cross-listed" product is one which can be found in both the VEX IQ and V5 sections of the VEX Robotics website.
e. Mechanical/structural components from the VEX GO and VEX Robotics by HEXBUG product lines are so similar they would be nearly impossible to differentiate from the VEX IQ product line and therefore are legal. Please note that those product lines are designed to have the parts come apart more easily and might not be advantageous in a competitive environment.
f. Electrical components from the VEX GO and VEX Robotics by HEXBUG product lines are illegal for use.
g. Official components from the VEX IQ product line that have been discontinued are still legal for Robot use. If using a discontinued part, Teams must be cognizant of <R7a>.
h. 3D printed components, such as replicas of legal VEX IQ parts or custom designs, are not legal for Robot use.
i. Additional VEX IQ products that are released during the season are legal for use.

<R8> N/A

<R9> One Brain per Robot. Robots are limited to one (1) VEX IQ Robot Brain.

a. Robot Brains, microcontrollers, or other electronic components that are part of the VEX Robotics by HEXBUG, VEX EDR, or VEXpro product lines are not allowed.
    i. The Robot AA Battery Holder (228-3493) is the only exception to this rule, per <R12>.
b. Robots must use one (1) VEX IQ 900 MHz radio, VEX IQ 2.4 GHz radio, or VEX IQ Smart Radio in conjunction with their VEX IQ Robot Brain.
c. The only legal method of driving the Robot during Driving Skills Matches is the VEX IQ Controller.

<R10> Six motors per Robot. Robots may use up to six (6) VEX IQ Smart Motors.

a. Additional motors cannot be used on the Robot (even ones that aren't connected).

<R11> One battery pack per Robot. The only allowable sources of electrical power for a VEX IQ Challenge Robot is one (1) VEX IQ Robot Battery or six (6) AA batteries via the Robot AA Battery Holder (228-3493).

a. Additional batteries cannot be used on the Robot (even ones that aren't connected).

b. Teams are permitted to have an external power source (such as a rechargeable battery pack) plugged into their VEX IQ Controller during a Match, provided that this power source is connected safely.

<R12> Firmware. Teams must have their VEX IQ firmware (VEXos) up to date. Teams can download the latest version of VEXos at www.vexiq.com/vexos.

<R13> Modification of parts. Parts may NOT be modified. Examples of modifications include, but are not limited to, bending, cutting, sanding, gluing, or melting.

a. Cutting metal VEX IQ or the identical 1/8" VEX V5 shafts to custom lengths is permitted. This is the only legal exception to this rule.
b. When cutting metal shafts, students may only use non-powered hand tools. Eye protection must be worn by anyone cutting or standing within 6 feet (2 meters) of someone cutting a metal shaft.
c. Adults are permitted to cut metal shafts for their students during non-competition hours.

<R14> Prohibited items. The following types of mechanisms and components are NOT allowed:

a. Those that could potentially damage Field Elements or Balls.
b. Those that could potentially damage other Robots.
c. Those that pose an unnecessary risk of entanglement.

<R15> Passing Inspection. A robot is deemed successfully inspected when it has been recorded as "passed" by an Inspector.

SkillsUSA NLSC Robot Rules

<NLSC-R1> Building Robots during the Competition at SkillsUSA NLSC.

Teams will be required to fully disassemble their robot at the start of the competition or bring a fully disassembled robot to the competition. All Robot Rules must be adhered to, but teams will not be limited to use the quantity of parts in those specific kits. All applicable limitations are listed in the Robot Equipment section of this game manual. You must provide your own robot parts.

<NLSC-R2> Teams may use any programming language. Teams must come to competition with a laptop for programming their Robot. The laptop must have the programming software already installed and licensed. Some programming software options can be found here. https://www.vexrobotics.com/vexiq/resources/programming

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. Teams should not be able to insert entries between other entries. Leaving blank pages between entries defeats the purpose of being bound.

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 90-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)
- Using teeth as a tool (other than eating)
- Leaving equipment in aisles (creating trip hazards)

Note: Eye protection is not required in Junior Mobile Robotics Technology unless cutting metal shafts.

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 Jr.
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*

Team Number _____

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.

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? (eg. 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.

SCORECARD

Programming Interview

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

Team Number _____

(2-minute matches)

Highest Score _____

Trial 1

Discs Scored in 2-point Zone _____ x 2 = _____ Discs in Contact Zone _____ x 1 = _____

Discs Scored in 3-point Zone _____ x 3 = _____ Discs removed _____ x 1 = _____

Discs Scored in 4-point Zone _____ x 4 = _____

Discs Scored in 1-point Zone _____ x 1 = _____ **Total: _____**

Trial 2

Discs Scored in 2-point Zone _____ x 2 = _____ Discs in Contact Zone _____ x 1 = _____

Discs Scored in 3-point Zone _____ x 3 = _____ Discs removed _____ x 1 = _____

Discs Scored in 4-point Zone _____ x 4 = _____

Discs Scored in 1-point Zone _____ x 1 = _____ **Total: _____**

Trial 3

Discs Scored in 2-point Zone _____ x 2 = _____ Discs in Contact Zone _____ x 1 = _____

Discs Scored in 3-point Zone _____ x 3 = _____ Discs removed _____ x 1 = _____

Discs Scored in 4-point Zone _____ x 4 = _____

Discs Scored in 1-point Zone _____ x 1 = _____ **Total: _____**

Driving Skills Matches

Team Number _____

(2-minute matches)

Highest Score _____

Trial 1

Discs Scored in 2-point Zone _____ x 2 = _____ Discs in Contact Zone _____ x 1 = _____

Discs Scored in 3-point Zone _____ x 3 = _____ Discs removed _____ x 1 = _____

Discs Scored in 4-point Zone _____ x 4 = _____

Discs Scored in 1-point Zone _____ x 1 = _____ **Total: _____**

Trial 2

Discs Scored in 2-point Zone _____ x 2 = _____ Discs in Contact Zone _____ x 1 = _____

Discs Scored in 3-point Zone _____ x 3 = _____ Discs removed _____ x 1 = _____

Discs Scored in 4-point Zone _____ x 4 = _____

Discs Scored in 1-point Zone _____ x 1 = _____ **Total: _____**

Trial 3

Discs Scored in 2-point Zone _____ x 2 = _____ Discs in Contact Zone _____ x 1 = _____

Discs Scored in 3-point Zone _____ x 3 = _____ Discs removed _____ x 1 = _____

Discs Scored in 4-point Zone _____ x 4 = _____

Discs Scored in 1-point Zone _____ x 1 = _____ **Total: _____**

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 3 = 150		3	
Highest Driving Skills Score	60 x 2.5 = 150		2.5	
Safety Points	90 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