ROBOT DRONE LEAGUE

2024 Official Challenge Manual

MINESHAFT

2024 MINESHAFT - Official Field

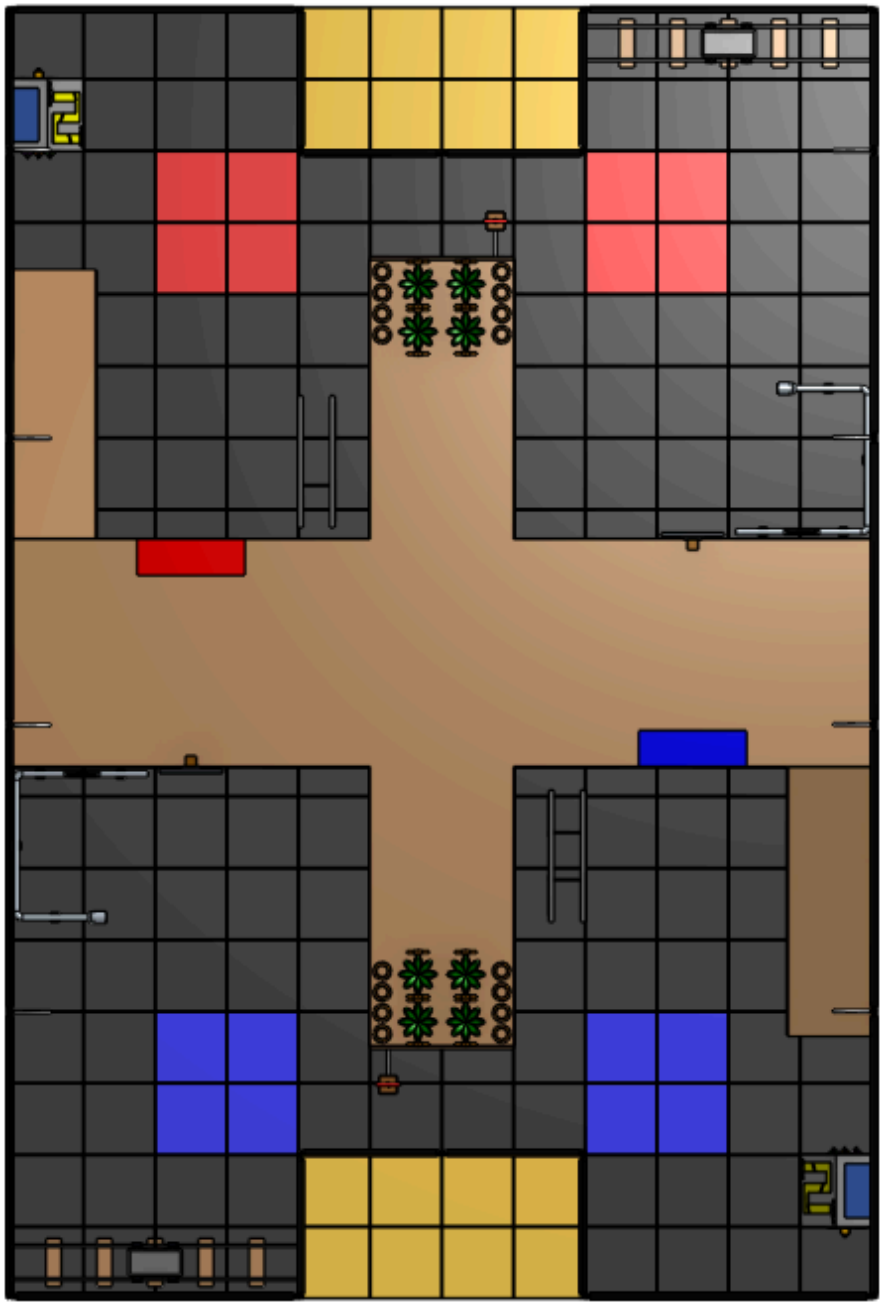

Figure 1; RDL MINESHAFT Field

Three Laws of Robotics

1. *A robot may not injure a human being or, through inaction, allow a human being to come to harm.*

2. *A robot must obey the orders given it by human beings except where such orders would conflict with the First Law.*

3. *A robot must protect its own existence as long as such protection does not conflict with the First or Second Laws.*

~Isaac Asimov

And one more….

4. *A robot may not intentionally injure another robot unless the action or inaction conflicts with the First, Second, or Third Laws.*

~ Scooter Willis (Creator of RDL)

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Revisions Date	Page	Notes
11/4/2024	**11**	**Addition of colors to the coal bio mining specimen game pieces**
01/17/2025	**17**	**Change to hoop rings points and rules**

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Illustrations

Introduction

Creativity and innovation are key elements to advancing the fields of science, technology, engineering, and mathematics (STEM) into the future. Robot Drone League (RDL) has been designed to provide students with open-ended challenges that allow for creation and innovation by engaging in hands-on design, engineering, and programming of interactive robots and drones. Students are presented with the opportunity to develop real-world connections to classroom learning. Working with robots in a collaborative game format can be a very powerful tool to engage students and enhance math and science skills through hands-on, student-centered learning. Through participation in RDL, students can develop the essential life skills of teamwork and collaboration, as well as critical thinking, project management, and communication required to become the next generation of innovators and problem-solvers in our global society. The 2024 RDL "MINESHAFT" Challenge, presented by STREAMWORKS, is designed to inspire students to develop a lifelong passion for learning and pursuing educational and career opportunities in STEM fields by implementing real-world STEM-related problems that require innovative and critical thinking to find solutions.

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STREAMWORKS

Challenge Overview

RDL 2024 Challenge: MINESHAFT

Dear RDL Participants, Supporters, and Enthusiasts,

Welcome to the Robot Drone League (RDL) 2024 Challenge, MINESHAFT. This year, we embark on a remarkable journey that not only showcases the innovative spirit of RDL but also pays homage to a significant chapter in the American narrative—the history of coal mining in the Appalachian region.

The Appalachian mountains, home to vast coal deposits historically dubbed as "black diamonds," have played a pivotal role in shaping the economic and social landscape of the Southeastern United States. From the late 19th to the early 20th centuries, these resources fueled the rapid industrialization of post-Civil War America, transforming local economies and attracting a diverse workforce. However, this boom was not without its cost, bringing about harsh labor conditions, health risks, and ecological challenges.

Today, as we witness a shift in energy sources and economic paradigms, the decline of traditional coal mining presents an opportunity to reflect on its legacy. The MINESHAFT challenge is not just a competition; it represents a platform for innovation and education. Through this initiative, we aim to leverage modern technology to address both past and present challenges, exploring innovative solutions such as biomining. This technique offers a sustainable method for extracting valuable materials, minimizing environmental impact, and promoting the restoration of ecosystems affected by traditional mining practices.

Our robots and drones are more than just tools for exploration and competition; they symbolize our commitment to understanding the impacts of industrial activities and innovating towards sustainable and safe practices. As STREAMWORKS champions the fusion of Science, Technology, Robotics, Engineering, Arts, and Mathematics, we are molding a skilled, knowledgeable, and adaptable workforce. This initiative embodies our dedication to transforming educational experiences into practical, real-world applications.

Through this challenge, participants will gain invaluable insights into the complexities of industries like mining while contributing to technological advancements that promise safer, more efficient, and environmentally responsible practices.

Let us move forward with the spirit of innovation and collaboration, honoring the rich history of Appalachia, while paving the way for a future where technology and tradition merge to create sustainable solutions for the challenges of yesterday, today, and tomorrow.

Thank you for joining us on this exciting journey, and let the 2024 RDL MINESHAFT challenge begin!

Sincerely,

Taylor Burgess

Taylor Burgess
Boys and Girls Clubs of Central Appalachia | CEO
STREAMWORKS Education Executive Board Member

Game Rules

Object of the Game

The object of the game is to successfully complete as many of these tasks as possible within a ten-minute match, with the first sixty seconds being the autonomous period (**QUADRUPLE** points). RDL - MINESHAFT is played on a 7.3 m by 11.0 m indoor enclosed field, surrounded and separated into equal halves by a combination of game elements designed for the current RDL challenge. The two field sides are mirror images of each other. Two teams make up an alliance, and compete against two other teams, making up an opposing alliance. The goal: score higher than the opposing alliance. In the last two minutes of the match, all game elements are considered neutral, meaning teams are allowed to cross the field into the opposing alliance side and score elements once brought to the alliance side.

Alliances & Matches

Alliance Selection and Point System:

- There will be two alliances competing against each other: the Red Alliance and the Blue Alliance.
- Each alliance will consist of two teams. The teams will be assigned to alliances after random selection at the start of the competition, during round-robin matches, alliances will change.
- The competition will consist of several matches, with each alliance competing against another alliance.
- After the initial placement matches, the top-performing teams with the highest **cumulative match scores** will be allowed to select the alliance they want to join. The team with the highest alliance score (of their two runs) will be chosen to select first, followed by the team with the second-highest alliance score, and so on.
- Once all teams have been assigned to alliances, the alliances will compete against each other in an elimination-style tournament.
- Points will be awarded to each alliance based on their performance in each round.
- After the completion of each match, the winning alliance will continue on in the tournament, with the losing alliance (both teams) being eliminated from the bracket.
- At the end of the tournament, there will remain one undefeated alliance that will be pronounced “RDL Alliance Champions”

In addition to the alliance competition, individual teams may also be eligible for awards based on their performance in specific tasks or objectives.

Mission Task: "Coal Extraction with TNT Detonation" - 330 Points

Assigned Mission Task - program or operate a robot that can simulate the controlled detonation of TNT to release coal from the rock within the mine. The robot must navigate to the location of the TNT detonator, press down on the handle to trigger the explosion, release the coal from above into the mine, and retrieve the desired amounts of coal. Activation of the TNT detonator will also activate lighting systems within the mines, allowing for ease of navigation.

Specific requirements for the mission include:

1. TNT Detonation: The robot must have the capability to press down on the handle of the TNT detonator, simulating an explosion. At full activation of the detonator, points are awarded. **+50 Points**

2. Coal Retrieval / Mine Cart Fill: After detonating the TNT, the robot must enter the mine shaft and begin to retrieve the coal chunks within the mine. The robot must place the retrieved coal in their alliance's respective mine cart. **+5 points per loaded coal**

3. Mine Cart Retrieval: Once the mine cart has reached the "fill-line", teams are then able to push it to the driver station in order to collect the coal. **+30 points per cart retrieval**

4. Coal Identification and sorting: Once the coal has reached the Driver Station, teams will be tasked with inspecting the coal and identifying the type of coal the team has retrieved amongst 4 possible coal types: *Anthracite (yellow)*, *Bituminous (blue)*, *Lignite (green)*, *Peat (pink).* Teams will then place the identified coal in its respective sorter bin. **+5 points per identified and sorted coal**

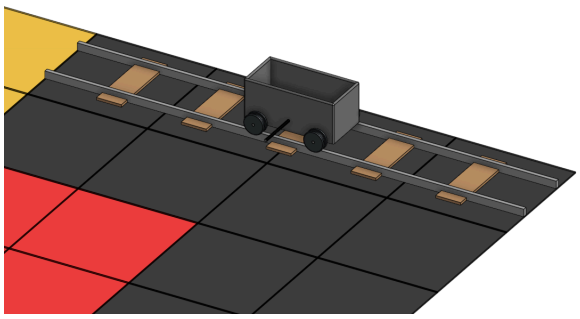

Figure 2; Mine Cart

Mission Task: "Mine reclamation" - 100 Points

Assigned Mission Task - program or operate a robot that can traverse the top of the mountain to the overgrown area. The robot must be able to remove the vegetation and place it in their respective collection area. Robots or drones must then be able to drop grape seeds into their mounds for points.

Specific requirements for the mission include:

1. Vegetation Clearing: The robot must traverse to the top of Mount Photon and clear the vegetation from the vineyard. All vegetation must be transported to the green collection zone before teams are allowed to begin planting seeds. **+50 Points**

2. Grape Seed Planting (Robot): The robot must transport seeds to the top of the mountain, and drop only one seed per mound, for a total of 8 seeds in 8 mounds. **+10 points per seed planted (robot)**

3. Grape Seed Planting (Drone): The robot must transport seeds to the top of the mountain, and drop only one seed per mound, for a total of 8 seeds in 8 mounds. **+20 points per seed planted (drone)**

Figure 3; Mineshaft Entrance Tunnel

Mission Task: "Cyber Attack Defense" - 205 Points

Assigned Mission Task - program or operate a robot or drone to navigate the field to find the hydroelectric dam. Once located, teams will utilize the camera from either the robot or drone to access the QR code on the back side of the dam. This will grant access to the dam's system logs, allowing the team to analyze **what** type of attack has happened and **how** to re-establish power to the mine.

Specific requirements for the mission include:

1. QR Code Scan: Using the camera from either the robot or the drone, teams must traverse to the back side of the dam and scan the QR code to access the terminal logs. **+30 points for terminal access**

2. Threat Identification and Quarantine: At the Driver Stations, teams will search the logs for the System-Identified Threat and the quarantine procedure to identify what sector of the dam must be turned off and reset. **+50 points for threat identification; +50 points for sector quarantine identification**

3. Sector Quarantine & System Reset: Robots must navigate to the back side of the hydroelectric dam to disconnect the respective network cable to the identified sector in need of quarantine. **+ 25 points** Once the cable has been disconnected, the IT tech robot must wait a period of 15 seconds before reestablishing the network by clearing the log cue and reconnecting the terminal network cable.. **+25 points** Once the network cable has been reset, the robot must then navigate to the opposite side of the dam and re-establish power to the RDL MINESHAFT field by resetting the power switch.. **+25 points**

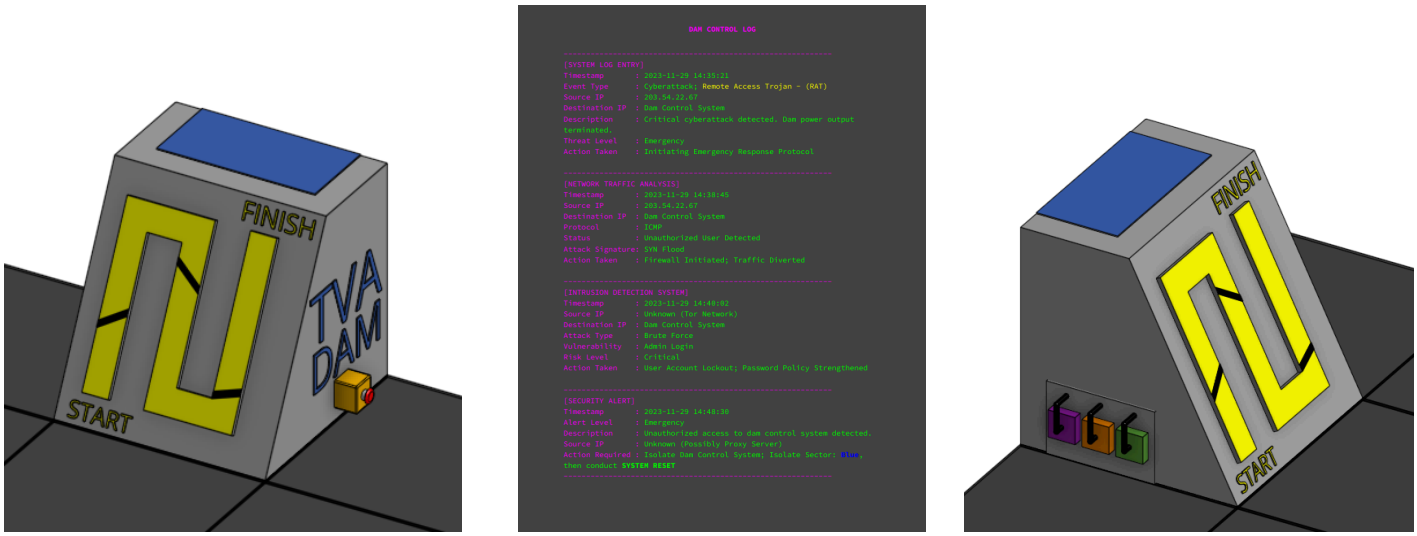

Figure 4; Cyber Attack / DAM Operations

Mission Task: "Hydroelectric Dam Inspection" - 200 points

Assigned Mission Task - program or operate a drone to navigate to the front of the hydroelectric dam and inspect the dam for damages. The drone must identify which zone the dam has suffered damages to.

Specific requirements for the mission include:

1. Dam Inspection: Teams must utilize the camera on the drone to fly along the upstream face and conduct a routine inspection of the face of the dam. **+50 points**

2. Damaged Locations: On the face, there will be anywhere from 1 to 3 damaged locations that teams will need to identify from the Driver Station using their map of the dam. **+25 points**

3. Water Quality Test: Using the drone, teams must retrieve a water sample from the water at the top of the hydroelectric dam and return it to the Driver Station **+100 points.** At the Driver Station, teams will conduct a water quality test. Upon completion of analysis, points will be awarded. **+25 points**

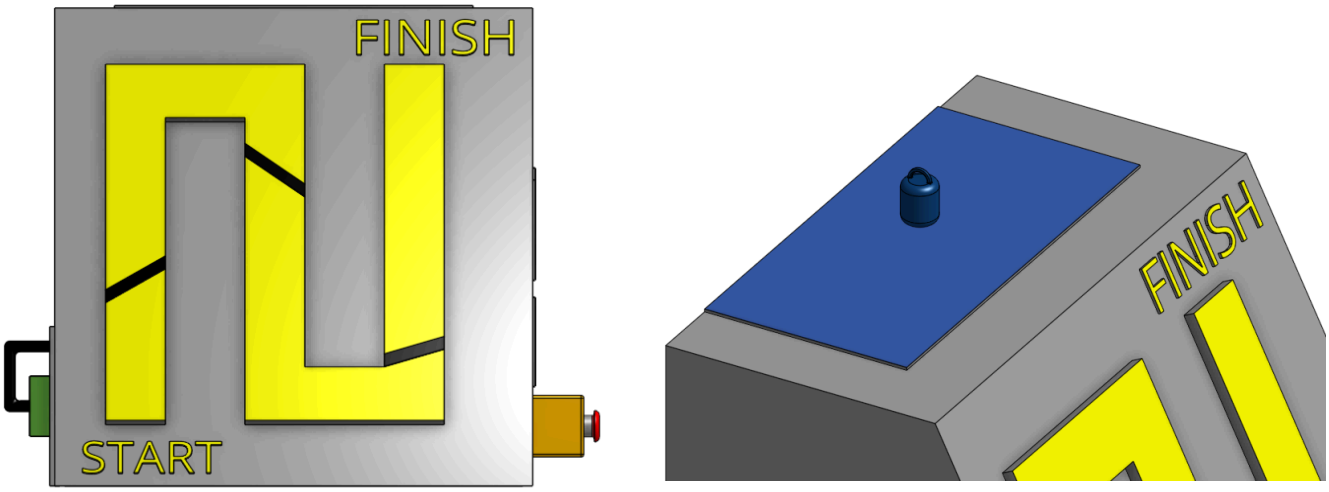

Figure 5; Hydroelectric Dam Inspection

Mission Task: "Water Pump Maintenance" - 105 points

Assigned Mission Task - program or operate a robot to navigate to the flood prevention pipe, turn off the water pump, clean the exit valve, change the damaged pipe section, and enable the pump.

Specific requirements for the mission include:

1. Disable Water Pump: Teams must utilize their robot to navigate to the water pump power source and switch the power switch to the "off" position. **+ 20 Points**

2. Close the water valve. **+ 20 Points**

3. Pipe Cleaning: Using the robot, teams must clean out the exit valve of all potential debris. **+15 points**

4. Pipe Repair: The robot must retrieve the damaged pipe section and take it back to the Driver Station **+25 points.** Upon return, the robot will be given the new pipe section to be placed into the pipe. Upon full setting of the pipe, teams will be awarded points **+25 points**

5. Enable Water Pump: After completion of all previous subtasks, teams will then

utilize their robot to switch the water pump's power switch into the "on" position.**+20 points**

6. Open the water valve. **+ 20 Points**

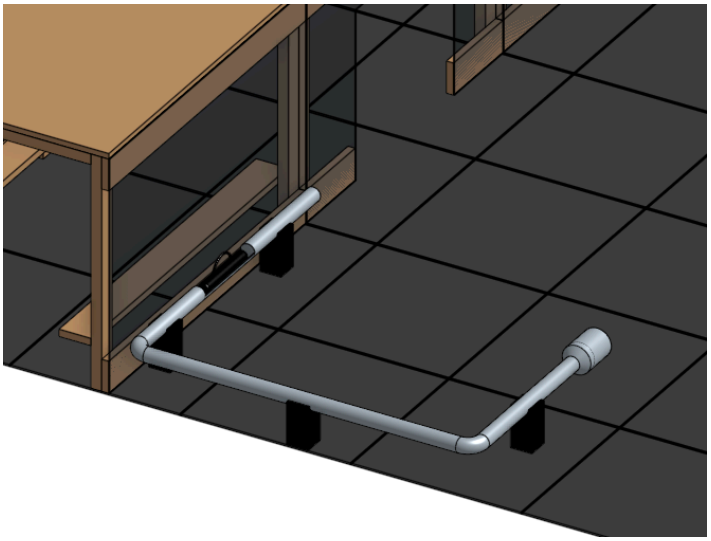

Figure 6; Water Pump Maintenance

Mission Task: "Sensor Deployment" - 105 points

Assigned Mission Task - program or operate a drone to navigate to the top of the mountain and find the mine vent. Utilize the drone to drop a methane sensor into the mine vent. After 1 minute has passed in the match, robots will then be able to retrieve the sensor from within the mine.

Specific requirements for the mission include:

1. Sensor Drop-off: Using the drone, teams must find a way to transport and release a methane sensor given to them at the Driver Station. The sensor will be dropped into a funneled 2-inch pipe on the left side of each mountain. **+60 points**

2. Develop A Reading: After the sensor has dropped into the mine, the sensor will need to collect its data. To do this, the sensor will need 1 minute's time to develop a reading. After 1 minute has passed, the sensor will have developed a reading and teams will be awarded **+10 points.**

3. Sensor Retrieval: Upon the end of the 1-minute-long data collecting timer, teams may then utilize their robot to retrieve the methane sensor from within the left

side of the mine shaft. Retrieval points will be awarded once the sensor has reached the Driver Station. **+30 points**

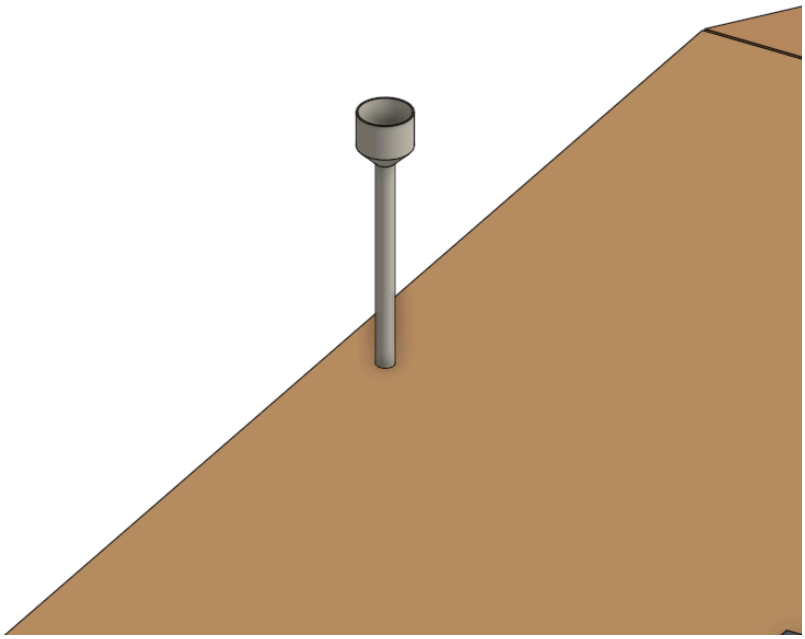

Figure 7; Sensor Deployment Chute

Mission Task: "Beacon Capture" - 25 Points (Teleop)

Assigned Mission Task - there are red or blue alliance beacons on the field in the deactivated state. The beacons do not require a hover; instead, for better consistency, your drone will need to fly through the scoring element rings. Once the drone has successfully traversed through, the beacon will illuminate with your alliance's color, indicating you have captured that specific beacon.

Specific requirements for this mission include:

Teleop Beacon Capture:Flying through the beacon during the teleop period is an automatic 25 points. The beacon will stay illuminated with your alliance color for 60 seconds, indicating it is uncapturable by the opposition during this time. After 60 seconds, it returns to the off state, becoming available for capture. During the final 2 minutes of the match, beacon rings are eligible for capture from the opposing alliance if

in the off position. Drones are not allowed to remain on the beacon for the entire 60 seconds to prevent monopolizing it. Drones must leave the captured beacon until it is once again eligible for capture.

Autonomous Beacon Capture *(Teleop Period)*: If a drone completes an autonomous beacon capture sequence during the teleop period, the alliance will be awarded double points for a 200 point capture.

Autonomous Beacon Capture *(Autonomous Period)*: If this is done during the Autonomous Period, teams will be awarded quadruple points for a 400 point capture.

Rule Update for Nationals: Hoop Ring Traversal Limitations

Effective Immediately

To address confusion during regionals regarding the allowable number of hoop ring traversals, the following clarifications and adjustments are made to the official challenge rules:

Traversal Limitations:

1. Teams are allowed a maximum of **5 hoop ring traversals** per match.
2. A hoop ring traversal is defined as a complete pass through of all hoops consecutively, in one single flight attempt. Any interruption (crash, missed ring, etc) to the flight attempt will be deemed unsuccessful and the drone must reconfigure to the original starting position and reattempt the task.
3. This includes the **1-minute autonomous period** and the **9-minute teleoperated (teleop) period**.*

- 400 points in Autonomous (1st minute of match play)
- 100 points in Teleop (remaining 9 minutes of match play)
- 200 points in Autonomous Teleop (remaining 9 minutes of match play)

*The maximum amount of Hoop Ring points a team can possibly earn in any one match is 1,200 points.

- **Autonomous Traversals in Teleop Period:**
    1. Autonomous flight operations are permitted during the teleop period under the following conditions:

1. The drone pilot or team captain **must inform the official** prior, (not during or after), to the autonomous attempt by calling out "**Beacon Capture Attempt Autonomous in TeleOp".**
2. The team must demonstrate that the drone is performing an **autonomous task** (e.g., *"hands off the controllers"* during the attempt).

2. **Beacon Reset Mechanism:**
    1. Hoop ring beacons automatically reset within **60 seconds** after being traversed.
3. **Scoring Eligibility:**
    1. During the **final 2 minutes** of the match, opposing alliances are allowed to attempt to capture any available rings on either alliance side.
    2. If rings are illuminated or deemed "previously captured" by either the assigned or opposing alliance (as determined by any field or head official), **further traversal attempts by drones will be ineligible for scoring**.
    3. If the rings return to a state of eligibility, teams may resume traversal attempts until the match time expires.

This update ensures fairness and consistency while maintaining the competitive integrity of the game.

Note: Ensure that your drone is programmed to fly or manually flown over the sensor located near the bottom of each ring to ensure for beacon activation.

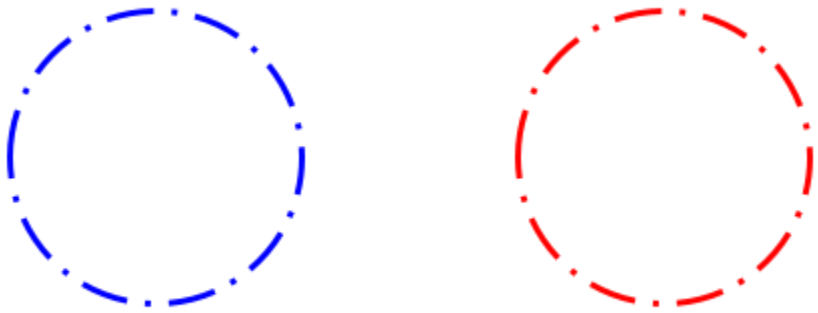

Figure 8; Beacon Rings

STEM Questions - 300 Points

Assigned Mission Task - program or operate a drone to view and answer STEM questions in order to test the teams' knowledge of STEM topics.

Specific requirements for the mission include:

1. Drones must fly to the other alliance's side and view the TV on the mountain.

2. On the mountain will be displayed a STEM question related to science, technology, engineering, or math

3. The human players in the driver stations must answer the STEM question using the assigned tablet or laptop.

4. After they answer the initial question, they will receive two more STEM questions for a maximum of three (3) STEM questions. Each correct answer will earn them points. **+ 100 Points Per Correct Answer (+400 if done in autonomous period)**

STEM questions are aligned with NGSS, Common Core, ISTE, P21 and individual state standards and are directly correlated to what students learn in the classroom. Question difficulties are dependent on a team's division *(see League Overview)*, which are arranged and aligned with the appropriate grade level to each division, either DIV I, II, or III. Teams must correctly answer the question and receive points from the RDL official prior to advancing to the next STEM question.

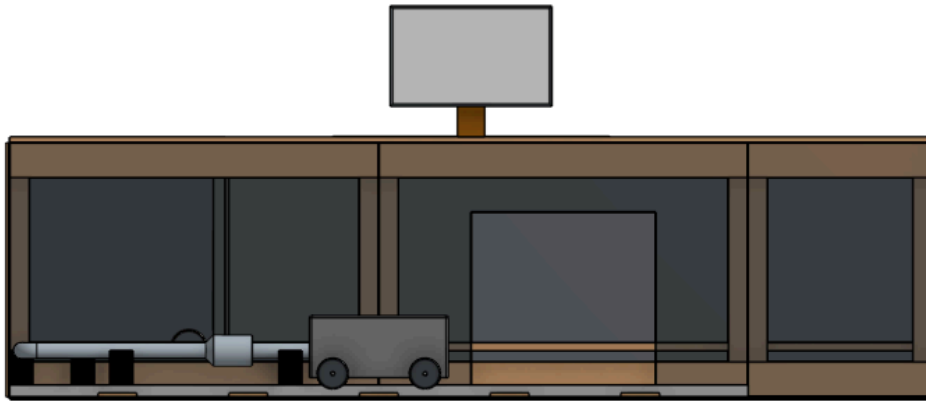

Figure 9; STEM Questions TV

Autonomous Period

At the beginning of a 10-minute match, the first 60 seconds is considered the autonomous period. Human control of the robot or drone is not allowed. Teams are awarded points for autonomous movement of the robot or drone as depicted in the scoring table below. **NOTE: Drones and robots will not be reset during this time in the event of task failure.** Completing these tasks autonomously results in **quadrupled (x4)** points during the autonomous period.

Teleop Period

Upon completion of the 60-second autonomous period, the remaining 9 minutes are considered a teleop (human control) period. Autonomous functions are not restricted during the teleop period; however, human operators will maintain hands-on control of the robot or drone during the 9-minute period. Teams should announce to the RDL Alliance Official if attempting a specific task autonomously and will also need to provide a visual indication of autonomous operations (AUTO sign). If autonomous functionality is used within the 9-minute teleop period, points are **doubled (x2)**.

Team Organization

Teams may consist of an unlimited number of members; however, there is a limit of six players allowed in the driver's station (per team). There are designated team areas in the viewing stands as well as a designated pit area for all teams.

Lab Stations

For each alliance side, there is a designated area for interaction between human players and robots called the lab station. The lab floor is identified by the yellow mats both in the lab and adjacent to the perimeter of the lab. Each team needs to assign a lab technician who is responsible for accepting elements and identifying samples (for a total of two lab technicians per alliance side). Robots and drones either deploy from or bring collected elements to the lab station, where the lab technician can then accept or attach game items. The lab technician may retrieve these elements such as the water sample, methane sensor, etc. The lab technician is only permitted to touch the robot or drone when in the neutral and non-moving configuration and fully in the yellow safety zone. Lab technicians **may not** reach out into the field with anything but their arms. (Reaching in where your head crosses the lab station onto the field will constitute a yellow card. Repeated violations will constitute a red card.)

League Guidelines

League Overview

The Robot Drone League season runs from early September through January. RDL is a multi-week game where a percentage of scoring elements are changed each year, and point values are adjusted to meet the requirements of the game. Teams should benefit from the guidance of teachers or mentors, with the constraint that only the students are the only ones allowed to build the robot and drone and compete. When faced with a challenging problem, students appreciate guidance on different methods the problems can be solved or solutions to improve upon an existing student-driven design.

RDL Team Showcase

Teams are **required** to submit a five (5) to seven (7) minute video no later than 1 week prior to the specific regional event the team has registered. Advancing teams to the 2024 RDL Championship must submit the video no later than December 31st, 2024 in MOV. orMP4 format with applicable permissions afforded to RDL for viewing, distribution, and republication..

In this video, teams will be expected to showcase their robot, drone, and supplemental devices (such as grippers, hooks, etc.). Apart from material aspects, teams will also be expected to discuss different things such as team funding, fundraising, community outreach, team & project management, and anything else teams feel necessary to describe the scope of accomplishments of the team for the competition season.

As an option, teams are allowed to include technical documents (less than 10 pages, i.e. engineering notebook, reports, posters), and published materials to aid the RDL Team Showcase in support of the team's presentation to the judging panel.

New for 2024! Teams are encouraged to take a more in-depth research approach towards the RDL theme as this challenge relates directly to their communities, states, etc. i.e. the mining industry, and address these issues and potential remedies / solutions in the team showcase video production. In addition, your team is encouraged to share if AI was utilized to aid in the RDL challenge project and how this technology has added to the learning experience.

Engineering Notebook

An engineer's notebook is a book in which an engineer will formally document, in chronological order, all of the teams work that is associated with a specific design project. For RDL, the engineering notebook serves a unique purpose in recording the

teams' actions and discoveries throughout the RDL season. Although the engineering notebook is not required to officially compete or to participate in the RDL Team Showcase presentation (which is required), teams should know that the engineering notebook is strongly recommended for teams competing for all award categories. The engineering notebook should have your team number and school name on the front cover. Engineering notebooks may contain other pertinent information such as community outreach, budgets, sponsorships, mentor notes, goals, and lessons learned. Each team session should be recorded in writing with accurate dates and times of meetings. Team members contributing engineering notebook entries must initial all entries responsible for inclusion. Illustrations and CAD diagrams are highly suggested. Only one notebook per team shall be submitted. Teams will leave notebooks with the judges' advisor and must retrieve them prior to the end of the competition.

Driver Station

The primary concern during any RDL event is safety. To ensure the safety of all participants and observers, safety restrictions within the driver station must be followed at all times. The number of team members allowed in the driver station during a match is limited to no more than six student participants.

Team members are not allowed to reach into the field perimeter for any reason, including the lab section access points.

Mentors are never allowed at the driver's stations during match play. All players in the driver's station must wear closed-toe shoes, as well as safety glasses. Long hair must be pulled back and secured. No loose clothing or dangling jewelry is permitted.

SAFETY GLASSES ARE MANDATORY WHEN IN THE VICINITY OF ROBOTS AND DRONES.

Starting Position

Robots and drones need to be placed in the starting position prior to beginning the match. The starting position is marked by a 122 cm x 122 cm square, colored to correspond with the alliance. There will be two different starting positions for each alliance side for each of the two teams making up the alliance. Alliances can choose to have each of their two teams deploy in the starting position in front of their respective driver station or, teams are welcome to deploy in any combination, the drones or robots on either starting position. What matters is that the drones and robots start within a "starting position mat." Robots and drones may start with a scoring element or sensor preloaded at the base or within the rig. Alignment tools and devices are allowed onto

the playing field as long as the tools pass safety inspection and do not interfere with the ability of the opposing alliance to retrieve game elements and score points.

Safety Check

The game has numerous scoring strategies which impact the design and construction of the team robots and the programming of the drones. Following the Four Laws of Robotics, safety is the primary concern for humans, robots, and drones related to inspection. Each robot and drone are required to successfully pass a safety check before competing in the tournament. To pass a safety check, robots and drones need to successfully meet the specifications defined below. If a robot or drone is not deemed safe, it is not allowed to compete. After a robot and drone have passed safety checks, teams will be given a safety card that is required to bring on deck and present to the alliance official when competing in scoring matches. **Please note that when practicing for or competing in an event, safety should always be the priority. Unsafe operations of both robots and drones can result in serious injuries in the occurrence of misuse or malfunctions.**

Robot Specifications

Robots must undergo and pass all of the following criteria in order to pass safety inspection:

- No more than 61.0 cm wide, 61.0 cm long, and 61.0 cm high (in starting configuration)
- Robots are limited to using no more than 20 amps
- Wires should be attached to the frame and/or organized in a safe and secured configuration
- Robots must have **no exposed wires**
- Robots may not use batteries greater than 12V
- All robots **must have an ON/OFF control switch, visibly labeled**
- Robots must not have sharp edges that would allow the robot to intentionally disregard any of the Four Laws of Robotics
- Hydraulic systems **are not allowed**
- Pneumatic systems, while legal, must have a pressure relief valve and be **limited to 50 PSI**

Drone Specifications

Drones must undergo and pass all of the following criteria in order to pass safety inspection:

- Must not exceed 50.0 cm diagonal length from tip of propeller to tip of propeller (Extended to fullest)
- Must not exceed 50.0 cm tall
- Drone propellers must be shrouded with protective devices

Teams can use any means of programming the drone.

When not in use or during transportation, it is advised to remove propellers to ensure safety.

Team Members

During a match, a team cannot use other participants outside of the driver station to guide robots or drones. If the team is viewed as using external participants to gain an advantage, a yellow card can be issued. If the issue persists, the team can be issued a red card. Team members are not allowed on the field during a match and must remain in the driver station or pit at all times, with the exception of the lab technician, who is in the lab station. **Under no circumstances shall a team member (including the lab technician) reach in with any body part onto the field.** The only human interaction with robots is to be from the lab technician and is limited to the safety zone (orange mats). If the robot or drone is not working, an RDL official will place the robot or drone into the lab area for the team to work on. Team members who violate the field access rules are awarded a penalty card at the discretion of the RDL official.

Team Pits

Teams are assigned a designated space during the competition which is referred to as the "Pit Area". Robot and drone testing operations are not allowed in these areas. A designated area for testing and practice will be made available. For specifics on safe testing practices, consult with the regional event coordinator.

Match Scoring

Each team is recommended to designate a scoring captain. The scoring captain is responsible for keeping track of the team's points during the match. If a scoring captain sees a possible error after an RDL official has calculated the final scores for both teams, the scoring captain may challenge the scoring with two different RDL officials. The two RDL officials will reconsider the team's score. Scoring captains will need to present evidence for any scores to be reconsidered, including, but not limited to, video evidence. Any adults affiliated with the team, to include the lead coach or mentor, must not interfere and / or be involved with the scoring challenge process.

Match Setup & Field Reset

Before each match, teams have five minutes to set up the robot and drone. Teams also have a five-minute breakdown period after each match. After each match, RDL officials will reset the field. This reset period lasts approximately five minutes. During this time, teams are required to remove their robots and drones from the field.

Penalties

Definitions

Yellow cards serve as warnings to teams. Red cards result in a fifty (50) point deduction from a team's score **for each occurrence**. Three consecutive red cards constitute the team to whom the red card was issued to forfeit the following match, unless it is the final match for that team wherein that match will be forfeited in its entirety. An individual team member may receive a yellow / red card for intentional and / or repeated safety violations or poor sportsmanship.

1. Following the intent of the Four Laws of Robotics, a robot or a drone may not purposely harm another robot, unless that somehow violates the First Law related to the safety of a human. The field is large, and it is expected that robots from each team might come in proximity to each other. Robots should not intentionally contact another robot to play defense or prevent the other robot from accomplishing a task.
2. Purposely blocking a robot or a drone with another robot to prevent scoring or movement of the robot results in a yellow card.
3. Drones that intentionally crash into a robot as a way to prevent scoring result in a red card for the offending drone pilot. Drones that purposely crash into an opposing robot are not eligible to be rescued during the match. (RDL Officials reserve the right to constitute what is intentional vs. accidental crashing.)
4. If a drone collision occurs, pilots are awarded a yellow card. If, in the opinion of a referee, a drone intentionally crashed into another drone or did not show clear intent to avoid a collision, a red card can be issued for the offending drone's pilot.
5. Intentional electronic interference with a team's robot or drone control systems is cause for immediate event disqualification and permanent ban from future RDL events. Electronic interference is caused by operating robots and drones in close proximity to the field of play. Robots and drones powering up are only allowed in designated practice areas or under the supervision of a RDL official.

Yellow Card

A yellow card serves as a warning for robot or drone behavior that is not in the spirit of the Robot Drone League. Any yellow card that is issued can be reviewed by league officials at the end of the match to determine if the actions of the robot under the control of the driver were intentional to gain an advantage and disregard rules. If the league officials determine that the rule violation was intentional, it can become a red card.

Red Card

A red card issued for poor robot or drone behavior will result in the designated driver's absence in the next match, as well as a fifty (50) point deduction from the offending team's

final score. The driver is allowed in the driver's station during the next match. A drone that is awarded a red card requires that the pilot of the drone sit out the following match.

Excessive Mentorship

Mentoring is essential in everything, especially robotics. That said, STREAMWORKS values the sound learning principles of project-based learning and self-directed discovery as it pertains to STEM learning and career interest. It is very simple, teach your students the fundamentals and then get out of the way!

During an RDL event, if mentors, parents, or any adults are seen by an RDL Official or Judge actively working on a team's robot, this will result in a verbal warning from the competition director, possible team disqualification from competition matches and forfeit of any awards related to the competition matches or design of the robots. Additionally, if judges/officials have a suspicion of excessive mentorship which has affected the outcome of the design of the robot, the judges/officials have the right to conduct an investigation into a more thorough understanding of the team's knowledge of their own robot.

Video Replay

If video-captured evidence, by RDL, clearly shows that a yellow card or red card should not have been issued, a team can appeal to the head referee to have the penalty overturned. If in the opinion of RDL officials, the video shows clear evidence that the penalty should not have been awarded, the penalty is removed. If RDL officials conclude the appeal had no merit and the video does not provide any evidence that the penalty should be reversed, an additional yellow card can be issued.

The 2024 RDL MINESHAFT game is designed to be a challenging and fun game. In the interest of fairness and clarity, rules may need clarification or additional rules added during the season.

Awards

Champions Award – Awarded to the top team that encompasses the overall best in competition, both on and off the challenge field. The following factors are taken into consideration for this prestigious award:

Challenge field scores

Team Showcase presentation

Community Outreach

Tournament Professionalism

Collaborative Spirit

Top Score Award – Awarded to the 1st place team based solely on scores finalized at the end of the challenge field play.

Professor's Award – (Championship event only) Awarded to the team demonstrating the best of community outreach that helps to promote STEM learning in an individual community. Submission for this award is optional and must include specific elements of the community effort and evidenced in the Team Showcase Video. Pictures, articles, and letters of appreciation or acknowledgment are recommended for serious consideration of the award. Submissions will be submitted no later than midnight on December 1st, 2024. An engineering notebook and team Showcase video is required for award consideration.

Engineering Award – Awarded to the team that best demonstrates innovation in design and provides best evidence of documented engineering practices to a panel of SME professionals. An engineering notebook and team Showcase video is required for award consideration.

Judges Award* – Awarded to the team that best demonstrates team grit and tenacity no matter the scoreboard. *Note* (This award is optional and awarded at the discretion of the Head Judge).*

Top Dog Award – Awarded to the team demonstrating the highest competition autonomous scores.

Top Rookie Award – Awarded to the best of the best Rookie team competing in their first RDL season. An engineering notebook and team Showcase video is required for award consideration.

Scoring rubrics can be found online at www.robotdroneleague.com

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Sample STEM Questions

1) Calculate the amount, in g, of Copper Sulphate produced when 5g of Copper Oxide is reacted with 20 ml of 0.5M of Sulphuric acid.
CuO + H_2SO4 --> $CuSO_4$ + H2O

2) Fluid pressure is always directed?

   a. Up
   b. Down
   c. Sideways
   d. In All Directions

3) It costs $\$\mathbf{2.5}$ MUSD to make each AUV and $\$\mathbf{1.75}$ MUSD to make each drone for exploration on Titan. Which equation represents the cost, $\boldsymbol{C}$, of making $\boldsymbol{x}$ UAVs and $\boldsymbol{y}$ drones?

   A $C = 1.75x - 2.50y$
   B $C = 1.75x + 2.50y$
   C $C = 2.50x - 1.75y$
   D $C = 2.50x + 1.75y$

4) Which best describes an angle?

   A two distinct rays that originate from a common point
   B two parallel lines on a plane
   C the set of all points equidistant from a particular point
   D a line with a starting point that extends to infinity

Sample STEM Questions cont.

1) A magazine reports that a robot sent to Mars drilled on the surface to collect rock samples. What kind of technological instrument is the robot?

   A satellite
   B space observatory
   C space probe
   D spectroscope

2) How do greenhouse gasses in Earth's atmosphere interact with heat from the Sun?

   A. Greenhouse gasses block heat from the Sun by forming clouds.
   B. Greenhouse gasses use heat from the Sun to generate light.
   C. Greenhouse gasses decrease the amount of heat created from the Sun.
   D. Greenhouse gasses trap some of the heat from the Sun.

3) What is the product of **14.7** × **5**. **32**?

   A 7.8204
   B 78.204
   C 782.04
   D 7,820.4

4) What is the value of 63 − 12p when p = 2?

   A 12
   B 24
   C 192
   D 202

Robot Drone League Standards Alignment

For a complete listing of state curriculum standards and alignment with the Robot Drone League annual STEM challenge, please visit RDL Curriculum Standards.

Don't see your state curriculum alignment standards?
Email us at dcourtney@streamworkseducation.org for additional information.