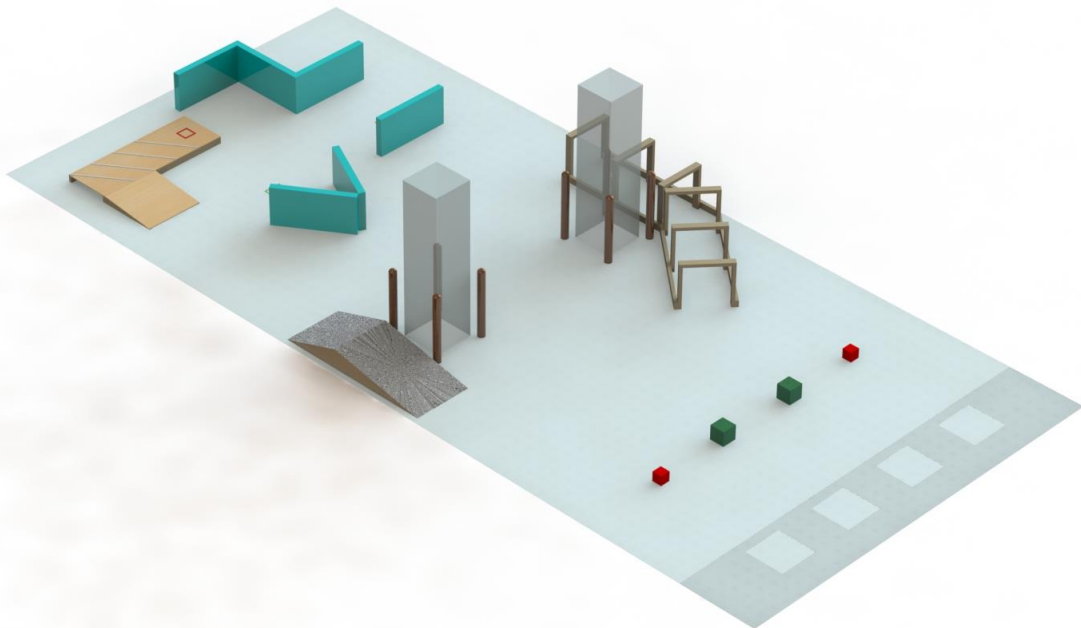


Moving On

2015 Kentucky Bluegrass High School Robotics Competition

Sponsored by
Western Kentucky University
Department of Engineering

Kickoff Meeting: September 11, 2015
Competition Day: November 7, 2015



Introduction

WKU Engineering has created a game for the 2015 WKU Kentucky Bluegrass High School Robotics Competition that will challenge your technical skills as robot designers of the future. To succeed in the competition your team will need to create a quick, agile, yet tough robot.

For the WKU Kentucky Bluegrass competition, your team must build a remotely controlled device that can move around a carpeted surface, and compete against other devices. Speed, agility, and reliability are all crucial points of the design as each team must try to outmaneuver and outrace the others to complete their objectives.

Good luck! You have **only eight weeks** to design, build and test a device before the competition begins!

1.0 Robot Construction Constraints

There are three categories of robot materials that you may use to build your device. You have been provided with (1) WKU Returnables and (2) WKU Consumables kits, and (3) **you may also choose to use other materials at your expense.** Material lists are provided for the WKU Returnables and Consumables kits.

- 1.1 Devices can be constructed using WKU materials or any of your own materials, however only the WKU Returnables items may be used to power and to control your device. No additional motors or controllers may be used.
- 1.2 Returnable motors **may not** be opened for any reason (such as to change gearing or re-wind the motor armature).
- 1.3 Use only the provided Quick Disconnect terminals and Twist-On Wire caps. Soldering is **not** allowed, either associated with the wiring, or for structural support.
- 1.4 No welding is allowed.
- 1.5 Tape and/or adhesive **may not** be used for mounting any WKU Returnable items. This includes using Velcro on the battery.
- 1.6 Lubricants may be used for lubrication only.
- 1.7 Paint and stickers or decals may be added as decorations only.
- 1.8 Non-functional decorations (excluding strobe lights) are permitted. Non-functional means that it does not aid the robot in performing the game.
- 1.9 Plastic may be heated and reformed.
- 1.10 Materials may not be changed chemically, with the exceptions that strings may be singed to prevent loose ends and that resin and hardener can be mixed to make epoxy.
- 1.11 Lost or damaged WKU Returnables kit materials may be replaced only with identical components purchased by the team. Your Returnables kit must be returned intact.

The following statements apply to the energy, size, weight and safety aspects of your robot:

- 1.12 Robot energy must come solely from: electrical energy from the single onboard battery. Your kit from WKU comes with a battery that is probably very old and weak. **You are allowed to purchase your own batteries to use, and we strongly suggest that you do so, otherwise you will be at a disadvantage to other teams. Batteries must have the same rating (7.2V and 1500 milliamp-hour capacity) as the WKU battery, or less voltage and capacity.**
- 1.13 Robots must fit unconstrained within a 2' by 2' by 2' cube at the start of the competition. The robot may expand beyond this limit when the competition starts, but it must do so under its own power. It does not have to return to the original dimensions at the end of the event, they only must meet the size requirement for the start of the next event.

- 1.14 There is no robot weight limit for the competition, but the robot must be able to power itself using a single battery and only the motors provided by WKU.
- 1.15 Safety is the most important aspect of the competition and will not be compromised.
- 1.16 Power supplies, batteries, charger and control system may not be tampered with. Only one battery can be used at a time. The cost of batteries (either WKU or your own) does not get included in the device cost.

The following statements apply to various aspects of your robot:

- 1.17 Robots may not gain traction through the use of chemical adhesives, or altering the playing surface.
- 1.18 Damaging the playing surface may result in disqualification
- 1.19 Machines must prominently display team/school name or logo, and team's assigned number.
- 1.20 During the competition runs robots may only be controlled through normal radio control system.
- 1.21 Robots must stay at the competition site between check-in time and the start of the competition.

The following statements apply to the control system of your robot:

- 1.22 Only WKU Returnables items may be used to power and control your device. No additional motors or controllers may be used.
- 1.23 The transmitter, receiver, servos, speed controllers, batteries, battery chargers and power supplies **may not** be altered in any way. This includes putting labels or rubber bands on the transmitters; internal, reversible modifications; and cutting the antenna.
- 1.24 Two exceptions regarding modifications are: servo horns may be removed and modified; some motor speed controllers may be tuned to adjust the null point and maximum speed (following procedures given in the instructions).
- 1.25 The receiver, battery, servos, speed controllers and wiring harnesses are the only components of the control system that may be attached to the robot.
- 1.26 The Quick Disconnect terminals and Twist-On wire caps supplied **must be** used to connect the motors and electrical devices to the speed controllers.

REMINDER ABOUT RETURNING MATERIALS: *Teams must return all Returnable items before leaving WKU at the end of the competition. Do not return portions of your purchased components or the WKU supplied Consumable items unless you have an unused consumables box. As you build your robot it must be possible to take the returnable items off your device, as well as Returnable components you don't use, so that they can all be returned on competition day.*

The following statements apply to determining the cost of your robot:

- 1.27 A part of the competition scoring includes the device drawing and Bill of Materials (explained below in Competition Scoring).
- 1.28 Your Bill of Materials must include all items used on your device: (1) WKU-provided Returnable and (2) Consumable kit items and (3) items that your team purchases or provides.
- 1.29 The final cost of your device must be provided on your Bill of Materials. When calculating this total cost you must include all WKU-provided Consumable items and all non-WKU items that your team uses on your device. Component costs for WKU-supplied items are provided in the Appendix. If some of the non-WKU items that your team uses are components that you already have available, even though their actual cost to you is \$0, you still must provide a valid purchase price. You must use the purchase price at a local store (Home Depot for example) or an online price (you may ignore shipping costs). **You cannot use an e-Bay bid price or similar sources, you must use new retail prices.** You must reference all purchase prices and sources.

2.0 Game Floor Layout and Overall Procedures

All events for the WKU Robotics Moving On competition will take place on a 20 ft by 45 ft carpeted area (Figure 1). For each competition round, robots will compete **sometimes alone, or two, three or four robots** at a time. The team driver will be allowed to move along one side of the playing surface, behind the starting positions, while another team spotter will be allowed to move outside of the playing surface at the far end from the starting positions.

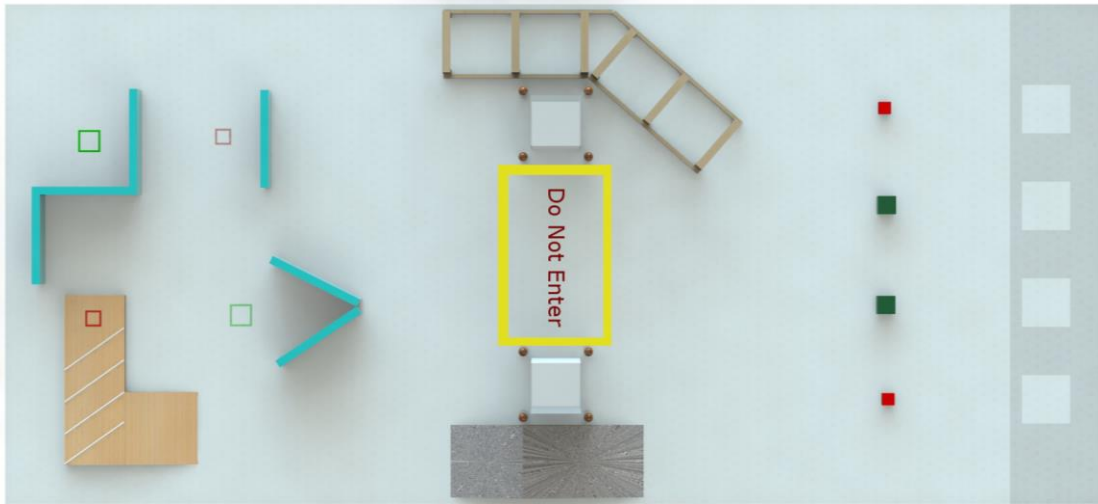


Figure 1: Overall Game Surface Layout (Subject to Minor Changes)

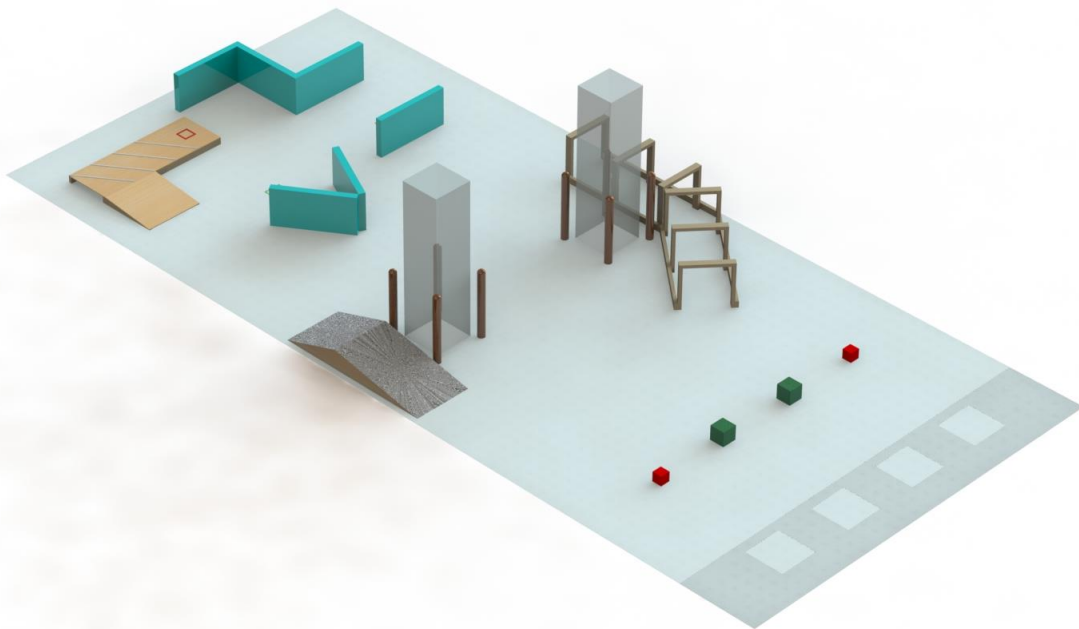


Figure 2: Isometric View of Field Layout (Subject to Minor Changes)

- 2.1 4" PVC piping will define the outside boundary of the 20' by 45' playing field surface; the playing surface will be constructed of carpet. During a game, robots may not leave and then return to the playing surface. Robots that touch the ground outside the playing surface will be required to remain motionless for 20 seconds.
- 2.2 At the start of each round, there will be two 6" cardboard cubes (red) and two 9" cardboard cubes (green) set on the game surface. Your robot is to move as many of the four boxes over to the scoring side of the playing surface, and position them on their target areas as possible in the 5 minutes allocated. Points will be awarded based on your success in achieving these tasks.
- 2.3 Each robot will begin the game in its own 2' by 2' starting area (shown on the right side of Figure 1), and the driver must remain in the driver's box behind the starting area. The team robot must move around the playing surface. The driver's view **will be obstructed at times**, and it will be the job of the team spotter to assist in robot movement.
- 2.4 To get from the starting side to the scoring side of the playing surface, robots must either pass through a tunnel or cross over a ramp (see figures in the Appendix). The central area of the playing surface between the building columns will not be visually obstructed, but robots will not be allowed to pass through.
- 2.5 On the scoring side (the left side of Figure 1), there will be 4 target areas: two 8" square red targets and two 11" square green targets. For each round, the positions of four targets will be as shown in the figure, however the order (larger green vs. smaller red targets) will be changed just before each competition round begins. The red/green boxes must be moved to the same target color in order to score points. See section 5.0 for scoring points.
- 2.6 There are 3 walls (a one-panel, a two-panel, and a three-panel wall) located in the scoring side. These walls will be randomly moved just before the start of each round. Robots must move around the walls, they cannot push the walls over.
- 2.7 Each team will have a spotter who will remain on the scoring side of the playing surface during each game. The primary job of the spotter will be to direct the team driver in the placement of boxes. **THE SPOTTER CAN MOVE ANYWHERE ALONG THE SIDELINE OPPOSITE THE STARTING AREA DURING THE COURSE OF EACH GAME.**

Teams may perform minor robot repairs during the rounds by returning to the team's assigned starting zone. Repairs may be made by the driver if the robot is within the start zone. No tools are permitted for repairs during a game.

3.0 Game Rules

The WKU HS Robotics *Moving On Games* will take place on a 20 ft by 45 ft carpeted area (Figure 1). Teams will compete individually, in pairs, or threes in the early seeding rounds, and then four teams will compete in each of the finals rounds. The objective is to move the various boxes from the starting side of the playing surface to target zones located on the scoring side during the time allowed.

3.1 Scoring for all rounds

Teams will have the opportunity to earn points by moving the four boxes from the initial positions on the starting side to the target areas on the scoring side of the playing surface as follows:

- 1) Moving each box either completely through the tunnel, or completely over the ramp earns the team points.
- 2) Moving each box so that it is at least 50% on the same color target area earns the team points. (Judges will determine when 50% is met and signal the driver)
- 3) Moving each box so that it is **entirely** on the same color target area earns the team points. (Judges will determine when this is met and signal the driver)
- 4) Once a team is in contact with a box and is moving (the robot is not stuck or unable to move) other robots are not allowed to interfere with the box. However, if a robot becomes incapacitated another robot may "steal" the box.

- 5) Once points are awarded by the judges for a box placed on a target area that box cannot be moved off the target, and no other box may be placed on that same target. Teams either earn the 50% score or the entirely on the target score, not both. If one team earns the 50% score and leaves the box, a different team **is not allowed** to move that box to earn the points for being entirely on the target.

3.2 Early rounds to determine seeding in the Final Rounds:

All teams will get one round to complete the course with no other robots. Then teams will be randomly placed in groups of either two or three devices for three additional rounds. Each competition round will continue until one of three scenarios occurs:

- 6) All four boxes are positioned.
- 7) The time limit of 5 minutes is reached.
- 8) The judges and driver(s) of all teams in play agree to end the round (no devices can move).

3.3 Robot Maintenance

Between rounds, the teams are allowed to modify and repair their robot. However, each round will play as scheduled regardless if modifications or repairs are complete. Teams are allowed to join in late if a round started without their presence.

3.4 Final Rounds

- 1) Based on the cumulative score earned by each team for the four seeding rounds, teams will be ranked (most points for seed #1). Ties will be broken by highest single round score. The twelve highest scoring teams will advance to the Finals Round.
- 2) Seeds #1 through #4 will receive a bye.
- 3) Seeds #5 through #12 will each compete in against each other in rounds involving four of these teams. The top two from each of these two rounds will advance to the semifinals.
- 4) In the semifinals Seeds #1 through #4 and the four teams that advanced from the Seed #5 through #12 rounds will compete in two 4-robot rounds. Again the top two from each round will advance to a final competition round to determine the winner.

The scoring in the finals rounds is the same as in the previous rounds. The top places for the competition will be based on the results of the final round, not the overall score for the day.

4.0 Point Scoring

Teams score points by moving the different sized boxes around as shown in the table:

- 4.1 Target areas will be randomly placed at the four locations shown in the playing surface figures at the start of each competition round.
- 4.2 Teams are **NOT** permitted to interfere with other robots that already possess a box. However, if another robot is unable to move, or a box is undisputedly unattended, then that box can be taken by another team.

Box Size	Scoring Activity	Points Earned
6" (red)	Passed through tunnel	1
	Crossed ramp	2
	50% on correct target	3
	Completely on correct target	5
9" (green)	Passed through tunnel	2
	Crossed ramp	4
	50% on correct target	6
	Completely on correct target	10

Team drivers will only be allowed to move along the end of the playing surface where the starting boxes are located. One team spotter will be allowed to move along the opposite end of the playing area and give directions to the driver. Other team members, or audience members may not give instructions to the drivers during the competition. **Teams that violate this rule may forfeit all points earned in a round for each infraction.**

5.0 Other Competition Categories

Device Documentation and Cost Effectiveness will also be evaluated for prizes:

Device Documentation scoring:

- 5.1 Each team must provide device drawing(s) clearly showing all components on the device, and a Bill of Materials that lists all items used on the device.
- 5.2 All documents must be provided by teams at check in on Competition Day. **Teams will not be considered for overall winner without Device Documentation.**
- 5.3 The device drawing(s) may be hand drawn or computer generated. Teams may submit as many (or few) drawings as are necessary to identify all robot components. The device drawings will be judged based on the ability of the WKU judge to identify all components that are on the actual device and are shown on the drawing.
- 5.4 Teams should provide a Bill of Materials (BoM) with three separate tables: WKU Returnables, WKU Consumables, and Other Team Materials. Each BoM table should have column headings for: item name, item description, and quantity used (either number used or amount used). The WKU Consumables and the Other Team Materials BoM tables should also have columns for item cost and for how the cost was calculated. An example entry is provided below:

Item	Description	Quantity	Cost	Cost Calculation
Robot Side Brace	2"x4" wooden board	1 foot long	\$1.50	An 8' long 2x4 cost \$12 at Lowes

- 5.5 Teams should clearly list the total cost of Other Team and WKU Consumables Materials somewhere in the BoM table. **TEAMS DO NOT HAVE TO INCLUDE COSTS OF SCREWS AND FASTENERS PROVIDED BY WKU, NOR DO TEAMS HAVE TO INCLUDE THE COST OF TEAM PROVIDED FASTENERS SUCH AS TAPE, SCREWS OR STAPLES. IF A TEAM PURCHASES A BATTERY THAT ALSO DOES NOT HAVE TO BE INCLUDED IN THE COST.**
- 5.6 The Bill of Materials will be judged based on the ability of the judge to identify all components that are on the actual device and are listed on the BoM tables.
- 5.7 If the judges locate components on the robot that are not listed on the BoM tables the cost of them will be added to the total using **conservatively high prices** as estimated by the judges. This revised price will be used for the Cost Effectiveness competition category.

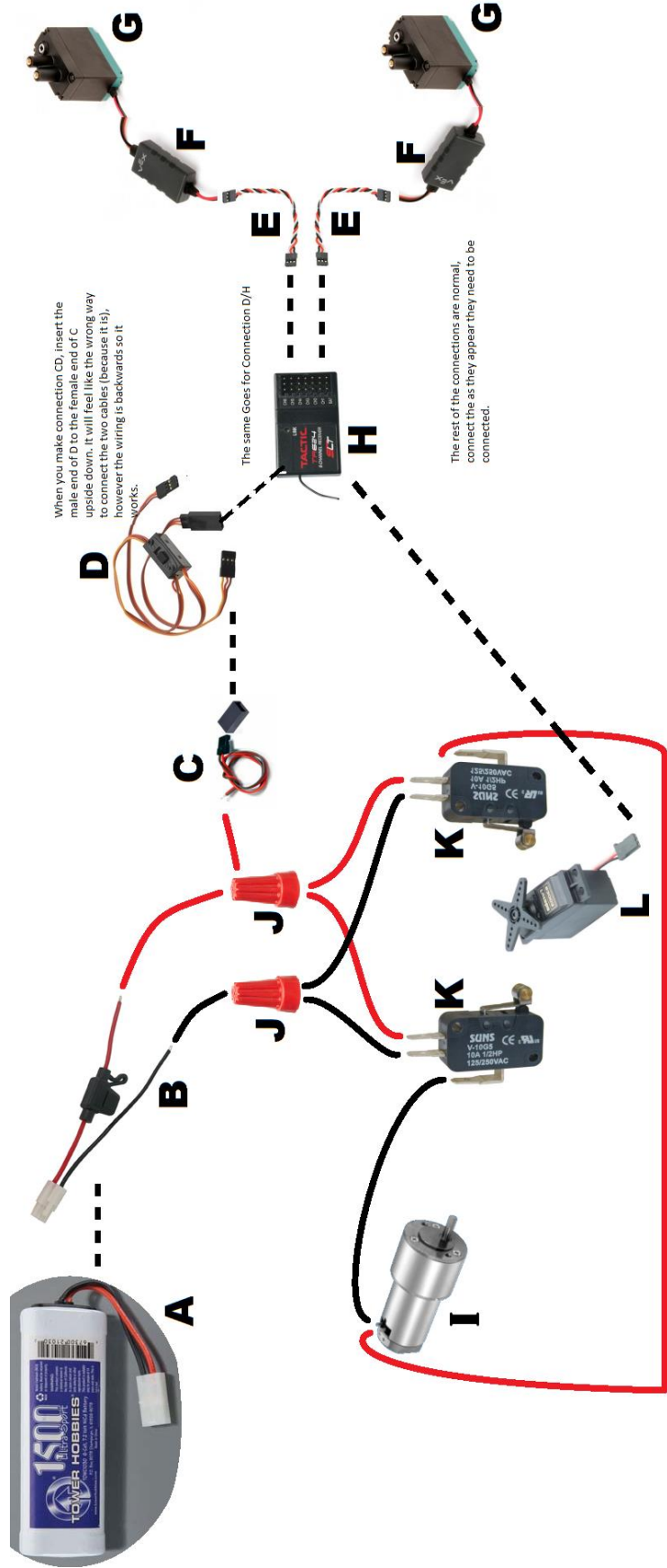
Cost Effectiveness scoring:

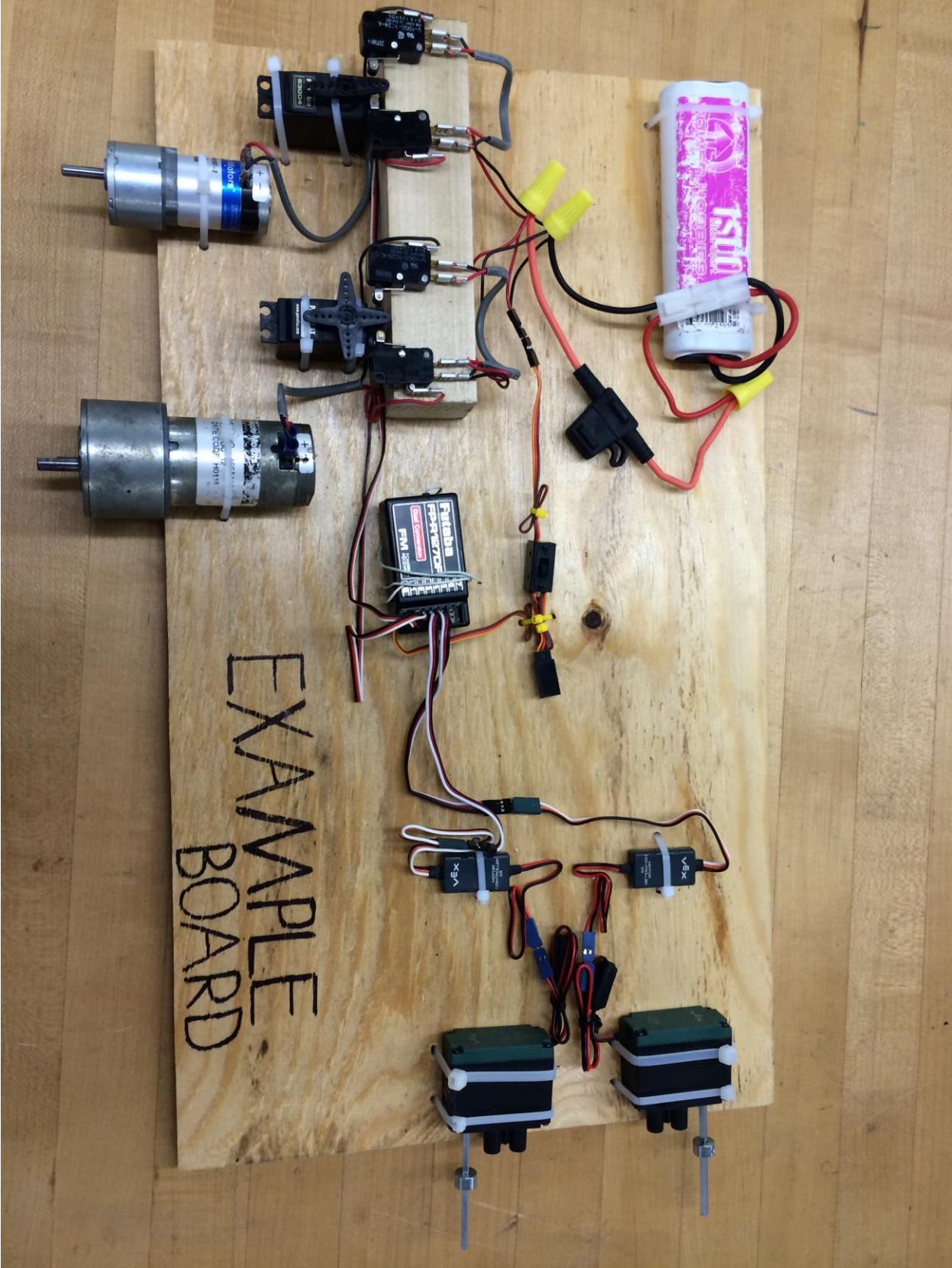
Cost Effectiveness Ratio will be calculated by taking the points scored in the team's best round divided by device cost from Bill of Materials (WKU-Consumables + team provided items.)

Appendix

1. Wiring Figures*	page 9
2. Information about VEX components	page 11
3. Playing Surface Drawings	page 12
4. Consumables Price Lists	page 15

*** Additional technical information will be emailed to all team coaches.**





VEX motor/connectors information

Since we don't know how your teams might chose to connect your VEX motors to your robots, you will need to purchase your VEX connectors. These are quite inexpensive, and you can find purchase information at their website www.vexrobotics.com

Specifically the links for their shafts and collars are:

<http://www.vexrobotics.com/vex/products/accessories/motion/276-2010.html>

Shaft Collar (16-pack) - Motion - Robot Accessories - Products - VEX - VEX Robotics

<div class="head"><h4>Usage Note</h4></div>The setscrews used in VEX Shaft Collars are 8-32 size threaded screws; this is the same thread size used in the rest of the kit. There are many applications where it might be beneficial to remove the setscrew from the Shaft Collar and use a normal VEX screw. If a setscrew is lost any other VEX 8-32 screw can be substituted although the additional height of the screw head must be considered!

[Read more...](#)

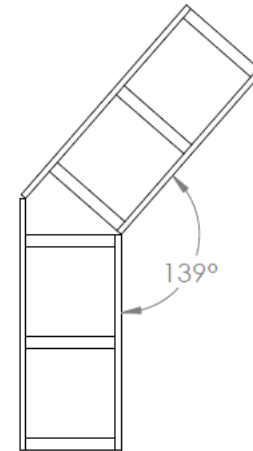
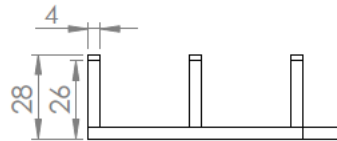
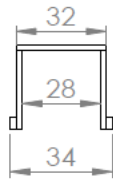
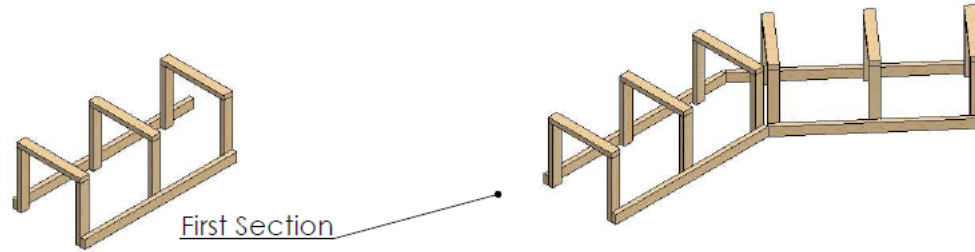
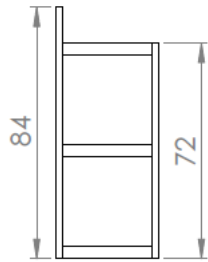
<http://www.vexrobotics.com/vex/products/accessories/motion/shafts.html>

VEX Square Bar Shafts - VEX Robotics

VEX Square Bar Shafts

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Ramp Drawing



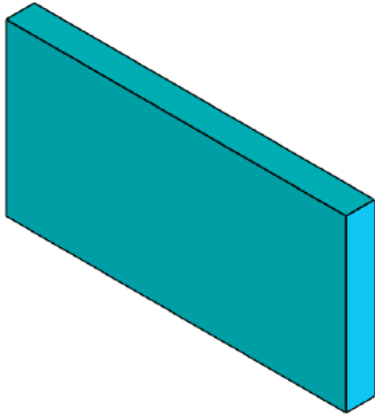
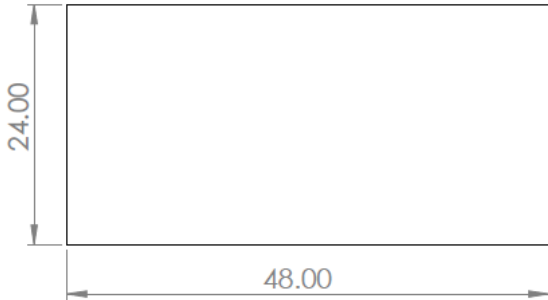
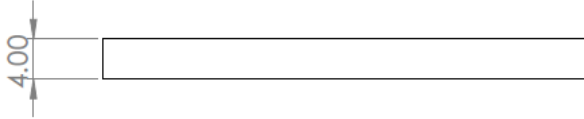
Note: Second half of "The Tunnel" is mirrored in construction along the length of the assembly

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Wall Segment Dimensions



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WKU Consumables Price List (page 1)

<u>Part #</u>	<u>Customer Part #</u>	<u>Description</u>	<u>Quantity</u>	<u>Price/EA</u>
0129754		2-1/2"x5/8" Z Crnr B	40	\$2.6865
62002		#4 5/8-1/4x5/16MHCSS	40	\$0.2338
0129935		2 Pack 2.5RemPinHnge	40	\$2.8620
63127		11" NAT CABLE TIE	200	\$0.0138
45753		H&L5'X3/4"TAPEBLK	20	\$10.8675
1136302		1/4"-20 FHN z 5	500	\$0.0284
1136306		3/8"-16 FHNz 5	400	\$0.0451
28908		RPh MS 8-32x1.25z KG	1,000	\$0.0335
1136024		8-32 MACH SCRW NUT Z	1,000	\$0.0126
29082		RPhMS 10-32x1.5z KEG	400	\$0.0336
1136030		10-32MACH SCRW NUT Z	400	\$0.0162
28678		RPh MS 4-40x1 z KEG	200	\$0.0139
1136012		4-40 MACH SCRW NUT Z	200	\$0.0094
31075		HWSL SMS 8X1 Z A KEG	1,000	\$0.0319
30509		RSL WS 4x3/4 Z KEG	200	\$0.0076
30565		RSL WS 6x1 Z KEG	1,000	\$0.0215
1133076		#12 SAE Z F/W	400	\$0.0230
1133612		#8 L/W Z	600	\$0.0068
1133074		#10 SAE F/W Z	600	\$0.0133
1133622		3/8 SplitL/W Z	600	\$0.0143
0705301		22-18 MaleDisconnect	200	\$0.1258

WKU Consumables Price List (page 2)

<u>Part #</u>	<u>Customer Part #</u>	<u>Description</u>	<u>Quantity</u>	<u>Price/EA</u>
0991210		PianoWire .063x1/4#C	20	\$2.2560
45132		SINGLE JACK Z #14	80	\$0.4377
0703468		IN-LINFSHLD MINIW/P	20	\$3.0720
0703315		20AMP MINI AUTO FUSE	40	\$0.3918
60083		Yellow Wire Conn	100	\$0.0892
0705140		16-14 L Disconnect	300	\$0.0710
0705143		16-14 LN Disconnect	200	\$0.1394
60062		16-14 (6 STUD) fork	100	\$0.1143
0701384		BRY-RS115I Swtch	20	\$0.8624
42151		3/16x1-15/16OALScEye	100	\$0.1829
1133618		1/4 SplitL/W Z	500	\$0.0057



2012 Packing list for WKU Robotics Kit

Part Number	Quantity	Item Description
Bag A		
42151	5	Eye Screw
60083	5	Yellow Wire Nut
60062	5	Blue #6 spade terminal
62002	2	Hose Clamp
0705140	15	Non-insulated quick disconnect
Bag B		
28678	10	4-40 x 1" Machine Screw
28908	50	8-32 x 1-1/4" Machine Screw
31075	50	8 x 1 HW11 Sheet Metal Screw
29082	20	10-32 x 1-1/2" Machine Screw
30509	10	4 x 3/4" Wood Screw
1133612	30	#8 Lockwasher
1136012	10	4-40 hex nut
1136306	20	3/8-16 hex nut
Bag C		
1133618	25	1/4" lockwasher
1136030	20	10-32 hex nut
1136302	25	1/4-20 hex nut
1136024	50	8-32 hex nut
1133076	20	#12 Flat Washer
1133074	30	#10 Flat Washer
1133622	30	3/8" lockwasher
30565	50	#6 x 1" Wood Screw
Bag D		
0703468	1	Fuse Holder
0705301	10	22-18 Bullet Disconnect
0705143	10	16-14 Female Disconnect
0703315	2	20 Amp Fuse
0984420	1	1/2 x 6 x 6 Aluminum Bar
0129754	2	Steel Corner Brace (4 pack)
0129935	4	Hinges
63127	10	11" Wire Tie
45753	1	3/4" x 5' Velcro
0991210	1	6' Carbon Steel Wire
45132	1	4' Single Jack Chain
10610-03420	1	25' 18 gauge 2 conductor wire, unshielded
0701384	1	Wall Switch