2017 SKILLSUSA CHAMPIONSHIP

MOBILE ROBOTICS COMPETITION

Leave No Trace

TEAM GUIDE

28 Dec, 2016
Revision B

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The success of the competition is the result of the motivated contestants and their instructors, the determined efforts of the National and State Technical Committees, and the generosity of companies donating equipment and supplies. The following companies have contributed resources and support.

Intelitek, Inc.
AZTECH Educational Resources
VEX Robotics, Inc.
UPS
Visual Edge Inc.

Mobile Robotics Technical Committee

The following individuals contributed their time and energy to the Technical Committee:

Trevor Pope
Intelitek

Rick Knisely
AZTECH Educational Resources

John V-Neun
VEX Robotics, Inc

Daniel Ward
Visual Edge Inc.

Isaac Onigman
ControlAir, Inc

Tom Hand
Honeywell

Ben Richardson
Learning Labs, Inc

Miller Roberts
Robotics Educations & Competition Foundation

Awards

The following companies have supplied awards:

Intelitek, Inc.
VEX Robotics, Inc.

2017 SkillsUSA Mobile Robotics Competition

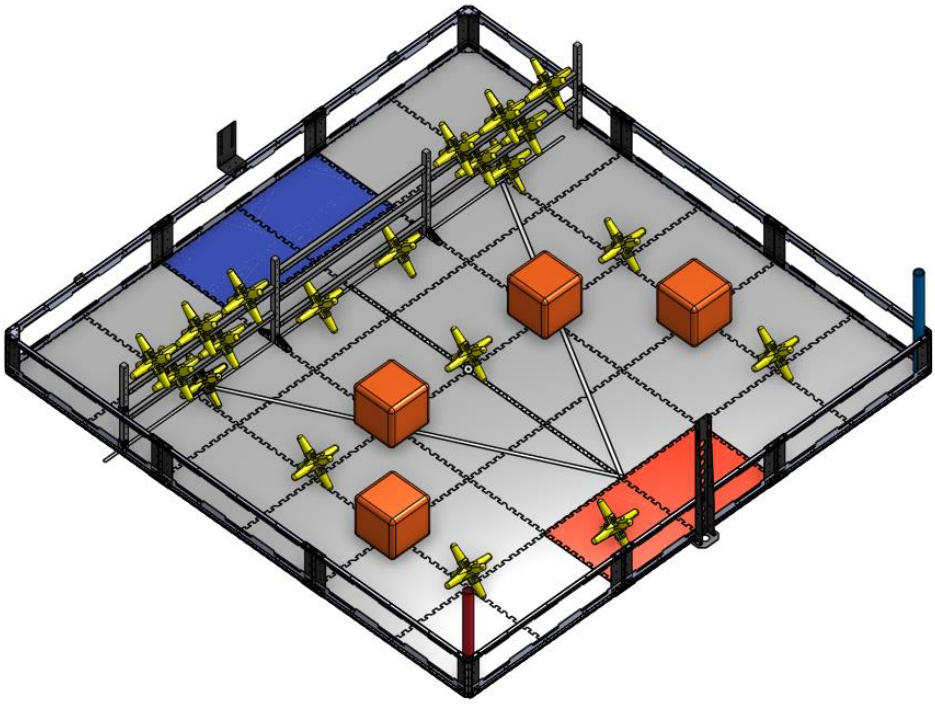


Figure 1: SKILLS 2017 'Leave No Trace' playing field

The Game:
This year's challenge is played on a 12'x12' square field configured as seen above. Teams are tasked with moving stars and cubes across the fence line into the scoring zones. The object is to score as many points as possible during a two-minute autonomous and operator control round.

The Field:
The 12' x 12' field contains 20 yellow stars along with 4 orange cubes. The field contains two different scoring zones. One zone consists of a 2' x 4' rectangle made up of blue tiles. A second scoring zone is located over the fence spanning the playing field. Any scoring objects that are completely inside the fence scoring zone will be scored. The field contains white tape lines forming a pattern on the inside of the field. There are red and blue PVC pipes on the starting corners of the filed.

Scoring:
Yellow Star Scored in the fence goal = 1 point
Yellow Star Scored inside the blue goal = 5 points
Orange Cube Scored in the fence goal = 5 points
Orange Cube Scored in the blue goal = 10 points
A Robot "Low Hanging" (1-12") = 1.5x multiplier
A Robot "High hanging" (+12") = 2x multiplier

The Round:
The competing robot will begin the round positioned completely inside the starting rectangle created by the red floor tiles. For the first 60 seconds of the round, the robot operates completely autonomously. Using sensors and pre-programmed instructions, the robot must attempt to strategically move the scoring objects into any scoring area. During the next 60 seconds of the round, drivers take control of the robot. Teams score points for each scoring object placed inside the scoring zones.

1: Contest Overview

A Need for Cutting-edge Technology

Many believe that in the future, robotics will encompass every part of life. Even today, robots do the jobs that people find dull, dirty, or dangerous. To compete in this evolving field of robotics, companies will be looking for individuals who are fluent in robotic design and programming, mechanical construction and electrical wiring.

Individuals rarely possess all the skills necessary to compete in current and future robotics design and engineering challenges. Therefore, team work will be necessary and advantageous to a successful robotics industry.

Your Team

Success in industry and in this Mobile Robotics Competition will be realized by a teamwork approach. In the interest of emulating industry, teams should be comprised of specialists in Mechanical Design and (Mobile Robotics) Programming.

1.1: The Client's Needs and the Team Goal

1.1.1: The Client's Needs

Today's National Parks practice a Leave No Trace (LNT) principle; challenging visitors to leave a minimal impact on the land by properly disposing of waste and adopting a 'Carry In, Carry Out' policy of removing any trash brought into the Parks and disposing of it appropriately. Initially, the Park Service decided that replacing trash receptacles with carry in, carry out waste bags was the solution. This only masked the problem; trash was still brought to the National Parks and instead of being left in one of the parks' trash receptacles, it was brought home and thrown in the visitors' personal trash. In both cases the trash ended up in the same location, the local landfill.

The National Parks have transitioned to an educational approach of teaching visitors how to reduce, reuse, and recycle. They have added trash receptacles throughout the parks that are specifically intended for *waste that can be composted, waste that can be recycled* and *waste that can't*. The parks label all the materials sold within the National Parks, such as food product packaging, with a label describing whether it can be recycled, composted or trashed. Over a 12-month period, National Parks diverted 90% of the waste that previously went to landfills into a compost or recycling program.

The Client is aware that automation systems can boost productivity and reduce costs. By using automated robots to collect material, they are able to eliminate the process of manually picking and sorting. This can reduce human interaction of waste collection and enable the National Park Service (NPS) to process larger quantities at a much higher level of accuracy. The client is requesting this type of system from the Mobile Robotics Team.

1.1.2: The Team Goal

Tuckerman Grove Park (The Client) is one of the NPS and is looking to improve their waste disposal productivity. The Client is processing more recyclable and compostable waste resulting in a need for more accurate and efficient workflow. During the overnight shift, the Client is asking that a robot move

autonomously around the park picking, sorting and appropriately disposing of recyclable and compostable waste. During the day the Client's employees will use the robots to pick and transfer the remaining waste to the recyclable processing area. Therefore, as a Mobile Robotic development team, your goal is to create a robot that can fulfill the picking and sorting process autonomously and perform under control of the Tuckerman Grove Park Rangers.

On the Competition Field the processing areas consist of a waste collection area and a recycling plant; within the recycling plant is an efficient disposal system that produces zero emissions. The recycling processing plant consists of the side of the playing field anywhere over the fence boundary. The efficient disposal system is the area within the red tiles over the fence boundary. Any waste materials that are over the fence boundary will be processed.

There are four compostable waste materials (orange cubes) and twenty recyclable waste materials (yellow stars) located within the Tuckerman Grove Park boundary (field walls). Any recyclable material placed inside the processing area is beneficial to the Client and will increase productivity.

At the end of the day, Park Rangers are asked to put away the robot by parking it off the ground.

1.2: Specific Project Instructions

1.2.1: Initial Design

The Client, Tuckerman Grove Park is a company that is looking for an automated way to collect waste throughout the National Park and then place it in the correct processing locations. The National Park Service has provided a layout of the park property; along with these general robot operating requirements. 1) the robot must autonomously pick up and move recyclable material into the processing areas, and, 2) The next day, the robot must transition into an operator-controlled vehicle. Your team's goal is to create a robot that can effectively and efficiently meet these requirements.

The Client also requires that each stage of the design, fabrication, and programming process be well-documented. This requires that your team provide a complete bill of materials including assembly instructions

After your prototype robot has been designed, programmed, assembled, and documented, your Team will test the robot in a simulation of the Client's facility at the Mobile Robotics Competition event.

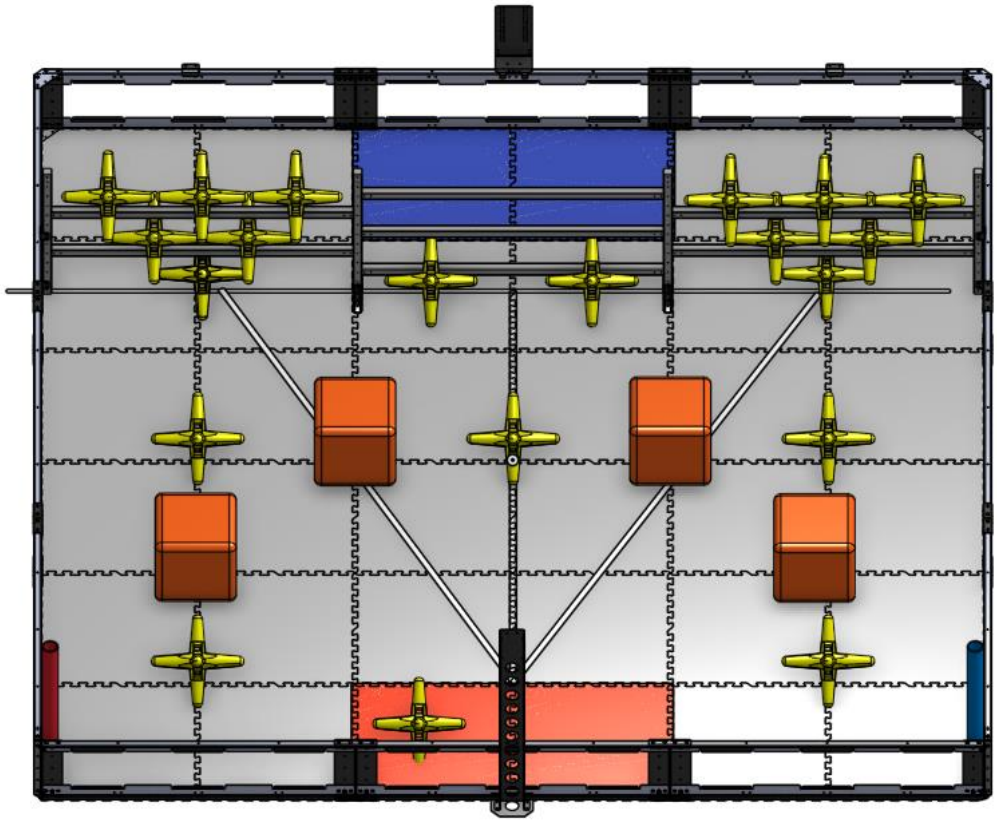


Figure 2: Top view of Clients processing locations

1.2.2: Design Change and Concurrent Engineering

The Client will review the prototype and may require one or more changes. The Team must be prepared to handle different configurations of a park waste collection facility or processing locations that may need to be moved at different times. Having a robot that can handle diverse challenges will make your design more appealing to the Client.

1.3: Project Guidelines

1.3.1: Specific Requirements

The Client's Engineering Project Manager has provided an outline of materials to begin your planning and manufacturing process. Your success on this project is based upon the following criteria:

1. Teams will be given an objective by the Technical Committee. The goal is to be met by using a mobile robotic system.
2. Teams must be comprised of two members.
3. An Engineering Notebook is to be created and used by team members to chronologically document their project for the competition. It should include pictures, detailed assembly instructions; design evolution with changes, problems encountered and solved, decisions made, and test results. All pages must be bound, numbered, and dated.
4. Teams will be tasked with a programming challenge using CoderZ virtual software.

4a. CoderZ is an online Java based programming tool using virtual robots in a variety of landscapes. To create a demo account with full feature access, go to www.gocoderz.com/skillsusa
5. Teams may bring only their Engineering Notebook and a wireless WiFi-enabled laptop to the competition to be used as reference tools during the build phase. The laptop may already have programming code for the robot.
6. All team members are responsible for double-checking each other's work. Thus, they shall both assist with build and quality control.
7. At the competition, the robot must be constructed from only the materials supplied by the technical committee.
8. During an oral presentation session, each team will have 10 minutes to share their solution with a group of judges, which should be viewed as the "Client". The presentation may incorporate support materials such as posters, lab notebooks, a prototype robot, and/or PowerPoint presentation.
9. After teams have completed the first competition rounds with their Robot (designed and built for the client), a design change may be introduced. At this time, the competition will be repeated.
10. At all times, team members are required to adhere to industrial safety standards, such as wearing of eye, ear, and hand protection where appropriate.
11. All engineering notebooks, forms, documentation, and programs must be turned in to the technical committee members during orientation session.
12. All team members and advisors are required to attend a debriefing session after the competition has concluded.

1.4: Kit of Parts

1.4.1: Kit of Parts Overview

Your robot may only be made of components listed on the SkillsUSA kit of parts. A full list is available in Appendix A.

1.5: Team Rules and Guidelines

1.5.1: Competition Rules

Below are the official rules and guidelines for the Mobile Robotics Competition. All teams will be expected to adhere to these rules.

1.5.1.1: Definitions

- Autonomous Period: A 60-second period in which robots operate based only on pre-programmed instructions and sensor inputs. Team members are not allowed to interact with the robot during this period.
- Operator-Control Period: A 60-second period in which robots are operated by team members through the use of a wireless transmitter and receiver.
- Preload – One (1) star a team may place on the field or on their robot. The preload object must be fully within the starting zone prior to the start of each match.
- Fence – The 17.25" tall edge and 21.25" tall center PVC structure which divides the playing field. The fence marks the scoring boundary.

- Hanging Bar –The red or blue 30" high, vertical PVC pipe located in the two driver control side corners of the field.
- High Hanging – A robot is considered high hanging if it is touching the hanging bar and is completely above the plane parallel to the foam field tiles, formed by the top of the field perimeter.
- Low Hanging – A robot is considered low hanging if it is touching the hanging bar and at least 1" above the plane parallel to the foam field tiles.
- Scored – An object is scored if it is not touching a robot and meets the following criteria.
    - The centerline of the object must be within the perimeter of the goal.
- Scoring Object – A yellow star or an orange cube.
- Cube – An orange cube shaped cloth scoring object filled with pillow-type filling.
- Star – A yellow scoring object consisting of six (6) points extending from a common center, with an overall diameter of 14".
- Colored Foam Tile - A foam floor tile colored gray, blue or red.

1.5.1.2: Field Setup

- The field is 12' by 12', enclosed by an 11.5" tall field border.
- The surface of the field is comprised of gray, blue and red foam tiles.
- There are 2 red floor tiles centered along the perimeter of the field. This is considered the starting location for the robot. The robot can be placed anywhere within this rectangle however; it must be fully within the starting rectangle.
- There are 20 yellow stars placed on the field along with 4 orange cubes. One star is placed in the red starting rectangle and can be pre-loaded.
- There are a total of three scoring zones.
    - One scoring zone is considered the opposite side of the fence that robot starts from. The centerline of the scoring object must be across the center line of the fence to be considered scored.
    - A second scoring zone is the blue rectangle within the fence scoring zone. Any scoring object within this goal will be scored. The centerline of the scoring object must be across the center line of the blue tile border to be considered scored.
    - The third scoring zone are the vertical PVC pipes in the field corners directly to the left and right of the starting zone. The robot must be hanging completely off the ground with its lowest point at least 1" above the field surface to be considered hanging.

1.5.1.3: Scoring

- The complete scoring object must be within the perimeter of the fence scoring zone to be considered "scored".
- The centerline of the scoring object must be within the perimeter of the blue tile scoring zone to be considered "scored".
- A yellow star scored inside the fence scoring zone is worth one point.

- A yellow star scored inside the blue tile scoring zone is worth five points.
- An orange cube scored inside the fence scoring zone is worth five points.
- An orange cube scored inside the blue tile scoring zone is worth ten points.
- Any robot "low hanging" more than 1" and less than 12" from either the red or the blue PVC bar at the end of the operator control period duration will multiply the total points scored by 1.5.
- Any robot "high hanging" more than 12" from either the red or the blue PVC bar at the end of the operator control period duration will multiply the total points scored by 2.

1.5.1.4: Match Sequence

- Autonomous Period: 0-60 Seconds (Night Shift processing operations).
- Operator Control Period: 60-120 Seconds (Day Shift processing operations).

1.5.1.5: Competition Match Rules

- Each round will be two minutes long and will feature only **ONE** robot.
- Any object that leaves the field will NOT be returned to the field.
- During a round, robots may be remotely controlled only by the drivers and by software running on the control system. If any team member touches his or her team's robot at any time during a round, the robot will be disabled and the team disqualified from that round.
- Scores will be calculated at the end of the 120 seconds after all robots and field elements come to rest. Operators are not to enter the field or touch the robot at the end of either round until event personnel gives permission.
- Robots must start the round completely inside the rectangle created by the red starting tiles.

1.5.1.6: Robot Rules

- Robots must have a starting size of no larger than 18" by 18" by 18" at the start of a round but they may expand to any size once the round has begun. If the robot exceeds the starting size, it will not be allowed to compete. The size of the robot may be checked by the judges at any time during the competition if they feel that the robot is over the size limit.
- Robots may only be constructed from the same type and quantity of parts found in the SkillsUSA VEX Robot Kit or additional, approved non-VEX materials, and only after the challenge has been released to teams. See Appendix A for a list of parts found in the SkillsUSA VEX Robotics Kit.
- No robot may have mechanisms that could potentially damage the scoring objects, playing field or field elements, or pose a safety hazard to teams or spectators.
- All parts of the robot must remain attached to the robot for the duration of the round. Any infraction of this rule may result in an immediate stopping of the round and a loss of points scored. Minor pieces that unintentionally become detached from the robot, or are the result of improper design/construction will not cause a point loss.
- Teams may not modify any part of the control system or any motor or sensor.
- Robots are allowed only the following non-VEX components:

- Any parts which are identical to legal VEX parts, such as screws, zip ties etc.
- Any non-functional decorations that do not affect robot performance.

Commercial threadlocker may NOT be used.

1.5.2: Field Malfunctions

IN THE CASE OF A FIELD FAILURE: The team leader will communicate the problem to a representative of the Technical Committee. The representative will then discuss the problem with no less than 2 additional Technical Committee members for a formal decision. If it is determined that it is in fact a field problem, the round will be replayed. In the case of a replayed round, the previous score will not be counted and the team's new round score will count, regardless of whether the team scores more or less points. If no field failure is determined the score for that round will stand as is.

IN THE CASE OF PROGRAMMING PROBLEMS: A robot's program is the responsibility of the team. All software must be original copies. If your team develops a problem with the software or robot program, the Technical Committee will work in whatever way it can to resolve the problem but no rounds will be replayed due to problems with the robot's program. The following software platforms are recommended:

EasyC V4 for Cortex
EasyC V5 for IQ / Cortex

Other programming software will not be supported by the Technical Committee.

1.6: Group Organizational Goal

1.6.1: Team Dynamics

The competition should run much like you would expect commercial projects to be undertaken. Group members are expected to interact professionally, respect ideas & suggestions from each other and work as a team. At a minimum, the Team shall have a mechanically-oriented person to lead in mechanical design and a programmer to lead robot programming. Both team members should assist in the actual construction process.

The contest is designed to demonstrate the value of teamwork on a project. Teams should divide duties equally among all members; no individual should dominate. When necessary to achieve a particular outcome or goal, a team member will assist their partner. All Team members are responsible for evaluating each other's work and contributing to the overall project's quality control.

1.6.2: Team Objectives

The competition consists of developing a robotic device, at a low cost, for a customer. The device must meet specific performance requirements provided by the customer. Multiple teams will be designing a device to meet the customer's requirements, thus a competition will be scheduled to evaluate the competing devices and select the winning proposal.

With this in mind, each team should work towards the following objectives:

- Construct a fully operational prototype robot that meets the requirements of the customer, at a low cost.

- Maintain an Engineering Notebook chronologically documenting the design evolution, materials used, and problems encountered & resolved, decisions made, and test results obtained.
- Be prepared to write Blockly based Java programming code using CoderZ virtual programming software.
- Be prepared to orally present the team's final solution to the problem, incorporating support materials such as posters, lab notebooks, prototype robot, and/or PowerPoint presentation. Each team member is expected to participate in the presentation.
- Demonstrate the functionality of the robotic device in competition.

A successful project will require the use of critical thinking and problem solving abilities, self-management skills, professional writing skills, and clear oral communication.

1.7: Judged Scoring

1.7.1: Oral Presentation and supporting Material (200 points available)

Each team will have ten minutes to orally present their final solution to the Judges ("Client"). They may bring additional support materials such as posters, sales brochures, lab notebooks, and the prototype robot to share with the judges.

Presentation Quality
A successful oral presentation will demonstrate or contain:

- Both team members participate in presentation.
- Subject matter is well organized
- Objective of presentation is clear to customer
- Problem description - What does the customer want or specify?
- Inspiration for robotic device design - What prompted the design?
- Evolution of design - What design changes were necessary?
- Problems - What significant problems were encountered & resolved?
- What are the advantages of the design being presented?
- Summary - What are the final design features?

Support Materials
A successful oral presentation also has the following attributes:

- Slides or View graphs which are clear, concise and easily understood.
- Bill of Materials that lists the cost & materials for the prototype.
- Programming documentation that includes a program flow chart for review.

Note: A projector and screen will be available but teams must supply their own laptops for their presentation. Bring power cords and any cables you might need to plug into "typical" projector.

1.7.2: Engineering Notebook attributes (200 points available)

Note: The Engineering Notebook will be submitted for judging prior to the assembly portion of the event. Bring your engineering notebooks to the Orientation session prior to the contest.

Overall Appearance and Professionalism:

The Engineering Notebook will be judged on format, organization, and presentation. For information on formatting and content of an engineering notebook, visit http://www.bookfactory.com/special_info/engr_notebook_guidelines.html.

Bill of Materials:

Each team will be required to list all of the materials used on their robot. The type, quantity and cost of each part should be provided.

Assembly Instructions:

Teams are encouraged to create detailed assembly instructions for their robot prior to arriving at the competition.

Illustrations of Design Process:

Teams are encouraged to include pictures and sketches of their design process in their Engineering Notebook.

1.8: Required Materials

1.8.1: Required Components and Supplies

Teams require the following materials to complete the competition.

1.8.1.1: Technical Committee-Provided Components

The Technical Committee will provide:

1. Design Challenge competition field and scoring objects.
2. General workspace for teams to cut materials along with a vise and hacksaw.
3. One eight-foot conference table.
4. One standard 120V electrical outlet.
5. The description of the Mobile Robotic Design challenge.
6. SkillsUSA Robotics Kit of Parts (VEX Robotic Design System).
7. One 12" x 24" piece of polycarbonate. 1/16" thick

1.8.2: Team Provided Components

Teams are to bring the following components (and may also bring a small toolbox):

1. Engineering Notebook.
2. Safety glasses and work gloves.
3. Dremel (or similar) rotary tool with appropriate attachments.
4. Drill and drill bits.
5. Allen wrench set (Imperial).
6. Aircraft metal snippers for cutting VEX metal.

7. A Wi-Fi enabled laptop equipped with licensed VEX programming software (for the Cortex microcontroller) and suitable presentation software (such as Microsoft's PowerPoint). An additional tablet device is allowed for presentations.

8. Power strip and extension cord.

9. Calculator (standard, scientific or graphing).

10. Tape measure and/or ruler.

11. Hammer.

12. Phillips and slotted screwdrivers.

13. Metal file.

14. Pliers.

15. Graph paper, pens, pencils, tape, electrical tape, markers and scissors.

16. Multi-meter.

17. Replacement batteries and chargers - <u>All 7.2V robot batteries must be made by VEX Robotics. 9V and AAA can be manufactured by any vendor.</u>

18. Grease or graphite (non-aerosol).

19. VEX competition switch simulator and VEX programming cable

20. Empty small parts bin or storage container.

21. Tap set

Note: ONLY the above listed items will be allowed in the contest area during the competition.

2.0: Safety

2.1: Importance of Safety

In industry, it is in the best interest of both employer and employee to maintain a safe work environment. When a company's history of employee injury incidents is low, the company increases its likelihood of reduced insurance rates and Workers Compensation fees.

Safety considerations will be taken into account during the Mobile Robotics Competition judging to mirror a professional industrial environment.

2.2: Safety Violations

If a team or a team member violates a safety rule, or operates their robot in an unsafe manner, the following penalties will be levied:

1st Violation:
Team will be issued a written warning.

2nd Violation:
Team will have 50 points deducted from their total score.

3rd Violation:
Team will be disqualified.

2.3: Safety Issues

1. Team members must keep their work area reasonably clean. Clean work places promote efficient and safe working conditions. Special attention should be paid to keeping the floor clean and to the elimination of tripping hazards such as uncovered or dangling power cords in of walking aisles.
2. Team members must keep their teammates and other teams aware of possible dangerous situations, such as pinch points, sharp edges, tripping hazards (power cords) and tethered or wireless enabling of robots.
3. Team members must wear safety glasses when they are on the playing field and while they are in their work area.
4. Tampering with or dismantling of any part of the supporting equipment (e.g., computers, printers, etc.) is a direct safety violation, and can be grounds for immediate disqualification.

3.0: Documentation

3.1: Document Submission

The following documentation will be judged at the Competition.

- Virtual Programming Challenge Code
- Engineering Notebook
- Math Problem

SKILLSUSA
Mobile Robotics
Judging Form 2017

Team: _____

	MAXIMUM POINTS	CHECK	POINTS AWARDED
Oral Presentation			
1. Presentation Quality	150		
2. Presentation Support Materials	50		
Presentation Subtotal	**200**		
Engineering Notebook			
1. Overall Appearance and Professionalism	50		
2. Bill of Materials	50		
3. Assembly Instructions	50		
4. Illustrations of Design Process	50		
Engineering Notebook Subtotal	**200**		
Robotic Task Performance			
1. Round 1 and 2 Score	300		
Robotic Design Challenge Performance Subtotal	**300**		
Virtual Programming Code			
1. Virtual Programming Code	0		
Virtual Programming Code Subtotal	**0**		
Concurrent Engineering and Area Organization			
1. Round 3 and 4 Score	150		
2. Area Clean and Organized	50		
Concurrent Engineering Performance Subtotal	**200**		
Math Problem	**100**		
Safety (deductions) (if any)			
GRAND Total	**1000 pts**		

Appendix A – SkillsUSA VEX Robotics Kit Bill of Materials

This year's kit will be the VEX Classroom & Competition Super Kit: P/N 276-3000

Note: The kit comes with (1) 7.2V 3000 mAh battery and six AAA batteries as well as their respective chargers.

Teams may bring additional 7.2V 300 mAh batteries and chargers to the competition; however, the batteries and chargers must be made by VEX to guarantee consistency and to level the playing field. Other brands of AAA batteries are allowed.

276-3000 Kit Contents *(per VEX website)*

Curriculum & Manuals

- (1)Quick Start Guide, Clawbot

Logic

- (1)VEX Cortex®-based Microcontroller
- (1)USB A-A Tether Cable
- (6)Motor Controller 29

Control

- (1)VEXnet Joystick
- (2)VEXnet Key 2.0
- (1)LED Indicator Pack
- (3)Cable, VEX "Y"
- (3)Cable, 3-Wire Extension, 6"
- (3)Cable, 3-Wire Extension, 12"
- (1)Cable, 3-Wire Extension, 24"
- (1)Cable, 3-Wire Extension, 36"

Sensors

- (2)Bumper Switch (2-pack)
- (2)Limit Switch (2-pack)
- (1)Motor 393 IME (2-pack)
- (1)Potentiometer (2-pack)
- (1)Line Tracker
- (1)Ultrasonic Range Finder
- (1)Optical Shaft Encoder (2-pack)

Motion

- (7)2-Wire Motor 393
- (1)Claw Kit Assembly (includes motor)
- (4)Shaft Coupler
- (37)Shaft Collar
- (12)Shaft, 3" Long
- (4)Shaft 11mm long
- (4)Shaft 2" long
- (2)Shaft 4" long
- (4)Shaft 12" long
- (44)Bearing Flat
- (6)Bearing, Pillow Block
- (4)Lock Plate, Plastic
- (6)Spur Gear, 12-tooth
- (4)Spur Gear, 36 tooth
- (10)Spur Gear, 60-tooth
- (4)Spur Gear, 84-tooth
- (20)Rack Gear, 19-tooth
- (4)High Strength 12-tooth Gear
- (4)High Strength 36-tooth Gear
- (4)High Strength 60-tooth Gear
- (16)High Strength Square Gear Insert
- (16)Free Spinning Gear Insert
- (4)Intake Roller
- (1)2.75" Wheel (4-pack)
- (4)4" Wheel
- (2)4" Omni-Directional Wheel (2-pack)
- (25)Tank Tread Traction links
- (30)Conveyor-belt Base links
- (10)Short Conveyor-belt inserts
- (10)Medium Conveyor-belt inserts
- (10)Tall Conveyor-belt inserts
- (4)High Strength 6-tooth Sprocket
- (2)High Strength 12-tooth Sprocket
- (2)High Strength 18-tooth Sprocket
- (2)High Strength 24-tooth Sprocket
- (2)High Strength 30-tooth Sprocket
- (280)High Strength Chain Links
- (40)Chain Attachment Links
- (2)12" Long Linear Slide Track
- (2)17.5" Long Linear Slide Track
- (2)Rack Bracket
- (4)Inner Acetal Slide Truck
- (4)Outer Acetal Slide Truck
- (1)Latex Tubing (10')
- (1)Rubber Band (20 Pack)

Structure

- (8)Bar, 25-hole
- (2)Bar, 20-hole
- (2)Chassis Bumper (25-hole)
- (2)Chassis Bumper (20-hole)
- (4)Chassis Rail (25-hole)

- (4)Chassis Rail (16-hole)
- (4)C-Channel, 1x2x1x15 hole
- (1)C-Channel, 1x2x1x20 hole
- (2)C-Channel, 1x2x1x25 holes
- (2)C-Channel, 1x5x1x25 holes
- (2)Plate 5x5 holes
- (2)Plate 5x15 holes
- (2)Plate 5x25 holes
- (2)Angle, Slotted 30 holes
- (2)Angle, Slotted 30 holes Inverse
- (2)Angle, Segmented 25 holes
- (4)Gusset, Pivot
- (4)Gusset, Angle
- (4)Gusset, Plus
- (10)Standoff 1/2in
- (8)Standoff 1in
- (4)Standoff 2in
- (4)Standoff 3in
- (102)Screw, 8-32 x 1/4" Long
- (42)Screw, 8-32 x 1/2" Long
- (28)Screw 8-32 x 3/8"
- (14)Screw 8-32 x 3/4"
- (3)Screw, 8-32 x 1 1/2" Long
- (10)Screw 6-32 x 1/4in
- (10)Screw 6-32 x 1/2in
- (6)Locking Screw, 6-32 x 1/4" Long
- (6)Locking Screw, 6-32 x 1/2" Long
- (172)Nut, 8-32 Keps
- (28)Nut, Nylock 8-32
- (30)Washer, Steel
- (10)Washer, Plastic
- (82)Bearing Attachment Rivet
- (26)Shaft Spacer, Thin (4.6mm)
- (20)Shaft Spacer, Thick 8mm
- (50)4" Zip Ties

Power

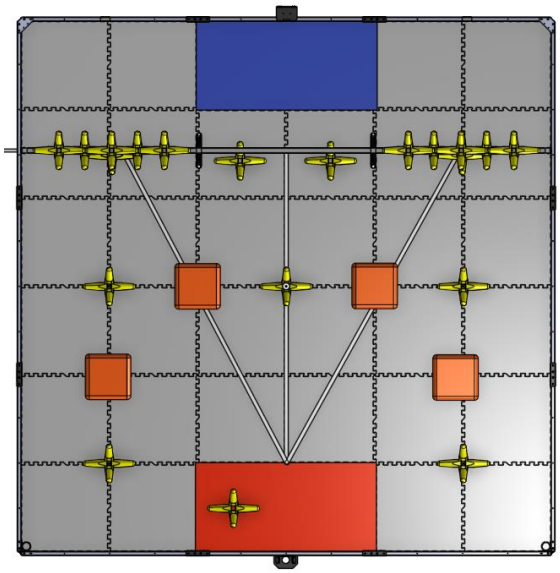
- (1)7.2V Robot Battery NiMH 3000mAh
- (1)AAA NiMH Rechargeable Battery
- (1)Smart Charger Power Cord
- (1)8-Bay AA/AAA Smart Battery Charger
- (1)VEXnet Backup Battery Holder

Equipment

- (2)Tool, Hex Key (5/64”)
- (2)Tool, Hex Key (3/32”)
- (2)Tool, VEX Open-Ended Wrench

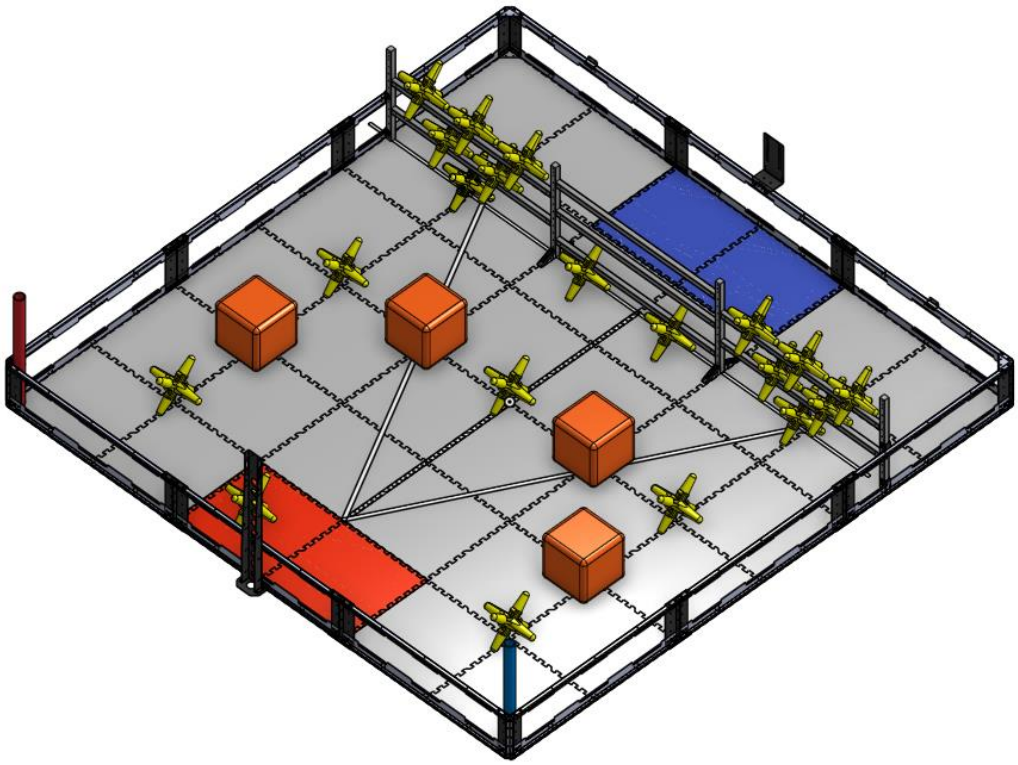
Appendix B – Field Information

Field Pictures



Top View

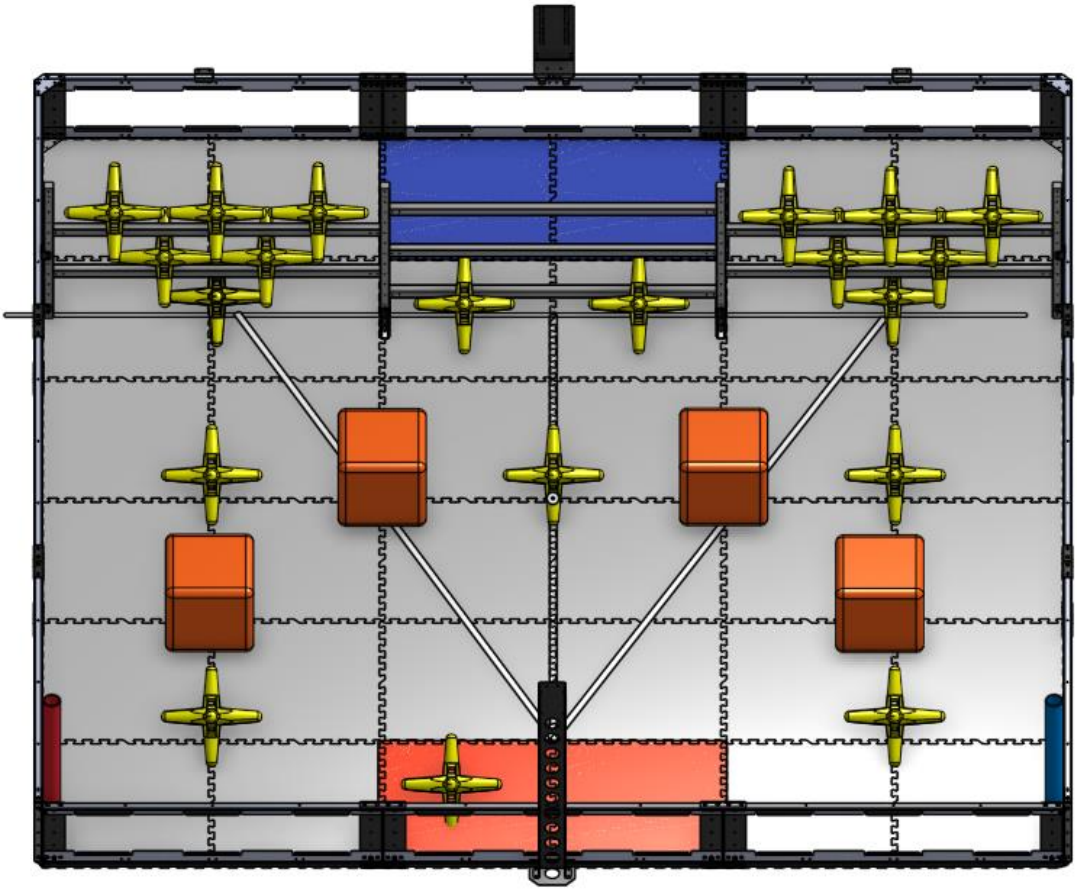
- **The lines are created by using 3/4" wide white electrical tape.**
- **Two tape lines run at an angle from the front center edge of the red tiles 2 feet from the field wall at the fence line.**
- **One tape line runs vertically from the front center edge of the red tiles to the center of the fence line.**



Isometric View

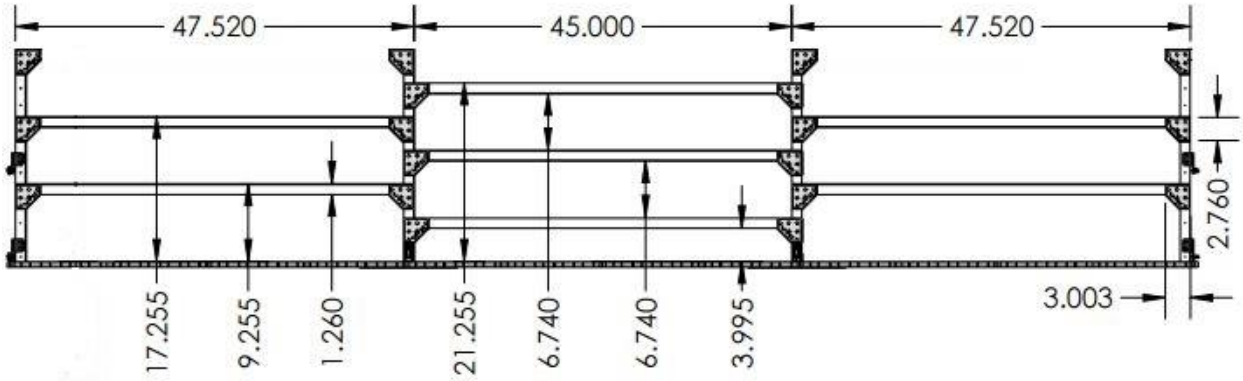
The Yellow Stars and Orange Cubes are placed on the field as shown (below) prior to each match.

- There are (6x) yellow stars placed on each side of the fence. 3x are placed on the top row, 2x on the middle row and 1x on the floor.
- There are (3x) yellow stars placed horizontally along the center line of the field at 2', 6' and 10'
- There is (1x) yellow star placed at each of the 2' x 2' corners of the starting side of the field.
- There are (2x) orange cubes placed horizontally along the center line of the field at 4' and 8'
- There are (2x) orange cubes placed 2' from the vertical wall and 4' from the horizontal wall marking the red and blue corners.
- There is (1x) yellow star the operator can preload onto the robot or place anywhere within the red staring zone.

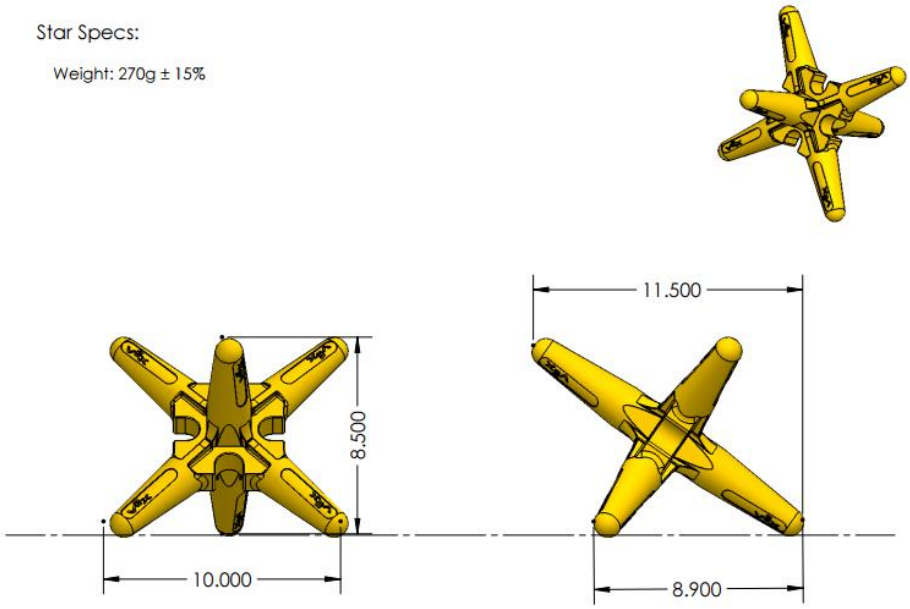


Game Pieces

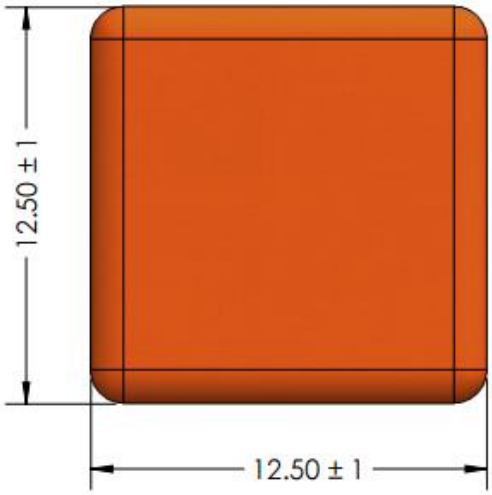
Fence specifications



Star Dimensions



Cube Dimensions



NOTE:

Cubes will come vacuum packed and will need to be fluffed before use.

All dimensions are nominal and will vary due to deformation.

Weight: 760g ± 15%

Star and Cube dimensions

Note: As described above, Game Objects may vary in size; teams need to accommodate this in their designs. It is always a good practice to develop mechanisms capable of adapting to this potential variance.

Appendix C – State Competitions

Some State SkillsUSA competitions are held in smaller venues and are typically only four hours long. Because of this, the state director and his or her technical committee may choose to substitute or change the Mobile Robotics challenge in a variety of ways. It is up to the state to determine the how they would like to change the contest to better suit their needs. Here are some suggestions:

- Omit the math problem.
- Omit the virtual programming challenge
- Omit an engineering change order.
- Increase or decrease the number of rounds per team.
- Omit the assembly period (allow teams to bring pre-assembled and ready to compete robots to the event).
    - Additional VEX components not listed on the Bill of Materials used at the National Contest may be permitted at a state competition. Note that teams will need to build their robot from scratch at the National Contest using only parts provided by the Technical Committee.
        - **Local state technical committee retains the right to determine permitted or non-permitted components.**
    - Inspection based on size constraints should be included
- Modify the competition scoring matrix or BOM to align with other changes for their state.

Please check with your SkillsUSA State Director and the associated Technical Committee for information regarding any modifications to the event as described in this document. State Competitions are allowed to modify the rules of this competition to fit their specific state requirements.

For more information on how to run or find resources for a Mobile Robotics Competition in your state, please contact the Mobile Robotics National Technical Chair, Trevor Pope at Tpope@Intelitek.com.