Robotics: Urban Search & Rescue Challenge

Explosive Ordnance Disposal (EOD)

2020 National Event

Technical Standards

(Version: September 13, 2019)

Note: *Event rules/regulations are subject to revision prior to competition.*

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Corporate sponsor:

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Robotics: Urban Search & Rescue Challenge

2019 SkillsUSA National Champions

Postsecondary: Joseph Walsh and Miles Bossman, Northeast Community College, Norfolk, NE;

High School: Landon Davis and Caden Branch, Heritage High School, Maryville, TN;

Middle School: Ty Clark and Rosendo Dominguez, Texas City High School, Texas City, TX

Explosive Ordnance Disposal Robot, Springfield (MO) Fire Department

Event

The 2020 Robotics: Urban Search & Rescue Challenge: Explosive Ordnance Disposal (EOD) enables students to create a mobile robot like those employed by emergency service personnel (fire, police, military). The robot is designed to secure an area by locating, neutralizing, moving, and disposing of explosive materials. The demand for designers, skilled technicians, and manufacturing workers who are fluent in mechanical design and electrical systems and highly skilled in troubleshooting and maintenance of robotic systems is projected to continue to grow. The current generation of students is expected to take artificial intelligence and robotics into the evolving world of emergency services, finding new ways to help trained personnel react more quickly and effectively. Therefore, it is imperative that our future labor force be on the leading edge of current and emerging technologies and possess the technical and team skills necessary to maintain industry leadership in design, manufacture, maintenance, and operation of life-saving robotic equipment.

Purpose

- To evaluate team members' skills and preparation for employment in fields related to and including robotics, engineering, automation, manufacturing, electronics, and emergency services.
- To recognize outstanding performance by participants in scenarios that require problem solving and teamwork in a real-world situation.

Clothing Requirement

Official SkillsUSA white polo is required. Safety glasses are required for all stages of the competition. For complete details, visit www.skillsusastore.org. If you have questions about clothing or logo attire, call 800-401-1560 or 703-956-3723.

Eligibility

The Urban Search & Rescue (USAR) Challenge is open to active SkillsUSA members.

Equipment and Materials

Supplied by Technical Committee

- Challenge field: 12' x 12' simulated neighborhood
- Field elements: components of a residential area and obstacles to traverse, open, and manipulate in order to locate and dispose of simulated explosive ordnances
- A command center area equipped with a table, two chairs, and a video monitor (see "Command Center" specifications in Appendix)
- General workspace for each team designated as a "pit" area, including one table, two chairs, and access to a 120-volt electrical supply

Supplied by Competing Team

- Safety equipment – eye protection is required at all times
- Laptop computer (Optional; for technical presentation purposes only. Laptop not used for robot operation.)
- Fully assembled, tested, and operational ordnance disposal robot conforming to the guidelines and parts restrictions listed in this document (see "Urban Search & Rescue Challenge Kit Bill of Materials" in Appendix)
- Team number affixed to robot
- Presentation software for oral presentation to judges (optional)
- CAD/CAM software for blueprint design (optional)
- Completed Engineering Notebook (**Notes**: Technical drawing/blueprint of robot drive chassis must be included in notebook.)
- Pens, pencils, and paper
- Tools (suggested):
    - Allen wrench set (English)
    - Clamping vise
    - Metal tin snips
    - Power strip
    - Calculator
    - Tape measure
    - Hammer
    - Metal file
    - Flat-head and Phillips-head screwdrivers
    - Wire strippers (one set)
    - Wire cutters/snips (one set)
    - Roll of electrical tape
    - 4" nylon wire ties (25 pack)
    - Multimeter
    - Multinut pliers

- Metal-cutting hacksaw (manual)
- Cordless drill with charger
- Set of standard drill bits
- Pliers (needle nose or regular)
- Set of box wrenches

Challenge Overview

A two-member team builds its robot and arm mechanism prior to the competition and then, during the competition, remotely operates the robot, which should be capable of locating, grabbing, and moving simulated ordnances on the challenge course. This remotely operated vehicle (ROV) must traverse the course, locate the ordnances, secure them, and properly dispose of them. Each team will perform one round of competition consisting of **a time-limited mission to locate and dispose of the two ordnances**.

- During the mission, each team must complete several procedures specified in the rules provided at the event.
- The mission will be limited to **six minutes**.

Each two-member team will work from a command center to remotely operate its robot to carry out the mission. The command center will be equipped with a monitor displaying the video feed from an onboard wireless camera system attached to the robot. The robot will begin the challenge course from a starting point. The timed mission starts when the robot begins to move and ends when the robot drops the last ordnance into the containment unit, or when time runs out.

Contest Field

- 12' x 12' simulated residential area (See photos in Appendix D.)
- Features of neighborhood:
  - Starting point from which robot deploys
  - Containment boundaries marking the 12' x 12' challenge area
  - Objects often found in a neighborhood setting: home, street, grass, mailboxes

Note: Ordnances are randomly and strategically positioned on the challenge course in locations that require a robot to open doors and reach for and grab items to deliver them to a safe disposal site. Some ordnances may be located outside a direct line of sight from the command center, in which case tele-op capabilities will be put to use.

Command Center

The command center will be located within view of the contest field and equipped with a table, two chairs, and a video monitor. (See “Command Center” specifications in Appendix.)

Pit Area

A pit area where teams modify their robots and arm mechanisms will be provided. Each team will have a conference table, two chairs, and access to a 120-volt electrical outlet. **Note:** Cameras must remain *off* while in the pit area to minimize the chance of interference for the team actively driving the course.

Recommended Content for Urban Search & Rescue Challenge Kit

The Urban Search & Rescue EOD robot may be built using only components that comprise the Urban Search & Rescue Challenge Kit and/or other approved parts listed in the Appendix. Each kit contains everything necessary to construct a basic robot for the Urban Search & Rescue Challenge competition.

Upon registering for the event, teams may purchase an Urban Search & Rescue Challenge Kit. Each TETRIX®-based Urban Search & Rescue Challenge Kit contains:

- Metal construction elements for fabricating a robot chassis
- Metal construction elements for fabricating an arm mechanism
- Tools for construction
- Control system and power electronics of a 2.4 GHz R/C transmitter (up to 6 channels), receiver, DC motor controller, rechargeable battery pack, and charger
- Hookup diagrams and troubleshooting tips

Notes: Any off-the-shelf robotics building platform may be used for this event, as long as the robot complies with all parts restrictions (see page 9) and is operated by remote control; **autonomously controlled robots will be disqualified.** Any wireless camera system with a camera mounted to the robot and video display is allowed. A video monitor/TV with RCA inputs will be supplied by the Technical Committee for the purpose of displaying the team's video feed in the command center. A bill of materials for the Urban Search & Rescue Challenge Kit and a list of approved optional parts and raw materials can be found in the Appendix.

Challenge Checklist

- ☐ 1. Purchase robot challenge kit.
- ☐ 2. Design and build robot and arm mechanism within specifications that is capable of grabbing, holding, and moving objects. Document process and blueprints in Engineering Notebook.
- ☐ 3. Practice driving robot on various types of terrain while looking at a video monitor displaying the feed from the onboard camera.
- ☐ 4. Review basic mechanical, robotics, and electrical knowledge in preparation for written test.
- ☐ 5. Plan, prepare, and practice presentation.

☐ 6. Attend local, regional, state, and national Urban Search & Rescue Challenge competitions.

Sample Event Agenda

Following is a sample agenda for an Urban Search & Rescue Challenge event.

1. **Orientation and Testing:** Teams will bring robots for inspection and Engineering Notebooks for judging. The written test will be administered (30-minute limit for written test).
2. Robot and Engineering Notebook **inspection** by judges (items then returned to teams)
3. The following can be done simultaneously if the number of event personnel permits:
    - Teams complete **technical presentation** (oral and physical) over robot, Engineering Notebook, and arm mechanism (following presentation, items will remain in judges' possession until challenge field competition).
    - Final robot and arm mechanism **inspection** by judges
4. Time trials conducted
5. **Lunch**
6. Challenge field **competition** conducted

Contest Guidelines/Rules

Note: Guidelines and rules are subject to change.

- Each **team** must be composed of two members. If a team member is absent, the lone team member will be allowed to compete but a 30-point penalty will be applied to the overall score.
- Each robot must have an **identification label** with the team's number listed.
- Each **technical presentation** should last a maximum of five minutes and should be primarily oral, with supporting materials of printed or electronic media and physical models. Students should be prepared to discuss the roles they played, their robot design, and the functions of their robot. (**Note:** The Technical Committee will **not** provide projector, screen, or other presentation equipment.)
- **Before attending** the competition, team members should design, build, and experiment with robots constructed from the SkillsUSA Urban Search & Rescue Challenge Kit. Additional TETRIX or other approved parts and raw materials (see Appendix) may also be used. The prebuilt robot and arm mechanism will be required to grab, hold, and move objects during the mission.

- The robot's arm mechanism must be capable of opening a standard-size mailbox and reaching **into the box up to five (5) inches**, grabbing the simulated ordnance, and pulling it out of the mailbox. The arm mechanism must be capable of reaching items positioned **up to nine (9) inches above the floor**.

- The simulated ordnances (wooden block below, left) are not included in the competition kit and are **approximately 2.7 inches cubed** and **weigh 4.3 ounces**. The handles on doors and mailboxes (below, right) are **3.3 inches long and .41 of an inch wide**.

Ordnance (wooden block)

Mailbox handle

- **Part Restrictions:**
    - Limit of **eight** motors/servos per competing robot
    - Maximum of **one** transmitter/remote
    - **One** rechargeable battery pack for drivetrain motor power, maximum 12V 3,000 mAh.
    - **Wireless camera system** that must be mounted on robot
    - Robot must fit into an **18" x 18" x 18"** space when starting **but may be expanded to a larger size during the challenge**.

- Each team must provide in its Engineering Notebook a **technical drawing or blueprint** detailing the construction of its robot drive chassis and additional drawings/blueprints for its associated arm mechanism.

- The robot and arm mechanism must be **assembled by the team prior to the competition**.

- All robots will be required to **pass inspection** by judges (see page 12) to determine if all of the parts used are from the list of allowed parts. Any team whose robot fails inspection will be disqualified if proper modifications have not been made within 10 minutes.

- Robots will not be allowed to compete with an arm mechanism that poses **danger** to competitors or could potentially cause damage to the challenge field.

- Accuracy of the robot's **construction matching the blueprint** will be considered during scoring. All necessary parts and tools for construction must be brought to the competition site.

- Team members will be required to follow proper safety procedures and use eye protection.

- Teams may bring a **laptop computer and blueprint drawings** of their robot and arm mechanism designs to the contest building area. A description of the assembly process is required to be within the Engineering Notebook. The designs also may be printed or hand-drawn copies.

- Teams **may view the challenge course** prior to the beginning of competition and may watch other competing teams during the challenge event.

Engineering Notebook

The Engineering Notebook will be submitted for judging at check-in. Required elements:

- Overall neat and professional appearance

- A complete bill of materials for the robot drive chassis and arm mechanism designed and used in competition at the event

- A detailed description of the assembly process for the robot drive chassis and arm mechanism

- Illustrations, sketches, photos, and written log entries accurately documenting the design and prototyping iterations detailing the evolution and logical progression of the robot's design

- Explanations noting how testing was conducted, why modifications were made, skills learned, and how robot might further be modified to improve performance and achieve desired objectives if no restrictions were in place

Challenge Course Rules

Note: Team members must wear safety glasses at all times while they are in the competition area! All teams will be expected to adhere to the official rules for the Urban Search & Rescue Challenge competition and compete in a positive and professional manner.

- A time trial must be completed prior to the timed mission. The ordnance will be placed in a specified location on the course and the route traveled to retrieve and dispose of the ordnance must be identical for all teams. This route will be determined by the event chairperson. The fastest time will be awarded a 50-point bonus; the second-fastest time will be awarded a 30-point bonus.

- At the competition site, the **simulated residential area** will be provided and maintained by the technical committee. During competition, the course will be reset to its original state before each team competes. The ordnance pieces will be randomly placed before each team competes.

- The Urban Search & Rescue Challenge: Explosive Ordnance Disposal event will consist of a time trial and **a single timed mission** for each team. During the mission, the robot has up to six minutes to navigate the course, complete the challenge, and return to home base.

- Each team will **operate its mobile robot** and navigate by line of sight and by the video feed from an onboard wireless camera. The command center will be within view of the playing field, and team members must remain seated at the command center while competing.

- An official will be in charge of placing the team's robot at the starting point on the challenge course. (**Reminder:** The robot must fit within an 18" x 18" x 18" space at the start but **may expand to any size after it enters the neighborhood**.)

- After a "clear" signal is issued by a challenge course official, **time will begin** as soon as the robot moves. Following completion of a mission, **time will stop** upon successful return to home base following disposal of two simulated explosive ordnances.

- Robots should remain on roads and paths within the neighborhood in order to avoid property damage. Shortcuts are not allowed and will result in penalties.

- The mission will last a **maximum of six minutes**.

- Team members are **not allowed to touch** their robot at any time while a mission is in progress, unless instructed to do so by a judge.

- The **containment unit** where the ordnance pieces are placed by the robot after removal from the course must remain outside of the field of play and as close to the starting position as possible. Any team that deliberately moves the containment unit from its starting point may be disqualified.

- An official will award points for the team's mission based on the official **"Challenge Field Skills" rubric**.

Penalties

- A deduction (see rubric in Appendix) will be assessed each time an ordnance is dropped.

- Each time the **robot stalls or becomes hung up** and has to be freed by an official, a deduction will be assessed. An official will free a robot only at the request of a team member, but a deduction will be assessed.

- A deduction will be assessed whenever a robot goes off the designated path within the neighborhood or **outside of the course boundaries**. **Shortcuts are not allowed**.

Robot Inspection Checklist

Inspector: _____ **Team Number: _____**

Time of Inspection: _____ **Pass/Fail: _____**

Inspection Type: **____ Initial** **____ Mandated** **____ Random**

Pass	Fail	Rule/Guideline	Notes
		Robot fits in size limitation of 18" L x 18" W x 18" H.	
		Team name/number is attached and visible on robot.	
		Robot does NOT contain components that will intentionally detach on playing field.	
		Robot does NOT contain any components that could damage the playing field.	
		Robot does NOT contain any parts that are sharp, jagged, or pointed.	
		Robot poses NO obvious unnecessary risk of entanglement with any element on the playing field.	
		Robot contains a total of no more than eight DC motors, servo motors, or a combination thereof.	
		Robot contains only ONE transmitter/controller and receiver.	
		Robot contains only ONE 12V 3,000 mAh battery for drive train.	
		Robot wiring MUST be secured to chassis, free and clear of any moving parts to avoid entanglement while competing.	
		Robot battery pack(s) MUST be securely fastened to robot's chassis away from sharp edges, corners, screws, and moving parts.	
		Robot MUST contain a securely fastened wireless camera.	
		Robots using chain and sprocket or tank treads MUST have sufficient slack in the chain and/or tank treads.	
		Robot is built from ONLY approved materials listed in Appendix A of the current Urban Search and Rescue Technical Standards.	

Scoring Rubrics

Urban Search & Rescue Challenge – Possible Points: 150 **Team: _____**

Robot Drive Chassis

Objective	Points Performance Level					Points
	10	**20**	**30**	**40**	**50**	
Design, construction, and durability of power drive-system assembly (gears, chain, sprocket, wheels, treads)	Drive-system assembly is poorly designed or constructed and lacks durability.	Drive-system assembly demonstrates adequate design, construction, and durability.	Drive-system assembly demonstrates average design, construction, and durability.	Drive-system assembly demonstrates above-average design, construction, and durability.	Drive-system assembly demonstrates excellent design, construction, and durability.	
Electrical components installation and wire management	Poor effort given to wire routing and safety management.	Minimal effort given to wire routing and safety management.	Average effort given to wire routing and safety management.	Above-average effort given to wire routing and safety management.	Excellent effort given to wire routing and safety management.	
Basic driving performance test (FWD, REV, turn right, turn left)	Robot chassis does not function in any capacity when demonstrated.	Robot chassis powers up but performs only one basic control function.	Robot chassis powers up but performs only two basic control functions.	Robot chassis powers up but performs only three basic control functions.	Robot chassis powers up and performs all four basic control functions.	
					Total:	

Judge's comments:

Urban Search & Rescue Challenge – Possible Points: 150 **Team: _____**

Arm Mechanism and Gripper

Objective	Points Performance Level					Points
	10	**20**	**30**	**40**	**50**	
Performance test of arm mechanism	Arm mechanism does not function in any capacity.	Arm mechanism functions unreliably and is poorly engineered.	Arm mechanism functions satisfactorily but lacks engineering efficiency.	Arm mechanism functions well and is moderately engineered.	Arm mechanism functions reliably and is well constructed and engineered.	
Performance test of gripper	Gripper is ineffective and cannot maintain hold on ordnance.	Gripper functions unreliably and is poorly engineered.	Gripper functions satisfactorily but lacks engineering efficiency.	Gripper functions well and is moderately engineered.	Gripper functions reliably and is well constructed and engineered.	
Overall performance of arm and gripper assembly	Assembly does not allow for transport and disposal of ordnance.	Assembly is unreliable and is poorly engineered.	Assembly functions satisfactorily but lacks engineering efficiency.	Assembly functions well and is moderately engineered.	Assembly functions reliably and is well constructed and engineered.	
					Total:	

Judge's comments:

Urban Search & Rescue Challenge – Possible Points: 200 **Team: _____**

Engineering Technician Notebook

Objective	Points Performance Level					Points
	5	10	20	30	40	
Overall content format and appearance	Notebook did not follow mission format/guidelines or demonstrate understanding of task.	Notebook adequately follows some, but not all, of the mission format/guidelines and demonstrates understanding of task.	Notebook adequately follows mission format/guidelines and demonstrates understanding of task.	Notebook meets the mission format/guidelines and demonstrates understanding of task.	Notebook is outstanding and goes above and beyond format/guidelines and demonstrates understanding of task.	
Logical structure and documentation	Team did not document the project in a satisfactory manner.	Team adequately documents project but lacks logical flow and structure of project from start to finish.	Team completed documentation, flow, and structure in an average manner, but more could have been done.	Team documented the project "journey" with good flow and structure from beginning to end.	Team's documentation of project demonstrates an effort that goes above and beyond.	
Technical accuracy and bill of materials	Technical content (descriptions, sketches, drawings, tables, and figures) does not match robot project build.	Technical content (descriptions, sketches, drawings, tables, and figures) only vaguely resembles robot project build.	About half of the technical content (descriptions, sketches, drawings, tables, and figures) matches robot project build.	About three-quarters of the technical content (descriptions, sketches, drawings, tables, and figures) matches robot project build.	Technical content (descriptions, sketches, drawings, tables, and figures) matches robot project build with outstanding detail and clarity.	
Technical drawing quality (if no drawing provided, score is 0)	Drawing detail and quality are inferior.	Drawing detail and quality are adequate.	Drawing detail and quality are average.	Drawing detail and quality are above average.	Drawing detail and quality are excellent.	
Accuracy of technical drawing to assembled drive train	Technical drawing does not match assembled drive train.	Technical drawing matches few components of the assembled drive train.	Technical drawing matches major components of the assembled drive train.	Technical drawing matches all major and most minor components of the assembled drive train.	Technical drawing matches all major and all minor components of the assembled drive train.	
					Total:	

Judge's comments:

Urban Search & Rescue Challenge – Possible Points: 150 **Team: _____**

Technical Presentation

Objective	Points Performance Level					Points
	10	**20**	**30**	**40**	**50**	
Explanation of mechanical and electrical systems within the robot	Did not explain mechanical and electrical parts and their functions.	Demonstrates minimal knowledge of mechanical and electrical parts and their functions.	Demonstrates adequate knowledge of mechanical and electrical parts and their functions.	Demonstrates a working knowledge of mechanical and electrical parts and their functions within the mechanical system.	Demonstrates a thorough knowledge of mechanical and electrical parts and their functions within the mechanical system.	
Description of design challenges and solutions implemented for the robot	Did not explain design challenges faced or solutions implemented.	Demonstrates minimal knowledge of design challenges faced and solutions implemented.	Demonstrates adequate knowledge of design challenges faced and solutions implemented.	Demonstrates a working knowledge of design challenges faced and solutions implemented.	Demonstrates a thorough knowledge of design challenges faced and solutions implemented.	
Overall presentation quality	Teammates did not equally share responsibilities and presentation quality was poor.	Teammates did not equally share responsibilities or demonstrate adequate presentation skills.	Teammates somewhat shared responsibilities and demonstrated adequate presentation skills.	Teammates mostly shared responsibilities and demonstrated good presentation skills.	Teammates shared responsibilities and demonstrated polished presentation skills.	
					Total:	

Judge's comments:

Urban Search & Rescue Challenge – Possible Points: 250 **Team: _____**

Challenge Field Skills

Time Trial Performance	**Time:**								
Objective	**Points Performance Level**								**Points**
	0	**50**	**100**	**125**	**150**	**170**	**200**	**Time**	
Challenge Course Mission: Ordnance retrieval and containment	Robot became disabled on the course and could not continue.	Robot did not find any of the ordnances.	Robot found at least one of the ordnances but was unable to retrieve and dispose of it.	Robot was able to find both of the ordnances but not dispose of either within the allotted time.	Robot was able to retrieve and dispose of one of the ordnances.	Robot was able to retrieve but not dispose of the second ordnance within the allotted time.	Robot was able to retrieve and dispose of both of the ordnances within the allotted time.		

Point Deduction Worksheet		
Infraction	Number of Incidents	Points to Deduct
Loss of ordnance (5 points per incident)		
Vehicle stalled; official asked to help (5 points per incident)		
Robot intentionally outside of boundaries (25 points per incident)		
Deduction Total (insert into main scoring rubric)		

Total Time	
Time Trial Bonus 1st Place Time . . . . . 50 points 2nd Place Time . . . . . 30 points	
Challenge Field Points (subtotal)	
Deduction Total (from Point Deduction Worksheet)	
Challenge Field Point Total	

Judge's comments:

Urban Search & Rescue Challenge – Possible Points: 100

Team: _____

Written Test

	Number of Questions	Points Possible per Question	Points Possible	Points Scored
	20	**5**	**100**	

Judge's comments:

Team: _____

Urban Search & Rescue Challenge **Total Possible Points: 1,000**

Category	Possible Points	Points Scored	Judge's Comments
Robot Drive Chassis	150		
Arm Mechanism and Gripper	150		
Engineering Technician Notebook	200		
Technical Presentation	150		
Challenge Field Skills	250		
Written Test	100		
Team Total:	1,000		
No resume (deduction)	- 10		
No safety glasses (deduction)	- 50		
Team member absent (deduction)	- 30		
Team Total (minus deductions):			

Appendix

(A) TETRIX® MAX Urban Search & Rescue Challenge Kit

TETRIX® MAX Urban Search & Rescue Challenge Kit Bill of Materials	
Item	**Quantity**
4" Wheel	6
16T Sprocket	4
24T Sprocket	6
32T Sprocket	2
Chain w/Link	1
Chain Breaker	1
Gear Hub Spacer	10
100 mm Axle	12
DC Drive Motor	2
Motor Mount	2
Axle Set Collar	12
288 mm Channel	6
160 mm Channel	4
96 mm Channel	4
32 mm Channel	6
L Bracket	6
Flat Building Plate	2
Flat Bracket	6
2" Standoff Post	12
1" Standoff Post	12
180 Servo	2
Single Servo Bracket	2
Bronze Bushing	24
Axle Hub	12
Motor Hub	2
1/8" Axle Spacer	24
3/8" Axle Spacer	6
Motor Power Cable	2
On/Off Switch	1
12-volt TETRIX Battery	1
Motor Speed Controller	1
1/2 SHCS	200
Hex Keys	1
Zip Tie Pack	20
Kep Nut	200
3/8" BHCS	50
NiMH Battery Charger	1
288 mm Flat Bar	4
Servo Pivot w/Bearing	1
80T Gear	2
40T Gear	2
Electronics Deck	1
Lid	1
Top Card	1
Side Label Sticker	1

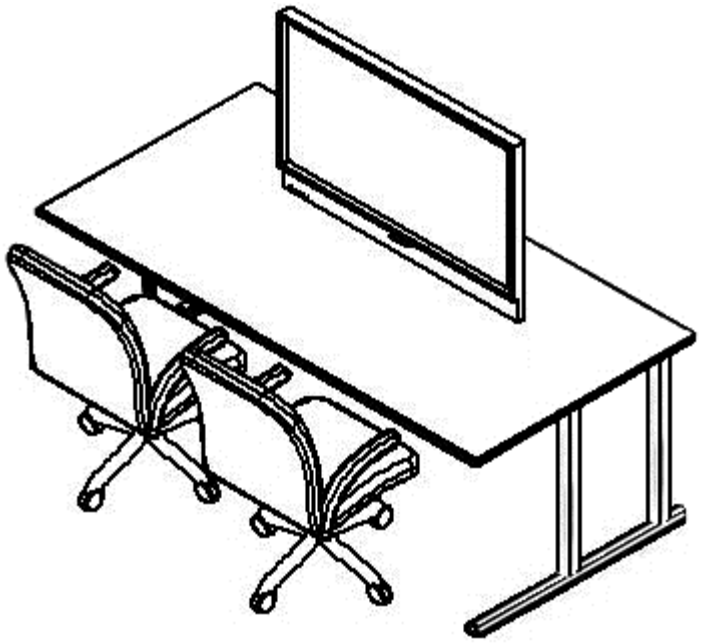
Control System	
Item	**Quantity**
2.4 GHz 6ch R/C Controller	1

Additional parts and raw materials legal for use:

- TETRIX Building System parts (http://www.pitsco.com/Robotics_Urban_Search_and_Rescue_Challenge_Kit, 800-835-0686, or competitions@pitsco.com)
- Other robot parts similar in size and design to Urban Search & Rescue Challenge Kit materials
- (1) 12" x 24" sheet of acrylic plastic, maximum thickness of 0.250"
- (1) 12" x 24" sheet of aluminum, maximum thickness of .080"
- 3D-printed parts of original design
- Raw material used for fabricating custom robot parts

(B) Command Center

- (1) Six-foot table or equivalent positioned **at least 20 feet from challenge field**
- (2) Chairs
- (1) Video monitor
- Access to a 120-volt electrical outlet



Urban Search & Rescue Command Center

(C) Example Challenge Field

(D) Standards, Competencies, Academic Skills

Standards & Competencies

- **RR 1.0 Demonstrate knowledge in safety rules and practices**
- 1.1 Maintain a safe work area.
- 1.2 Demonstrate safe and correct use of hand tools.
- 1.3 Follow safety rules during robotic assembly.
- 1.4 Demonstrate safe operation of robotic equipment in tele-op mode.

- **RR 2.0 Produce technical documentation**
- 2.1 Keep an engineering notebook detailing design discussions, design details, design changes, and troubleshooting notes.
- 2.2 Develop a technical drawing of the final competitive robot design.
- 2.3 Produce a bill of materials for the final competitive robot design.
- 2.4 Explain design choices and changes made within the engineering design process.
-
- **RR 3.0 Demonstrate knowledge of robot parts**
- 3.1 Identify mechanical and electrical parts of the final robot design.
- 3.2 Demonstrate understanding of the mechanical and electrical functions of the parts of the final robot design.

- **RR 4.0 Demonstrate understanding of robot mechanical systems**
- 4.1 Identify mechanical systems within the final robot design.
- 4.2 Demonstrate the function of control systems of the final robot design.
- 4.3 Demonstrate and explain the functioning of the drivetrain of the robot.
- 4.4 Demonstrate and explain the functioning of the package delivery system of the robot.

- **RR 5.0 Demonstrate understanding of robot electrical systems**
- 5.1 Identify electrical/electronic systems within the final robot design.
- 5.2 Demonstrate and explain the function of electrical control systems of the final robot design.

- **RR 6.0 Demonstrate tele-op skills and real-time problem solving**
- 6.1 Demonstrate ability to safely and quickly maneuver the robot through rough and unknown terrain via tele-op.
- 6.2 Demonstrate ability to overcome challenging areas of course terrain via tele-op.
- 6.3 Demonstrate ability to locate objects through remote robotic manipulation via tele-op.
- 6.4 Demonstrate ability to transport objects via tele-op.

- **RR 7.0 Demonstrate ability to present and explain technical information**

- 7.1 Demonstrate correct and effective use of oral, written, and technological tools to present technical information regarding engineering design process, robot construction, and robotic tele-op control.
- 7.2 Demonstrate knowledge of design choices and implementations during the engineering design process.
- 7.3 Demonstrate knowledge of team processes and individual team member contributions.

Committee-Identified Academic Skills

Math Skills

- Students use fractions in contextual applications to solve problems.
- Students use percentages in contextual applications to solve problems.
- Students solve problems through the contextual application of proportions.
- Students measure time, distance, and angles within contextual problem-solving applications.
- Students simplify numeric expressions.
- Students use comparisons, predictions, and inferences in analyzing data to solve a problem.
- Students utilize modeling techniques to solve problems.
- Students write and solve algebraic expressions in one or more variables.
- Students use derived measurements to solve problems.

Science Skills

- Students apply the scientific method to plan and conduct experiments.
- Students apply knowledge of heat, sound, mechanical, chemical, electrical, and light energy within contextual problem-solving applications.
- Students apply knowledge of kinetic and potential energy in contextual applications to solve problems.
- Students apply knowledge of Newton's laws of motion to solve problems.
- Students apply knowledge of simple and compound machines to solve problems.
- Students apply knowledge of gears, motors, and linkages to solve problems within contextual applications.
- Students use formulas to solve problems.
- Students apply scientific knowledge within the engineering design process.
- Students apply knowledge of force and motion concepts in contextual problem solving.

Engineering Skills

- Students apply the engineering design process to solve a contextual problem.
- Students apply the principles of circuit analysis.
- Students apply the elements of circuit design and construction.
- Students understand and apply energy and power types, sources, and conversions.

- Students apply methods of maintaining, servicing, troubleshooting, and repairing systems.
- Students apply skills and techniques related to building, repairing, and maintaining robotic mechanisms.
- Students apply techniques and technologies related to the production of technical drawings.
- Students apply basic mechanical skills related to robotic design, construction, and troubleshooting.
- Students understand and apply knowledge of safety during construction and use of equipment.
- Students apply problem-solving and engineering-design processes to solve unforeseen challenges.

Language Arts Skills

- Students make effective use of spoken, written, and visual communications with team members within the problem-solving and engineering-design processes.
- Students make effective use of spoken, written, and visual communications with a variety of audiences.
- Students use appropriate information resources within the research-and-design process.
- Students organize and synthesize information for use in research-and-design processes and in formal presentations.
- Students demonstrate the ability to correctly read and interpret rules, instructions, and specifications within the robotic challenge.
- Students demonstrate the proper use of language, both written and verbal.