2016 SKILLSUSA CHAMPIONSHIP

MOBILE ROBOTICS COMPETITION

Pick a Peck

TEAM GUIDE

18 December, 2015
Revision A

Contents

Acknowledgments

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. The following companies have contributed resources and support.

Intelitek, Inc.
AZTECH Educational Resources
VEX Robotics, Inc.
Robotics Education and Competition Foundation
UPS
Visual Edge Inc.

Mobile Robotics Technical Committee

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

Rick Knisely
AZTECH Educational Resources

Miller Roberts III
Robotics Education & Competition Foundation

John V-Neun
VEX Robotics, Inc

Daniel Ward
Visual Edge Inc.

Isaac Onigman
ControlAir, Inc

Tom Hand
Honeywell

Ben Richardson
Learning Labs, Inc

Awards

The following companies have supplied awards:

Intelitek, Inc.
VEX Robotics, Inc.
DeWALT

2016 SkillsUSA Mobile Robotics Competition

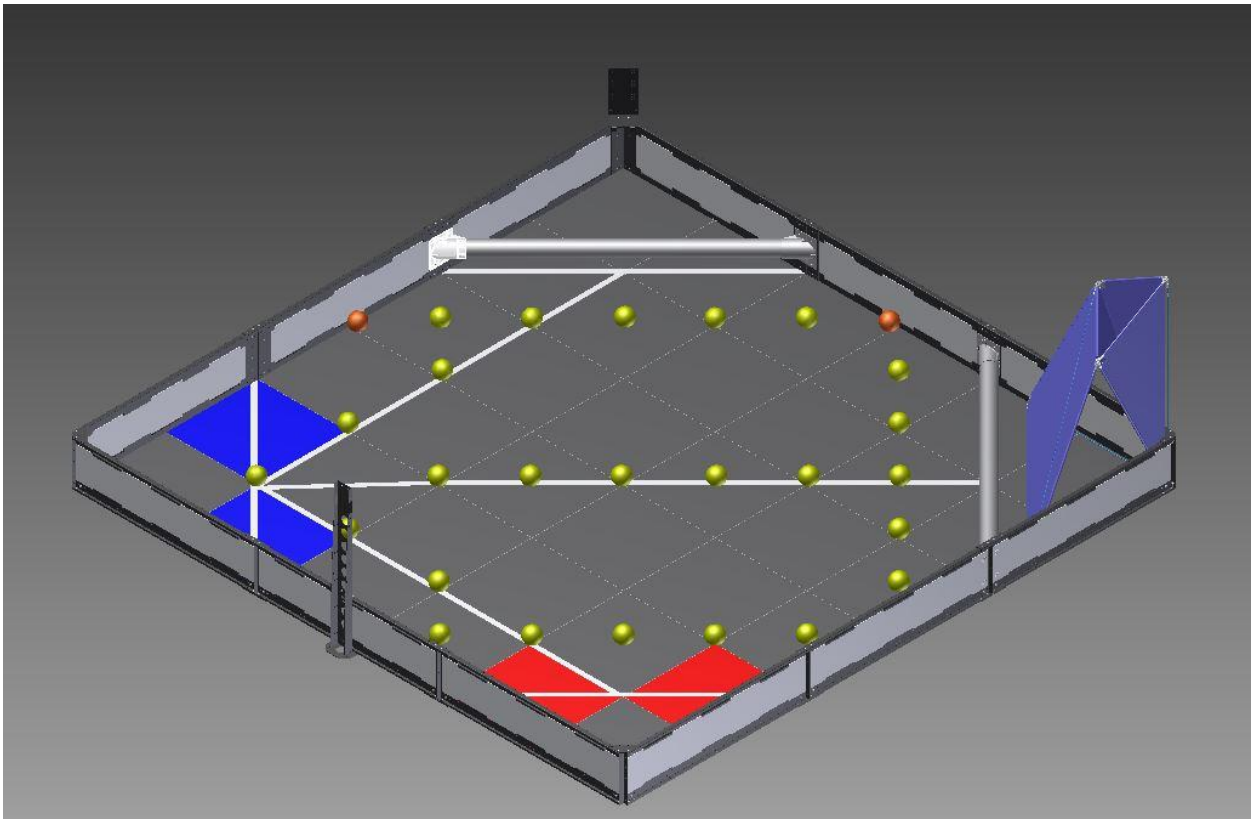


Figure 1: SKILLS 2016 playing field

The Game:
This year's challenge is played on a 12'x12' square field configured as seen above. Teams are tasked with moving balls into any of three 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 28 green balls along with 4 orange balls. The field contains three different scoring zones. One zone consists of the corner red tiles and is bordered by a white tape line. A second scoring zone is located over the PVC bar to the corner left of the driver starting position and the third scoring zone is found within the high net goal. Any balls that are over the net goal PVC bar but not inside the net will not be scored. The field contains white tape lines that form a pattern on the inside of the field.

Scoring:
Green Ball Scored in the Red Zone = 1 point
Green Ball Scored over the left PVC bar = 3 pts
Green Ball Scored in the Net goal = 10 pts

Any Orange Ball Scored will double the points for the scoring zone it is placed in.

The Round:
The competing robot will begin the round located completely inside the starting triangle created by the blue 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 balls into any scoring area. During the next 60 seconds of the round, drivers take control of the robot. Teams score points for each ball placed inside the corresponding 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

In today's apple orchards there is the need for a better way to harvest ripened fruit from the trees. At the same time, any spoiled fruit needs to be separated from good fruit. This must be done in a timely fashion to keep the ripe fruit from spoiling. Currently, this process is performed predominantly by workers in the fields and takes too much time to complete.

The Client is aware that automation systems boost productivity, reduce costs, shorten order fulfillment times, increase customer satisfaction and deliver a rapid return on investment (ROI). These ROI is achieved through faster harvests, order accuracy, and a decrease in labor costs. Today's orchard managers are consistently finding that two to five percent improvement across various performance metrics can mean hundreds of thousands of dollars in bottom-line returns to the business. By using automated robots in an apple orchard we are able to eliminate manual picking and sorting. This can improve the picking and sorting functions, enabling the orchards 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

Granny Smith Orchards (The Client) is looking to improve their orchard productivity. The Client is processing more orders 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 orchard picking and sorting. During the day the Client's employees will use the robots to transfer the remaining apple harvest to the apple processing areas. Therefore, as a Mobile Robotic development team, your goal is create a robot that can fulfill the picking and sorting process autonomously and during the time when Granny Smith Orchards' employees are controlling it.

On the Competition Field the apple processing areas consist of an apple sauce plant, an apple pie processing plant and a cider press. The apple sauce processing plant containers consist of the corner red tiles bordered

by a white tape line. Any apple (green ball) with its center line within this boundary will be mashed for apple sauce. The Apple pie processing plant container is considered any ball over the PVC bar on the left side of the field. Any apple within the net will be sent to the cider press for processing. Any balls that are over the Net PVC bar but not within the net will not be processed.

There are four Golden Apples (orange balls) located at the center of the apple orchard fence line (field walls). Any Golden Apples placed inside a processing area are beneficial to the Client and will increase productivity.

1.2: Specific Project Instructions

1.2.1: Initial Design

The Client, Granny Smith Farms is a company that is looking for an automated way to collect fallen apples throughout the apple orchard and place them in the various processing locations. Granny Smith Farms has provided a layout of the warehouse property; along with these general robot operating requirements. 1). the robot must autonomously pick up and move apples 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, assembly instructions, the programming code flowchart, and a printed C code program for the robot.

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.

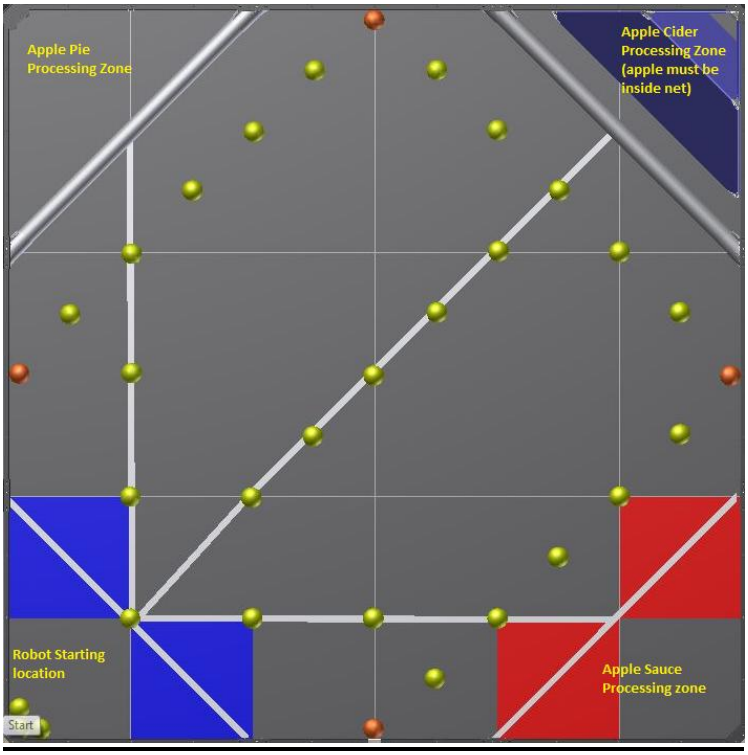


Figure 2: Top view of Clients orchard fields and processing locations

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 orchard layout 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 fulfilled 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, printed sections of EasyC code, 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 may bring only their Engineering Notebook and a laptop to the competition to be used as reference tools during the build phase. The laptop may already have programming code for the robot.
5. All team members are responsible for double-checking each other's work. Thus, they shall both assist with build and quality control.
6. At the competition, the robot must be constructed from only the materials supplied by the technical committee.
7. 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.
8. 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.
9. At all times, team members are required to adhere to industrial safety standards, such as wearing of eye, ear, and hand protection where appropriate.
10. All engineering notebooks, forms, documentation, and programs must be turned in to the technical committee members during orientation session.
11. All team members, advisors, and judges 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 – The three (3) Balls a team may place on the field or their robot. They must be fully within the starting zone prior to the start of each match.
- High Goal – The 36" tall fiberglass and mesh structure, where teams can score balls and bonus balls.
- Low Goal –The triangle area of foam field tiles defined by the PVC pipe, where teams can score balls and bonus balls.
- Corner Goal – the triangle area of red foam field tiles defined by the white tape line, where teams can score balls and bonus balls.
- Scored – A ball is scored if it is not touching a robot and meets the following criteria.
    - The centerline of the ball must be within the perimeter of the goal
- Scoring Object – A Ball or a Bonus Ball
- Goal – A corner goal, low goal or high goal
- 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 grey, blue and red foam tiles.
- There are 2 blue floor tiles in the corner of the field with a white tape line making a triangle. This is considered the starting location for your robot. The robot can be placed anywhere within this triangle however must be fully within the starting triangle.
- There are 28 green balls placed on the field along with 4 orange balls. Three balls are placed in the blue starting triangle and can be pre-loaded.
- There are a total of three scoring zones.
    - One scoring zone is the field corner to the right of the starting position with the red floor tiles and defined by a white tape line making a triangle. The centerline of the ball must be across the tape line to be considered scored.

- A second scoring zone is the field corner directly across the starting position. Any ball completely within the high goal will be scored. The PVC rod is mounted to prevent damage to the high goal. A ball over the PVC rod but not in the high goal does not count as a scored object.
- The third scoring zone is the field corner directly to the left of the starting zone. The centerline of the ball must be within the centerline of the PVC rod to be considered scored.

1.5.1.3: Scoring

- The centerline of the ball must be within the perimeter of the scoring zone to be considered "scored".
- A green ball scored inside the red scoring zone is worth one point.
- A green ball scored inside the PVC bar (to the left of the staring position) is worth three points
- A green ball scored inside the high net goal is worth ten points.
- Any orange ball scored inside a scoring zone will double the points for the scoring zone it is placed in.
- Only one orange ball can be placed in each scoring zone.
- A ball over the PVC bar defining the border of the high net goal will not be scored. The ball must be completely within the net.

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 ball 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 triangle created by the blue starting tiles and white tape line.

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 servo.

- 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 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.

Printed Program for Robot:

Teams should print their code and include it in the Engineering Notebook. This program should follow the team's flow chart. This does not need to be the final robot program; however, teams are encouraged to make their program as complete as possible ahead of time to maximize their score. **Only programs printed from EasyC programming software will be scored.**

Program Flow Chart:

Teams are encouraged to include a flow-chart of their robot's program. **Only programs printed from EasyC programming software will be scored.**

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.
4. SkillsUSA Robotics Kit of Parts (VEX Robotic Design System).

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 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.

- Engineering Notebook
- Math Problem

SKILLSUSA
Mobile Robotics
Judging Form 2015

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	40		
2. Bill of Materials	20		
3. Assembly Instructions	40		
4. Illustrations of Design Process	40		
5. Program Flow Chart in EasyC	20		
6. Printed Program for Robot in EasyC	40		
	200		
Robotic Task Performance			
1. Round 1and 2 Score	300		
Robotic Design Challenge Performance Subtotal	**300**		
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.

Curriculum & Manuals
(1)Quick Start Guide, Clawbot

Logic
(1)VEX ARM® 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 Integrated Motor Encoder (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

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

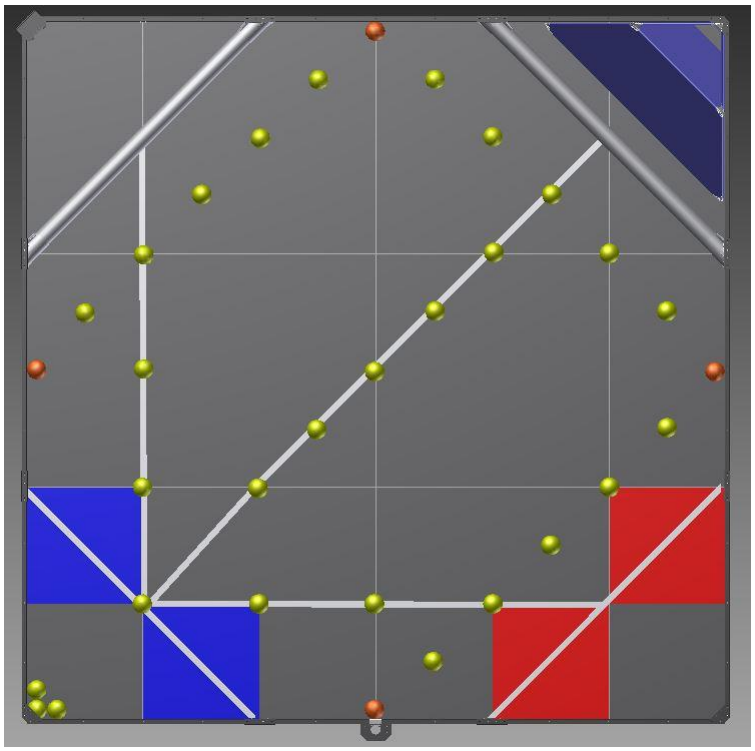
(1)7.2V Robot Battery NiMH 3000mAh
(1)AAA NiMH Rechargeable Battery 6-pack
(1)Smart Charger Power Cord
(1)8-Bay AA/AAA Smart Battery Charger
(1)VEXnet Backup Battery Holder

Equipment

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

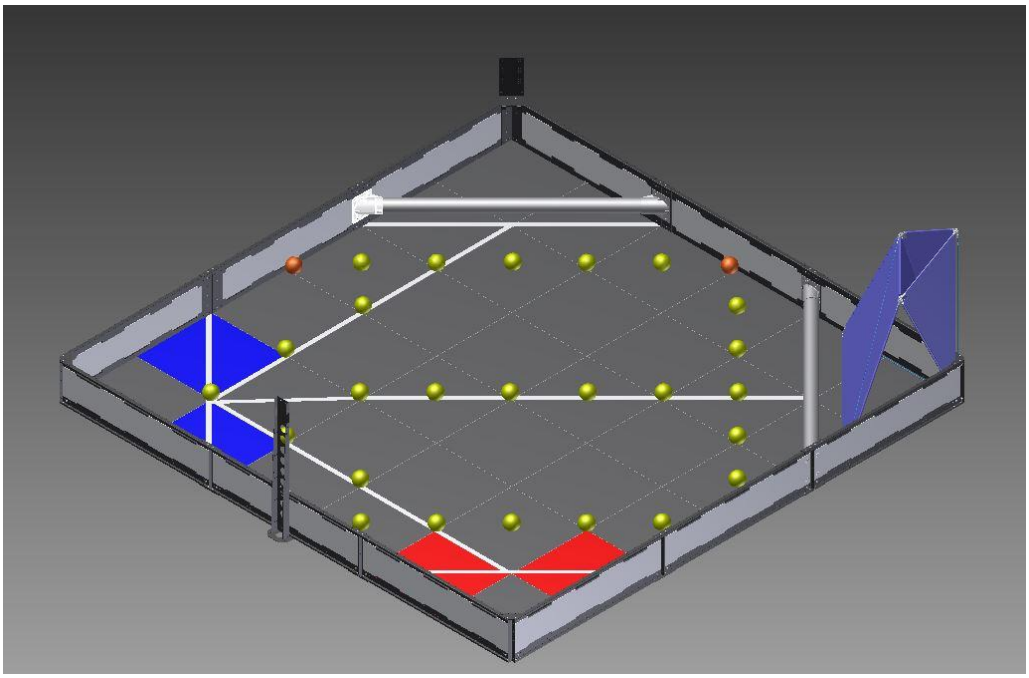
Appendix B – Field Information

Field Pictures



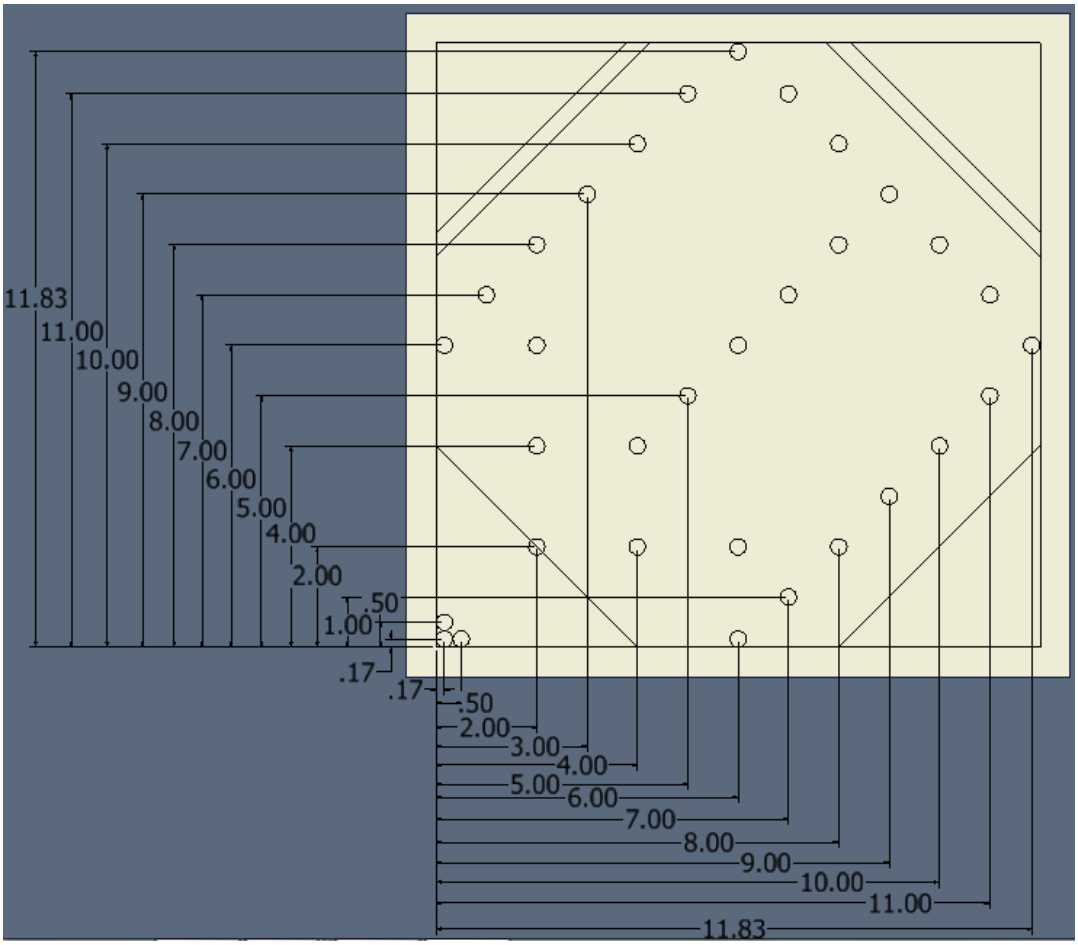
- **The lines are created by using 3/4” wide white electrical tape.**
- **One tape line runs at a 45 degree angle from the side walls 4 feet from the field corner at the corners of the blue tiles.**
- **One tape line runs at a 45 degree angle from the side walls 4 feet from the field corner at the corners of the red tiles.**
- **One perpendicular tape line runs from the center of the blue starting corner to the center of the PVC bar directly across the playing field.**
- **Two white tape lines run from the center of the blue starting tile to the center of the left and right corner scoring zones 2 feet from the perimeter of the field.**
- **One tape line runs at a 45 degree angle from the side walls directly below the PVC pipe.**

Isometric View



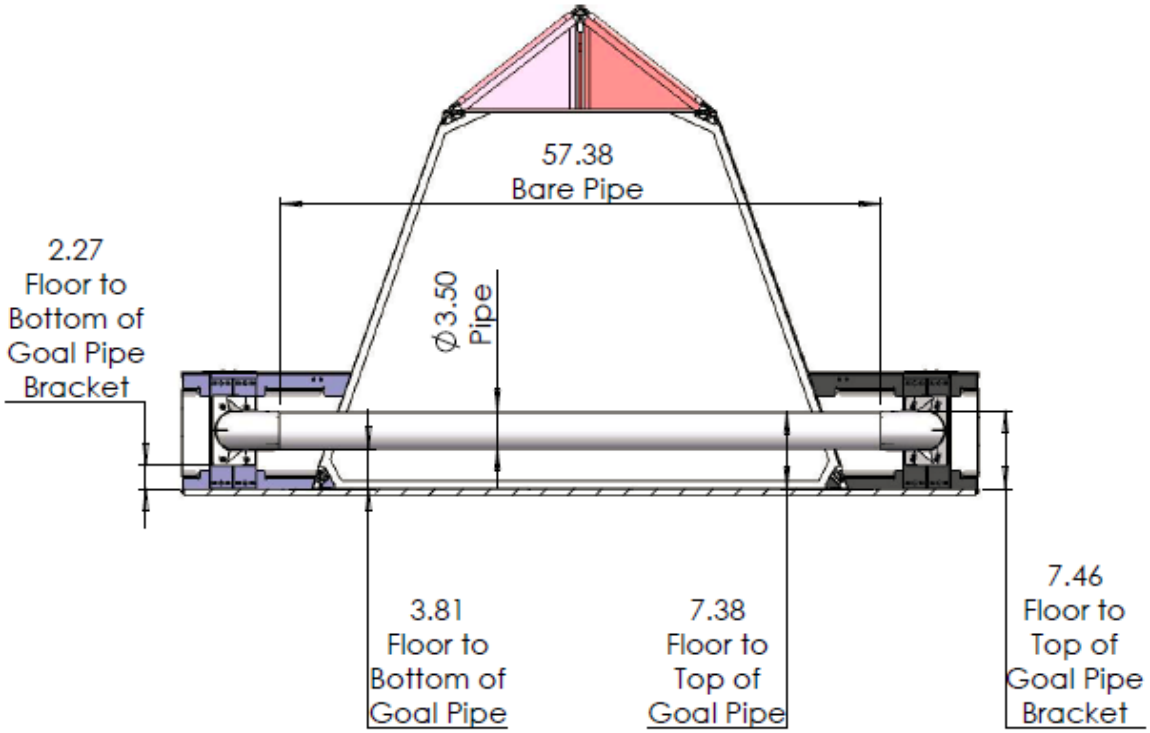
The Green Balls and Orange Balls are placed on the field as shown (below) prior to each match.

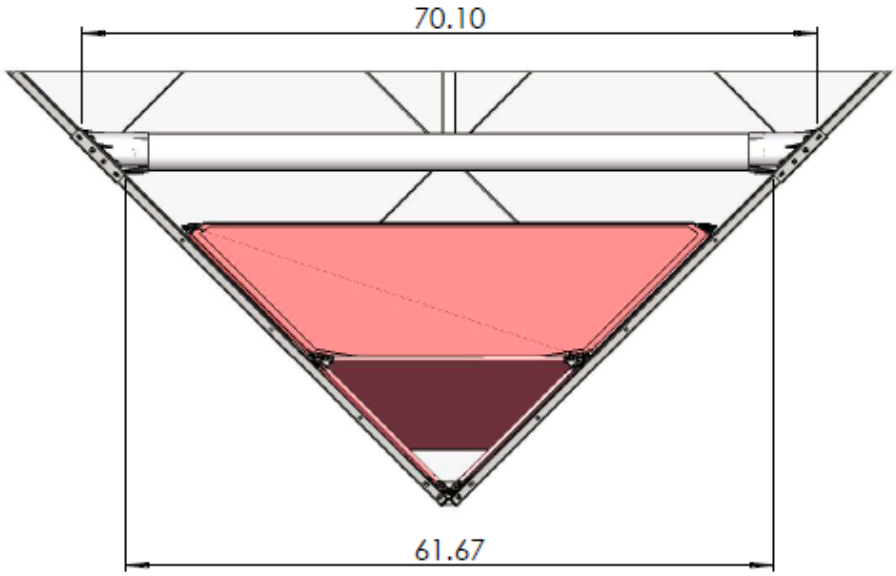
- There are (4x) orange balls placed at the center line of the field perimeter on each side of the playing field.
- There are (3x) green balls the operator can preload onto the robot or place anywhere within the blue staring zone.
- There is one green ball at the center of the white tape line defining the perimeter of the blue starting goal.
- There are (2x) green balls placed on the corner location marked by the corner of the blue tiles along the 45 degree tape line 2 feet from the side wall and 4 feet from the opposite wall.
- There are (22x) green balls placed in a square pattern in the center of the field. See reference drawing below for dimensional details.



Game Pieces

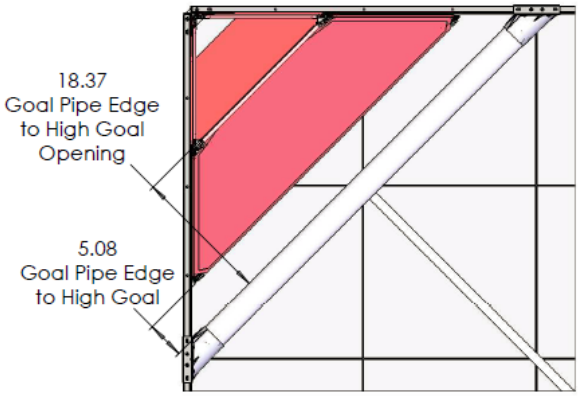
Goal pipe specifications (in Inches)

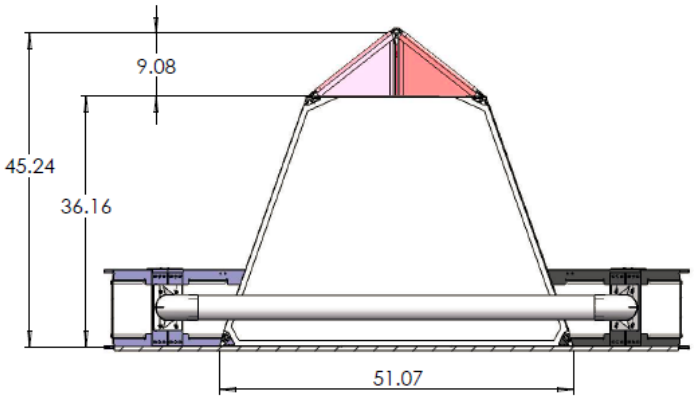




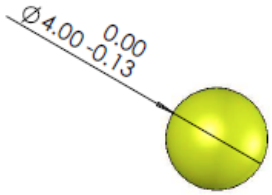
Goal Pipes are made of 3" (3.5" OD) Schedule 20 PVC.

High Goal specifications





Ball Dimensions



Green and Orange balls

There are 32 balls placed on the field. 28 are green and 4 are orange. Each ball weighs 0.115 lbs +/- 15%. Ball dimensions may vary by as much as 1/8".

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 an engineering change order.
- Increase 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.

2016 SKILLSUSA CHAMPIONSHIP

MOBILE ROBOTICS COMPETITION

Materials and Tools Requirement by Competitors

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 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.