ROBOTICS EDUCATION & COMPETITION FOUNDATION

Presents:

Mobile Robotics Game Manual

2018-2019

Adapted from VEX Robotics Competition
Turning Point Robot Skills Challenge
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OVERVIEW
Students will display their knowledge of the Engineering Process and demonstrate their ability to keep and maintain an engineering notebook as they engage in mobile robotics. Students will be judged on basis of their robot in design, construction, and programming by performing tasks in both autonomous and driver control functions, by the quality of their notebook, and by their ability to communicate their design process to the judges. The game that will be played is the VRC Turning Point Robot Skills Challenge.

ELIGIBILITY
Open to a team of two active SkillsUSA members enrolled in a career and technical education engineering program or a program that integrates robotics, engineering or pre-engineering techniques as an integral component of the instructional program.

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.

THE GAME

A Primer

VEX Robotics Competition Turning Point is played on a 12 ft x 12 ft foam-mat, surrounded by a sheet-metal and polycarbonate perimeter. There are eight Caps that can be Low Scored on the playing field tiles or High Scored on six Posts around the field. There are also nine Flags, including three Low Flags which can be Toggled by Robots, and six High Flags, which can only be Toggled by being hit with Balls. Teams also score points for Alliance Parking at the end of the Match on their own Alliance Platform, or by Center Parking on the Center Platform.

Figure 1: Initial setup configuration. All Caps and Flags are toggled to Blue.
Game Definitions

**Alliance Starting Tile** – A colored field tile, red or blue, that designates where Robots must start the Match. Teams can choose to start from any of the four (4) colored tiles.

**Alliance Station** – The designated region where the Drive Team Members must remain for the duration of the Match.

**Ball** – A yellow plastic spherical object with a diameter of 3.0” (76mm) and a mass of 0.12lb (55g). Balls can be used to Score Flags.

**Cap** – An 8-sided, disc-shaped plastic element with a “flat-to-flat” diameter of roughly 9.25” (234.95mm), an “edge-to-edge” diameter of roughly 9.70” (246.38mm), an overall height of roughly 4.6” (116.8mm), and a mass of roughly 335g (0.74 lb). Caps have one blue side and one red side, and a Core in the center.

**Core** – The cylindrical protrusion on either side of a Cap with a diameter of roughly 3.8” (96.5mm) and a height of roughly 1.8” (44.5mm) from the wide portion of the Cap. The Core has a red half and a blue half which are used when Low Scoring or High Scoring.

![Figure 2: Close-up of Cap, with the Core highlighted](image)

**Detent** – The protruding feature upon which the Flag pivots that is used in conjunction with the Flag’s pointer to determine if a Flag is Toggled.

![Figure 3: Close-up of Flag, highlighting the Detent and Flag pointer](image)

**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 after a Match for a rule violation. A Team that is Disqualified will receive zero points for that match.
**Drive Team Member** – Any of the two (2) Students allowed in the Alliance Station during a Match for each Team. Only Drive Team Members are allowed to touch the controls at any time during the Match or interact with the Robot as per <G5>. Adults are not allowed to be Drive Team Members.

**Driving Skills Match** – A Driving Skills Match consists of a sixty (60) second Driver Controlled Period. There is no Autonomous Period. Teams can elect to end their run early, however this will count as an official run.

**Entanglement** – A Robot status. A Robot is Entangled if it has grabbed, hooked, or attached to a Field Element.

**Expansion Zone** – The area of the foam tile playing surface bounded by the outer edges of the white tape lines and the inner edges of the field perimeter walls. Robots may expand vertically while contacting the foam field tiles or white tape lines within this zone. See rule <SG2> for more details on robot expansion.

**Field Element** – The foam field tiles, field perimeter, white tape, Net, Platforms, Posts, Flags, and all supporting structures.

**Flag** - A pivoting plastic element consisting of a red target, a blue target, and a hinge. Each target has rectangular dimensions of 9.9" (251.5mm) wide and 6.00" (152.4mm) tall. Flags are elevated above the field. The hinge on each Flag also features a pointer that is used in conjunction with the Detent to determine if the Flag is Toggled.

- Low Flags are roughly 18.3" (464.8mm) from the field tiles to their top edge. Note: the top of the Low Flags can be used as a rough visual indicator to see if Robots are below 18”.
- High Flags are made up of two rows: one that is roughly 32.4" (822.9mm) from the field tiles to their top edge, and one that is roughly 46.3" (1176.0mm) from the field tiles to their top edge.

**Game Object** – A Cap or Ball.

**Match Affecting** – A rule violation status determined by the head referee. A rule violation is Match Affecting if it changes the score of the match.

**Net** – The roughly 59" (1.5m) tall woven nylon net structure that spans the entire side of the field perimeter where the Flags are located, with a mesh width of roughly 2.0" (50.8mm) and an overall height of roughly 58.6" (1488.4mm).

**Parked** – One of two Robot statuses.

- **Alliance Parked** – A Robot status. A Robot is Alliance Parked when it is:
  - Contacting its Alliance Platform – the same color as the Alliance Starting Tile that the robot started the match from.
  - Not contacting the foam field tiles or white tape.

- **Center Parked** – A Robot status. A Robot is Center Parked when it is:
  - Contacting the Center Platform.
  - Not contacting any Alliance Platform.
  - Not contacting the foam field tiles or white tape.
Platform – One of three (3) raised surfaces made of PVC and polycarbonate, roughly 23.875” (606.4mm) by 21.70” (551.2mm), that can be used for Parking Robots. See Figures 5, 9, and 10.

Alliance Platforms are denoted by their red or blue structural PVC pieces, and can only be used for Parking by Robots of the same color Alliance as the Platform.

The Center Platform is denoted by its yellow structural PVC pieces, and can be used for Parking by Robots of either Alliance.

Note: The structures on the sides of the Center Platform are not considered part of the Platform and cannot be used for Center Parking. See Figure 5 and <SG9>. 
**Possession** – A Game Object status. A Robot has Possession of a Game Object if it is carrying, holding, or encompassing it. See rule <SG4> for details on Possession limits.

**Post** – One of six (6) vertical PVC pipes attached to the field perimeter with a diameter of approximately 0.84” (~21.5mm) where Caps can be Scored.

- Four (4) Posts (furthest from the Flags) are roughly 23” (584.2mm) tall.
- Two (2) Posts (closest to the Flags) are roughly 34” (863.6mm) tall.

**Preload** – The Ball, one (1) that must be placed on the field such that it satisfies the following conditions prior to the start of the Match.

- The Preload is touching one Robot.
- The Preload is fully within the field perimeter

**Programming Skills Match** – A Programming Skills Match consists of a sixty (60) second Autonomous Period. There is no Driver Controlled Period. Teams can elect to end their run early, however this will count as an official run. Ending early cannot be done as a game-play strategy such as ending the time just after the robot climbs on a Platform so that the robot does not continue to drive back off.
**Robot** – Anything that has passed inspection that a **Team** places on the field prior to the start of a **Match**.

**Scored** – One of two **Cap** statuses.

**Low Scored** – A **Cap** status. A **Cap** is **Low Scored** when the Blue half of the **Cap’s Core** is touching the foam field tiles, white tape lines, or **Platforms**, without touching a **Robot**.

**Note:** If a **Core** is touching both the foam field tiles and the **Center Platform**, it should be scored as if it was only touching the foam field tiles.

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**Figure 8 (left):** A **Cap** which is **Low Scored** for the Red Alliance, because the opposite **Core** is contacting the field tiles.

**Figure 9 (right):** A **Cap** which is not **Scored** at all, because the **Core** is not contacting any field tiles, white tape lines, or **Platforms**.

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**High Scored** – A **Cap** status. A **Cap** is **High Scored** when its Blue **Core** is touching a **Post**, the **Cap** is not touching any other **Field Elements**, and the **Cap** is not touching a **Robot**

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**Student** – Anyone eligible to compete in the SkillsUSA Mobile Robotics Competition.

**Team** – Two (2) **Students** make up a **Team**.

**Toggled** – A **Flag** status. A **Flag** is toggled when the **Flag’s pointer** is not nested anywhere in the **Detent** and the **Flag** is not touching a **Robot**. Flags are **Toggled for Red** if the pointer is to the left of the **Detent**. In the case that the **Flag** pivots beyond the containing PVC structure, the **Flag** is no longer **Toggled**. See Figures 18-20 on the following page.
Scoring

- A Toggled High Flag is worth two (2) points.
- A Toggled Low Flag is worth one (1) point.
- A High Scored Cap is worth two (2) points.
- A Low Scored Cap is worth one (1) point.
- A Robot which is Alliance Parked earns three (3) points.
- A Robot which is Center Parked earns six (6) points.

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.

a. Teams should be extra cautious when interacting with the Net, per <SG5>.

<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.
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. 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> 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 Competition.

<G3> Robots begin the Match in the starting cube. 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 <R4> 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.

<G4> 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.

<G5> N/A

<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, all Drive Team Members must remain in their Alliance Station. Drive Team Members are not allowed to use any sort of communication devices during their Match. Devices with communication features turned off (e.g. a phone in airplane mode) are allowed.

Note: Per <T02>, Drive Team Members are the only Team members that are allowed to be in the Alliance Station during a 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, in accordance with <R11> and <G9>.

Violations or refusal to comply with this rule could be considered a violation of <G1>.

<G8> 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.

<G9> 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.

<G10> N/A

<G11> N/A

<G12> N/A

<G13> N/A

<G14> N/A

<G15> 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.

<G16> 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.

<G17> Be prepared for minor field variance. Field Element tolerances may vary from nominal by ±1.0”. Game Object tolerances and weights may vary from nominal by ±0.25” and 10 grams respectively. Game Object placement at the beginning of Matches may vary from nominal by ±1.5”. Teams are encouraged to design their Robots accordingly. Please make sure to check Appendix A for more specific nominal dimension and tolerances.

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.

Note 2: There is no specification for “tautness” or “looseness” of the Net.

Note 3: Minor Net repairs that do not impact gameplay are permitted. These could include (but are not limited to) using tape to patch together a torn section or replacing the stock pipe clips with standard PVC connectors.

<G18> 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.

<G19> N/A

<G20> This manual will be updated for the SkillsUSA National Championship. All rules in this manual are subject to changes for the National Championship and will be announced when teams arrive at the Championship. Teams should be prepared to toggle for Red or Blue, and slight changes in the initial setup of the field. The Flags and Platforms positions will not be altered, but some or all Flags could be initially Togged for Red at the start of the match.
VRC Turning Point Specific Game Rules

<SG1> Starting a Match. Prior to the start of each Match, the Robot must be placed such that it is:

1. Touching one of the colored Alliance Starting Tiles.
2. Not touching any other foam field tiles or Game Objects that are not Preloads.
3. Preloaded with one (1) Ball.

<SG2> Robot expansion is limited once the Match begins. As per <G3>, 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.

a. Once the Match begins, a Robot which is contacting the Expansion Zone may expand vertically with no height limit. However, once fully outside of the Expansion Zone (i.e. no longer contacting it), the Robot must return to a height limit of 18” (457.2 mm) tall.

b. Once the Match begins, Robots may expand, but no horizontal dimension can exceed 36” (914.4 mm) at any point during the Match.

c. As a result of this rule, Robots may not contact High Flags.

Note: A Robot which interferes with gameplay as a result of violating this rule, such as Toggling a High Flag while outside of the Expansion Zone, will result in a Disqualification, whether the interference is Match Affecting or not. Minor violations of this rule that do not affect or interfere with 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.
Robots which choose to expand vertically in the Expansion Zone should be very cognizant of <SG2a> and the Note. It is expected that brief or minor violations, such as a mechanism that is in the process of retracting while the Robot leaves the Expansion Zone, may occur. These will likely only result in a warning if there is no gameplay interference.

However, Teams should be aware of the risk associated with “cutting it close” like this. To avoid any confusion or potential violations, Teams are advised to drive and design their Robots such that it is abundantly clear to the Head Referee that they have retracted back to a height of 18" before leaving the Expansion Zone.

The 18” height limit specified by <SG2c> refers to the Robot height when it is placed on a flat plane, such as a field tile or an inspection table. An 18” tall robot which tips slightly while climbing a Platform would still be legal.

<SG3> N/A

<SG4> **Watch your Possession limit.** Robots may Possess a maximum of one (1) Cap and two (2) Balls at a time.

**Note:** *Robots that interact with High Scored Caps while already Possessing a Cap will undergo additional scrutiny regarding this rule.*

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.

The intent of the Note is to point out that there are both legal and illegal ways to interact with a High Scored Cap while already Possessing a Cap. Teams should be cognizant of <SG8> and the definition of Possession if attempting any maneuvers around High Scored Caps.

<SG5> N/A

<SG6> N/A

<SG8> **Keep Game Objects in the field.** Though it is expected that some Game Objects may unintentionally leave the field during Match play, Teams may not intentionally or strategically remove Game Objects from the field.

a. **Balls** that leave the field during regular Match play, accidentally or intentionally, will not be returned to the field.

b. **Caps** that leave the field during regular Match play will be returned to the nearest foam tile, Low Scored with the Red Core touching the foam tile.

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.

<SG9> **Don't put Game Objects underneath the Center Platform.** Teams may not intentionally or strategically place Game Objects past the polycarbonate structures on either side of the Center Platform (see Figure 5).

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.
<SG10> Don't clamp your Robot to the field. Robots may not intentionally grasp, grapple or attach to any Field Elements, including the Platforms. 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.

Note: Contact with the Net of any kind is strictly prohibited, per <SG11>.

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.

<SG11> Stay away from the Net. Becoming Entangled with the Net is considered a violation of <S1> and will result in a Disablement.

Momentary or incidental contact, such as while Toggling Low Flags, is expected and is not considered a violation. Intentional, strategic, or repeated violations will result in a Disqualification at the Head Referee’s discretion.

<SG12> The field should be laid out according to the Manual. At the start of the Match, all Game Objects on the field will be placed in their designated locations with their designated colors facing upward or outward as applicable. The rotation of Caps is determined by the Balls that rest on top or underneath them, as applicable. Any concerns regarding Game Object starting position should be raised with the Head Referee prior to the Match; Team members should never adjust Game Objects or Field Elements themselves.

ROBOT EQUIPMENT

Competitors will be required to purchase their own robot kits for competition. In 2018-19 and the foreseeable future, teams will have two (2) options as listed below. They must choose one or the other and may not make a combination of the two. The parts listed are the maximum number of parts that can be used on the robot. Spare batteries and rubber bands are expected, but only the amount in the kit(s) can be used on the robot when on the field competing. Teams may choose to not use or purchase all kits, or all components listed. Teams will be able to reuse parts of the kit year-after-year, replacing parts only as needed.

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.

Option 1: VEX EDR V5

V5 Competition Super Kit (P/N 276-6650)

And the following:

Unlimited V5 Smart Cables for connecting motors and sensors only
Unlimited Zip Ties
Option 2: VEX EDR Cortex (V4)

**Classroom and Competition Super Kit** (P/N 276-3000)

The following can be added to balance the motor and electronics of what is included in the V5 kit:

- 4x **2-Wire Motor 393** (P/N 276-2177)
- 4x **Motor Controller 29** (P/N 276-2193)
- 1x **393 Motor Turbo Gear Set 4-pack** (P/N 276-3527)
- 1x **7.2V Robot Battery NiMH 3000mHh** (P/N 276-1491)
- 1x **Power Expander** (P/N 276-2271)

1x Standard 9V battery used as the backup battery for the VEXnet System

Unlimited **Extension Cables** for connecting motors and sensors only

The following can be added to the Classroom and Competition Super Kit to balance the Motion, Structure and Accessories of what is included in the V5 kit.

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<td>(20) 1/4&quot; Nylon Spacers</td>
</tr>
<tr>
<td>(40) 1/8&quot; High Strength Shaft Spacers</td>
<td>(60) 3/8&quot; Nylon Spacers</td>
</tr>
<tr>
<td>(20) 1/4&quot; High Strength Shaft Spacers</td>
<td>(40) 1/2&quot; Nylon Spacers</td>
</tr>
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<td>(20) 1/2&quot; High Strength Shaft Spacers</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Channels</th>
<th>Spacers</th>
</tr>
</thead>
<tbody>
<tr>
<td>(20) 1/8&quot; Nylon Spacers</td>
<td>(20) 1/4&quot; Nylon Spacers</td>
</tr>
<tr>
<td>(60) 3/8&quot; Nylon Spacers</td>
<td>(40) 1/2&quot; Nylon Spacers</td>
</tr>
<tr>
<td>(60) 1/16&quot; Nylon Spacers</td>
<td></td>
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<table>
<thead>
<tr>
<th>Channels</th>
<th>Spacers</th>
</tr>
</thead>
<tbody>
<tr>
<td>(6) 5x25 Aluminum Plates</td>
<td>(20) 1/8&quot; Nylon Spacers</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Channels</th>
<th>Spacers</th>
</tr>
</thead>
<tbody>
<tr>
<td>(4) 90-Degree Gussets</td>
<td>(20) 1/4&quot; Nylon Spacers</td>
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</tbody>
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<table>
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<tr>
<th>Channels</th>
<th>Spacers</th>
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</thead>
<tbody>
<tr>
<td>(4) 2x2x25 Aluminum Angles</td>
<td>(20) 1/4&quot; Nylon Spacers</td>
</tr>
<tr>
<td>(4) 1x1x35 Aluminum Angles</td>
<td>(40) 1/2&quot; Nylon Spacers</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Channels</th>
<th>Spacers</th>
</tr>
</thead>
<tbody>
<tr>
<td>(4) #64 Rubber Bands</td>
<td>(20) 1/4&quot; Nylon Spacers</td>
</tr>
<tr>
<td>(1) 12&quot; X 15&quot; Anti Slip Mat (Thick)</td>
<td>(40) 1/2&quot; Nylon Spacers</td>
</tr>
</tbody>
</table>
Screws
(175) #8-32 x 1/4" Locking Star Drive Screws
(125) #8-32 x 1/2" Locking Star Drive Screws
(250) #8-32 x 3/8" Star Drive Screws
(225) #8-32 x 1/2" Star Drive Screws
(100) #8-32 x 7/8" Star Drive Screws
(75) #8-32 x 1.000" Star Drive Screws

Nuts & Connectors
(20) 1-Post Hex Nut Retainers w/ Flat Bearing
(20) 1-Post Hex Nut Retainers
(20) 4-Post Hex Nut Retainers
(700) #8-32 Nylock Nuts
(100) #8-32 Hex Nuts

Bearings
(1) Pillow Block Bearing
(40) Flat Bearings
(8) Drive Shaft Bar Locks

Standoffs
(10) 1/2" Standoffs
(30) 3/4" Standoffs
(10) 1" Standoffs
(30) 2" Standoffs
(4) 3" Standoffs

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 team check in 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
- 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 for the purposes of the VRC program, a notebook must have been bound prior to any entries being made in it. Judges will not accept electronic notebooks on lap tops, 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.

**Design Rubric**

The next two pages contain the VRC Design Award Rubric.
## Design Award Rubric

**Directions:** Mark the descriptor that best describes the team’s performance for each criterion. Write the best features of the team’s Engineering Notebook and Student Interview and Discussion on the back of this page.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Expert (3 points)</th>
<th>Proficient (2 points)</th>
<th>Emerging (1 point)</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design Process: Challenge</td>
<td>Describes the challenge at the beginning of the notebook with words and pictures and states the team’s goals toward accomplishing that challenge.</td>
<td>Identifies the challenge at the beginning of the notebook.</td>
<td>Neglects to clearly identify the challenge.</td>
<td></td>
</tr>
<tr>
<td>Design Process: Brainstorming</td>
<td>Generates an extensive list of possible approaches to the challenge with labeled diagrams.</td>
<td>Provides an extensive list of possible approaches to the challenge.</td>
<td>Contains a very short list or does not list the results of the brainstorming sessions.</td>
<td></td>
</tr>
<tr>
<td>Design Process: Select Approach</td>
<td>Explains why the selected approach was chosen and why the other alternatives were not chosen.</td>
<td>Explains why the selected approach was chosen.</td>
<td>Does not document why the team selected the approach they did.</td>
<td></td>
</tr>
<tr>
<td>Design Process: Build &amp; Program</td>
<td>Records the building and programming process in such detail that someone outside the team could recreate the robot by following the steps in the notebook.</td>
<td>Documents the key steps in the process of building and programming.</td>
<td>Seems to skip some important steps in the process of building and programming the robot.</td>
<td></td>
</tr>
<tr>
<td>Test &amp; Redesign</td>
<td>Describes in great detail the process of troubleshooting, testing, and redesigning through all iterations (cycles) of the process.</td>
<td>Captures the key results of the troubleshooting, testing, and redesign cycle.</td>
<td>Leaves out important information about the troubleshooting, testing and redesign cycle.</td>
<td></td>
</tr>
<tr>
<td>Usefulness</td>
<td>Is such a detailed account of the team’s design process that the reader could recreate the project’s history. It is a useful engineering tool. It contains evidence that team made decisions about design process based on previous entries. The team can explain why the notebook is organized the way it is.</td>
<td>Is a complete record of the process, documenting the key events of each work session. It is organized in a way that any team member can locate needed information.</td>
<td>Is missing, or lacks the detail needed for the reader to understand the team’s history, and/or is not organized in a way that an outsider can make sense of it.</td>
<td></td>
</tr>
<tr>
<td>Resources</td>
<td>Shows the team’s efficient use of time with an overall project timeline. The team uses checkpoints to help them know how well they are staying on schedule and readjust their schedule as needed. The notebook illustrates the good use of human resources by assigning members roles based on their strengths.</td>
<td>Documents the team’s efficient use of time with planning and goal-setting for each day’s session. It shows that the team used its human resources wisely by assigning members specific tasks.</td>
<td>Does not provide evidence of the team’s wise use of the team’s time or talents.</td>
<td></td>
</tr>
<tr>
<td>Teamwork</td>
<td>Provides evidence that all team members were consistently involved in the process, that individual team members were self-directed enough to finish what needed to be done, and that all team members consistently shared ideas and respectfully considered each other’s input.</td>
<td>Shows that all team members were involved in the process, that members could be counted on because they did what they were supposed to, and that the whole team shared ideas and supported ideas of others.</td>
<td>Suggests that perhaps some team members did most or all the work, that one or more individuals had to be nagged or reminded to do their work, and/or that some team members did not contribute ideas or that their ideas were not considered.</td>
<td></td>
</tr>
</tbody>
</table>

Total the number of points earned from Notebook (Add 3 pts for a bound notebook & enter the number on page 2 of this rubric):

Rubrics are confidential judging documents and should not be returned to the team, coach, or Event Partner. Rubrics should be destroyed immediately after the Judge Advisor has recorded the winning team.
## Design Award Rubric

**Team # _____**  
**Judges ____**

### Student Interview and Discussion: During the interview...

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Expert (3 points)</th>
<th>Proficient (2 points)</th>
<th>Emerging (1 point)</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design Process</td>
<td>Students describe the goals of the design process and how the team accomplished the challenge.</td>
<td>Students provide possible goals of the design process but do not clearly identify how team accomplished the challenge.</td>
<td>Students neglect to identify any goals of the design process and cannot describe how the team accomplishes the challenge.</td>
<td></td>
</tr>
<tr>
<td>Design: Methods &amp; Strategies</td>
<td>Students describe multiple design methods and strategies considered; explaining both how and why the current design strategy was selected.</td>
<td>Students only describe their current design methods and strategy; explaining only one of either how or why the current design strategy was selected.</td>
<td>Students do not describe any of the design methods or strategies considered; do not explain why or how the current design strategy was selected.</td>
<td></td>
</tr>
<tr>
<td>Team Work: Contributions</td>
<td>Students explain how each team member contributed to the design and strategy.</td>
<td>Students explain how some team members contributed to the design and strategy.</td>
<td>Students only explain how 1-2 members contributed to the design and strategy.</td>
<td></td>
</tr>
<tr>
<td>Interview: Individual Contributions</td>
<td>All students independently answer the Judges’ questions.</td>
<td>Students support each other as needed to answer the Judges’ questions.</td>
<td>Students rely on one or two members to answer all the questions.</td>
<td></td>
</tr>
<tr>
<td>Interview: Professionalism</td>
<td>Students present their answers in a respectful and courteous manner to the Judges and other team members, making sure each team member has a chance to contribute and waiting until the other person has finished.</td>
<td>Students present their answers in a respectful and courteous manner to either the team members or the Judges.</td>
<td>Students do not present themselves in a respectful and courteous manner.</td>
<td></td>
</tr>
</tbody>
</table>

**Total the number of points earned from Student Interview and Discussion:**  

**Total the number of points earned from Notebook:**  
(including bonus for bound notebook)

**Total the number of points combined:**

---

*The REC Foundation thanks Northeastern State University, Oklahoma teacher training program for developing this rubric.*

**Comments:**

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*Rubrics are confidential judging documents and should not be returned to the team, coach, or Event Partner. Rubrics should be destroyed immediately after the Judge Advisor has recorded the winning team.*
TEAM RANKING

Teams will be given a total score based on the Engineering Notebook (Page 1 of the Design Rubric), the Design Interview (Page 2 of the Design Rubric), the team’s highest Programming Skills Score and the team’s highest Driving Skills Score. Teams are ranked by the sum of their scores in these four (4) categories.

All teams will be given the same number of Robot Skills Matches to be determined by the Competition Organizer.

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
4. Team’s next highest Programming Skills Score
5. Team’s next highest Driving Skills Score
6. Repeating 4 and 5 until all scores are exhausted
7. Design Interview score

In the very unlikely event that the scores are still tied, the judges will deliberate one last time to determine a winner.
SkillsUSA

Mobile Robotics Judges Score Card

Team Number _____________________________

Engineering Notebook (maximum 27 points) ___________

Design Interview (maximum 15 points) ___________

Highest Programming Skills Score (maximum 37 points*) ___________

Highest Driving Skills Score (maximum 37 points*) ___________

Total Score (maximum 116 points*) ___________

Used for tiebreaking purposes only:

_____ Engineering Notebook Score
_____ Team’s highest Programming Skills Score
_____ Team’s highest Driving Skills Score
_____ Team’s next highest Programming Skills Score
_____ Team’s next highest Driving Skills Score
_____ Team’s next highest Programming Skills Score
_____ Team’s next highest Driving Skills Score
_____ Team’s next highest Programming Skills Score
_____ Team’s next highest Driving Skills Score
_____ Team’s next highest Programming Skills Score
_____ Team’s next highest Driving Skills Score
_____ Team’s next highest Programming Skills Score
_____ Team’s Design Interview Score

Note: The game is designed to not be able to be maxed out. The expected high score is 20 points.