RoboCupRescue Rapidly Manufactured Robot Challenge (RMRC) 2024 Rulebook Working Draft

THIS IS A DRAFT!
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The details may still change between this document and the competition. There may also be things missing from this document. Please check https://rrl-rmrc.org for the latest version and submit comments to info@rrl-rmrc.org . Visit https://list.rrl-rmrc.org to join our mailing list and be kept up to date!

Table of Contents

Introduction

RoboCupRescue is a family of research competitions that drive the state-of-the-science in real world capabilities for robots used in applications such as search and rescue, hazardous materials response, and disaster recovery. It integrates with the NIST Standard Test Methods for Response Robots project, meaning that teams that do well in the competition have produced systems exhibiting capabilities that are immediately interesting to the real world end users who keep us safe every day.

This document describes the motivation, procedures, rules, and expected conduct for the RoboCupRescue Rapidly Manufactured Robot Challenge (RMRC). It is intended to be read in conjunction with the RMRC Arena Construction Guide. The latest versions of both this document, and the RMRC Arena Construction Guide, are available from https://rrl-rmrc.org .

Competition Spirit

The RoboCupRescue Rapidly Manufactured Robot Challenge (RMRC) combines the open, real-world research challenges, and rigorous, statistically significant, measurement science focus of the Major competition, with the lower cost, more structured, and pedagogical nature of the RoboCupJunior Rescue competitions. It brings the structure and innovation previously only available to well funded university teams and makes it accessible to modestly funded high schools, and combines incentives for learning about critical aspects of research, such as technical communication and collaboration.

Much like games such as golf, and as distinct from games such as chess, RMRC is a competition where all teams work together, against the application. Teams are rewarded both for performance against a wide variety of tests, as well as how they communicate their work to other researchers. Instead of individual holes of golf, teams perform different standard tests from the Standard Test Methods for Response Robots project. Unlike golf, however, teams are free to choose which tests they perform, the order in which they do them, and the number of times they try each test, to make sure that the result they achieve is reflective of their capabilities.

The scoring formula rewards excellence in commonly exhibited capabilities, as well as the demonstration of novel capabilities. Teams are further incentivised for developing novel systems that address real-world gaps in capabilities through additional Best-in-Class award categories.

Who is the Competition For?

RMRC is designed for teams of up to 6 students[1] and 2 mentors[2] (1 mentor for 3 or fewer students). Most teams consist of high school students, with teachers being the mentors. We also encourage teams to form outside of schools, such as in social groups and makerspaces. We particularly encourage university students to mentor groups of high school students, sharing their new-found knowledge and expertise.

Competition Summary

This section provides a very high level overview of how the competition is run. Detailed rules for the different parts of the competition appear in the rest of this document.

Qualification

First, teams qualify for the competition. For the International competition, this generally involves submitting a Team Participation Form in response to a call for participation, and Team Description Materials a month or so after that. The RMRC Committee reviews and decides which teams qualify. Some spots are generally held open for teams that qualify by winning domestic competitions and other regional qualification pathways. For Domestic competitions, these timings and requirements vary. Please monitor the mailing list at https://list.rrl-rmrc.org for details and variations for any given year. Contact info@rrl-rmrc.org if you wish to find out more information about domestic competitions that may exist in your area.

Updated Team Description Materials

Teams that qualify submit Updated Team Description Materials, due 2 weeks prior to the competition. These materials are scored by the RMRC Committee based on how well these materials help another team, new or otherwise, learn how to implement a particular RMRC-relevant capability. These materials must be released open source, under a permissive license. A growing library of these materials is available from https://rrl-rmrc.org . This score forms a multiplier onto the team's Preliminary Round score. This provides a strong incentive, particularly for the best teams, to also share their knowledge and experience, allowing other teams to build on their work.

In-person competition

The International competition itself generally consists of 1 setup day and 3.5 competition days. Timings may vary for domestic competitions.

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[1] According to RoboCup Federation guidelines for RoboCup Junior students at time of writing, students must be 19 years of age or younger on the 1st of July of the competition year. Teams that do not satisfy this criteria may participate in the Major RoboCupRescue Robot League. In the International competition, students must also be at least 14 years of age on the 1st of July of the competition year.
[2] Mentors must be at least 18 years of age on the 1st of July of the competition year.

Setup

During the setup day, teams arrive, register, set up their robots and equipment, and practice within the arenas. Robots are generally photographed at this point for documentation and configuration management. As the competition separates out an overall real world mission into component tests, the robot hardware[3] should stay the same through the first 3 days of competition. For instance, a robot that has an arm to pick up an object should also be equipped with that arm when it traverses the terrain tests, as during a real mission it would have had to carry that arm over the terrain to get to where it needs to pick up objects.

Preliminaries

Preliminary rounds are held during the first 2 competition days, split into 4 competition periods, morning and afternoon. Preliminary rounds consist of teams gaining points by performing the various Standard Test Methods for Response Robots within the many different, separate, test method apparatuses that make up the arena. The precise rules and scoring methods for each test are described in more detail later in this document.

Many teams may compete in these different tests at the same time. Missions are 5 minutes long and start every 10 minutes, with each mission confined to one test apparatus and apparatus setting. Missions are run according to a global clock and all missions start at the same time, 6 times an hour. If a team is not ready they skip that mission time slot. Due to the potentially congested radio environment, it is strongly recommended that all teams have the ability to run with a communications tether.

The number of teams who can run at the same time is generally limited by the number of volunteers available to judge the teams. This competition is team-run, meaning that all mentors are encouraged to volunteer to spend some time as a judge. The tests are designed to be easy to score, with most simply a matter of counting laps. There is limited to no need for judgment calls, and the scores are written on a publicly viewable scoreboard shortly after the mission. Other team members watching are encouraged to cross-check and verify the scores.

Prior to each competition period (generally the evening prior for morning competition periods) teams collaboratively determine their timetable for the following competition period. Given that there are so many opportunities to run, teams are not obliged to run in every time slot, and indeed are encouraged to allow time to rest and practice.

Only the best mission score that a team achieves in a given apparatus and setting counts so teams have ample opportunity to repeat tests if they have problems. The tests are designed so that within 5 minutes, the best teams will have performed a statistically significant number of iterations of the test. Teams do also have the opportunity to move time slots during the day, subject to availability, in response to unexpected issues or to take advantage of opportunities to improve performance.

[3] In general, software updates are ignored in recognition that these robots are prototypical and on the premise that in a real scenario, it is conceivable that software can be changed over the air.

The scores for each test are tabulated and normalized. For each test and setting, the best score(s) become 100%, with all other scores normalized accordingly. This balances the scores of easy and difficult tests, and encourages teams to develop new capabilities for tests that have not received as much attention.

Finals

The finals are held on the 3rd day but the preparation is done on the evening of the 2nd day, after the preliminary rounds have finished.

After the preliminary rounds, the scores are added up and combined with the updated Team Description Material multiplier. The largest gap in the scores between the teams in 3rd to 7th place is used as the cutoff for finals qualification, thus the number of teams admitted to the finals can range from 3 to 6 teams. The goal is to reduce the probability that a team just misses out on qualifying for the finals.

Depending on the schedule, either the evening prior to the finals or the morning of the finals, the finalist teams collaborate in designing and building the finals arena by arranging the individual test method apparatuses into a continuous maze. Competition organizers serve to mediate between the teams to ensure that all teams have input into the design.

The timing of the finals day is flexible and depends on the number of qualified teams. In general, teams run 2-4 missions of around 15-30 minutes, one at a time, in the full maze. Teams score one point for traversing an apparatus in one direction, and another point for traversing it in the opposite direction. Teams may traverse a given apparatus more than once in a given direction, but receive no additional points for doing so. Similarly, non-traversal tests, such as manipulation and sensing, can only be performed once per mission.

Team Challenge

The last day of the competition is only a half-day, due to the award ceremony. During this time, a casual “Team Challenge” competition is held, as a way for students, mentors, and organizers alike to have some fun and demonstrate collaborative robot capabilities in a less stressful manner.

Throughout the previous 3 days of the competition, the organizers solicit suggestions from teams for games or obstacles that may be played on this last day and a decision is made on the evening of the 2nd day, after the finalists are announced. This means that teams who did not qualify for the finals have a day to prepare and practice. The Team Challenge varies from year to year. Unlike the other rounds, robots may be modified for the Obstacle Course.

Awards

Awards are given for first, second, and third place, based on the number of points achieved in the finals. Scores that are very close, generally within 5%, are considered ties, in

acknowledgement of the inherent uncertainty of performance measurement. In rare cases, particularly if many teams are tied, organizers may use preliminary scores to break ties. Best-in-Class awards are also given, based on a subset of preliminary scores. The RMRC Committee may also issue an Open Source and Innovation award, and an award for the winner of the Team Challenge.

How Does a Team Get Started?

RMRC has many features that are designed to make it easy for a moderately well resourced team to get started!

Building the Robots

Robots for RMRC are of a size that makes them easy to build using 3D printed and laser cut parts, and with components such as controller boards, cameras, and servos that are common and cheaply available on the hobbyist market.

There is a growing library of designs and tutorials, produced by teams over the past few years, that new teams can make use of to jump-start their development. See https://rrl-rmrc.org for details.

Building the Arena

The arena construction guide is available from https://rrl-rmrc.org and is designed to be compact and cheap to produce. Teams may start by building a single pallet and a few different terrain components that may be mixed and matched for testing, without the need to build a full arena. Teams in a local region are also encouraged to get together to form larger arenas and hold mini-competitions to practice.

Definitions

Arena

All of the competition space, including lanes and bays. Does not include administrative areas or the team paddock.

Bay

A single apparatus or set of apparatuses that supports one robot performing a test at a time. A bay generally supports one test (possibly with multiple settings) although some bays may support more than one test (e.g. by changing out the terrain within the bay), particularly for smaller regional competitions and for teams building the apparatuses at home. Bays have a marked start position.

Competition Lead

The Competition Lead(s) will keep time and overall score (on a scoreboard visible to all competitors), without bias to any one individual or Team. They will ensure that fair play is observed, along with managing the paperwork aspects of the competition. They will also coordinate safety concerns (e.g. locating appropriate safety and fire equipment) and ensure teams, mentors, and judges are kept up-to-date on announcements.

Finals

Teams who access the finals (through their in-person scores during the preliminaries, TDM multipliers, etc), will have the opportunity to design and implement the design of the maze.

For the sake of fair play, it is strongly encouraged that **all** qualifying teams, who will be moving to the Finals, work together to decide and assemble their preferred configuration as a group, on the evening of the end of preliminaries. Once the maze has been assembled, this would allow for the greatest amount of time to practice and familiarize themselves with the maze.

Inspection

Generally held before competition begins, the Competition Lead(s) and/or Judges will determine if a robot configuration is safe, and follows the spirit and rules of the competition. An inspection may be called for at other times, if the Competition Lead(s) and/or Judges determine there is a need for it.

Judge

Judges are volunteered from available Mentors, (badged) Parents, and adult competitors from the Major league. (If a Major team volunteers to assist in judging, ensure they are aware of their own competition schedule, and count the entire team as one judge, to ensure coverage in the event of Major chaos.) A judge will keep score, without bias, and deliver scores to the Competition Lead for input onto the scoreboard. Judges should avoid keeping score for their own team.

Lane

A bay that is long and thin, usually a Z-pallet (see construction guide), and is generally used for terrain and obstacle type tests.

Lap

Some tests involve the robot performing laps of the bay.

General definition:

1. Start in contact with one end wall during the mission time.
2. Traverse the bay without leaving the bay.
3. Make contact with the opposite end wall.
    a. If the robot does not make contact with the end wall before returning, both (incomplete) laps do not count.
    b. It is up to the operator to determine if they have made contact with the end wall before starting the next lap. They should not be informed of this by the judge, team-mates, audience, or anyone else.
    c. Contact with the end walls must be made with a part of the robot (including arms, wheels, and flippers). The tether or anything else connected to the robot only by a wire, string, or similar does not count.

First lap:

The first lap of the mission shall begin at the end wall marked as the start position. If the robot moves prior to the mission start time such that it is no longer in contact with the end wall, once the mission starts it shall be driven, or positioned by hand, so that it touches the starting end wall before continuing the mission.

Successive laps:

Successive laps shall be run in opposite directions.

Resets:

If a reset is called, the robot shall re-start from the starting position. See definition of Reset for more information.

Teleoperated lap:

By default, a lap is considered teleoperated. The judge will tally the lap in the teleoperated section of the score sheet.

Autonomous lap:

For a lap to count as an autonomous lap, the operator shall not touch the controls unless any part of the robot, including arms, wheels, and flippers, is within 30 cm of either end of the bay. Parts that fall off the robot and/or parts that are not solidly attached to the robot (e.g. the tether or anything connected to the robot only by a wire, string, or similar) do not count.

The operator may monitor the robot's progress through the operator control unit only, without touching it. As usual, they may not look at the robot or bay, and may not communicate with anyone but the judge.

The team shall announce that they are attempting a lap autonomously prior to beginning autonomous operation (or continuing autonomous operation in a new lap), and receive confirmation from the judge to ensure that they are aware and can confirm that the operator is hands-off the controls. If the team successfully completes the lap autonomously, the judge will tally the lap in the autonomy section of the score sheet **instead** of the teleoperated section.

A team may attempt a lap autonomously, and during the lap, decide to take over teleoperation outside these 30 cm areas. If they do so, the whole lap now counts as a teleoperated lap. The judge will tally the lap in the teleoperated section of the score sheet.

Maze/Labyrinth

Used in the Finals, the Maze comprises the available lanes/bays, and can be configured completely flat or tiered (with multiple levels), depending on the available space and the amount of challenge the teams wish to face.

Walls, including end walls, may be removed during the configuration of the maze, in order to integrate bays/lanes into one another.

Mentor

Each team may have up to two mentors to assist and supervise. These individuals will be badged and are strongly encouraged to assist with running the competition (be it as a volunteer judge, assembly of lanes, etc).

Mission

This is the 5 minutes of active time within a time slot, when the robot is in operation.

Multiplier

Based on a variety of factors (TDMs, autonomous operation, etc) a team's preliminary score may be increased. This will affect a team's ability to move from preliminaries into the finals.

Preliminaries

Preliminary rounds/preliminary scores are trialed first at an in-person competition. Generally, each day will be composed of two sessions, morning and afternoon. Scores from the preliminaries will determine which teams will move onto the finals.

Penalties

All participants are expected to adhere to the intent of fair play. If this is not observed, penalties up to, and including, dismissal from the current competition, and barring from future competitions, may be meted out to individuals or entire teams. Further information is provided in the Code of Conduct.

Reset and Mini-mission

If anyone physically touches/moves the robot or arena during a run (eg. robot falls out of the terrain, robot gets stuck, tether gets pulled), a reset is called. This means that the robot is placed at the starting position of the bay, the scores for that run reset and then the run continues as if for a new mission, but only in the time that remains. Each 'reset' results in a separate 'mini-run' (or 'mini-mission' in RRL Major terminology). The judge shall record each "mini-mission" on a new score sheet. The score of the best 'mini-run' becomes the score for the whole run.

Robot Configuration

A robot configuration (often abbreviated to just "configuration" or "robot" elsewhere in this document) refers to the robot, along with any physical accessories and settings that require physical access to the robot to alter. A robot is expected to maintain the same robot configuration from the start of the preliminaries to the end of the finals (or end of preliminaries if the team does not reach the finals).

Motivation

The reason for this is because the competition consists of many individual tests that, together, represent a real mission. In a real mission, a person cannot touch the robot to change things. For instance, a robot that needs to pick up an object needs to have its arm installed as it traverses the terrain to get to where it needs to pick up the object. Therefore, in the competition, a robot that wishes to score points for manipulation must also have its arm installed for the mobility tests. Software changes are generally allowed, on the premise that in a real robot, this can often be achieved remotely.

Documentation

The configuration of the robot at the start of the competition is documented on or prior to the first day, through photographs, ideally with a grid background for scale. These photographs can be referenced to check that the robot configuration has not changed.

Changing configurations

A team may elect to change a robot configuration during the competition but this will be considered a separate robot configuration for the purpose of scoring. Thus unless a team does this early in the competition, they risk reducing the number of missions that they have to accumulate a good score to qualify for the finals. The robot configuration that the team runs in the finals must be a robot configuration that accumulated a high enough score to qualify for the finals. A team may only enter one robot configuration in the finals.

Repairs

It is understood that sometimes it is unavoidable that a robot configuration may change during the competition, such as because the robot is damaged and it may not be possible to repair it to exactly the same capability. If the team wishes to have the repaired robot configuration considered to be the same as the original robot configuration, so that they can continue accumulating scores, they shall consult with the Competition Lead(s) to see if any additional modifications are necessary.

In general, the Competition Lead(s) will consider the repaired robot configuration to be the same as the original robot configuration if they are satisfied that the repairs have not provided an unfair advantage to the team going forward. The Competition Lead(s) may also decide that some past missions may count while others do not.

For example, if the team has performed manipulation missions, then breaks the robot's arm and is unable to repair it:

- The team can keep their previous mission scores by satisfying the Competition Lead(s) that the robot would not score higher in subsequent tests in its broken configuration than its original configuration. This may be achieved by:
    - Keeping the broken arm on the robot, securing it as necessary in a shape that it was originally able to take. The team may adjust the shape of the arm between

subsequent missions as long as the Competition Lead(s) are satisfied that those positions are ones that the original robot configuration could have achieved by itself without physical human intervention.
    - Replacing the broken arm with something of similar size, shape, and weight, and satisfying the Competition Lead(s) that it affects the robot in a similar way to the broken arm.
- If the Competition Lead(s) decide that the repaired robot configuration would score higher in subsequent tests than the original robot configuration, the Competition Lead(s) shall decide which previously performed tests can be counted, using the following guidelines.
    - Mission(s) that the Competition Lead(s) decide are unlikely to have been affected by the arm can be counted. For example, sensor tests (with sensors that are not on the arm, not blocked by the arm, or are otherwise still working).
    - Mission(s) that the Competition Lead(s) decide the repaired robot configuration is likely to outperform the original robot configuration can be counted. For example, mobility tests where the arm was not used to assist in mobility (e.g. by pushing against the ground or changing the center of gravity).
    - Mission(s) where the Competition Lead(s) decide that the repaired robot configuration is not likely to outperform the original robot configuration, or are unsure about, **can not** be counted. For example, manipulation tests.

Setting

Some tests may be modified, to increase difficulty. Generally, the initial form of a test will be the easiest.

Results are only compared for tests performed with the same setting. Tests with multiple settings are considered separately for the purpose of scoring. For the purpose of the competition, teams who attempt a harder setting should also attempt the test at an easier setting.

Each morning of the preliminaries, teams will have an opportunity to attempt the test at the easy setting before it is made more difficult. The timing of the change depends on scheduling and team capabilities and is at the discretion of the organizers. This allows for additional challenges for the competitors, without taking up extraneous floor space during competition time.

Session (Morning and Afternoon)

Each trial day is broken up into two sessions, one in the morning, and one in the afternoon, with a break for meals and lane inspections in the middle. Each session will have a team meeting before competition begins, and the session itself will typically consist of approximately four hours of competition time. This competition time is broken up into 10 minute time slots.

Starting Position

Where appropriate, a specific location will be indicated in a bay or lane as the appropriate location for a robot to begin a mission. If in a lane, the robot will be required to begin its mission within physical contact of the wall at the end of the lane. If, by the start of mission time, it has rolled away from this starting position, it will be required to return to this position before commencing its mission. This may be done via teleoperation, or by hand (if it is running autonomously and has been programmed to avoid touching walls under its own power).

Team Meeting

A team meeting will consist of at least one mentor per team, along with a student as team captain, along with the Competition Lead(s). Any safety concerns will be covered (fire, crush, explosion risks), announcements, etc will be covered. Volunteer Judges will also be recruited, and the team's runs scheduled for the following session.

Team Participation Form (TPF)

Supplied by teams as the first step in the qualification process. This supplies competition organizers basic team information and declares intent to compete.

Team Description Materials (TDMs)

Supplied by the teams, these papers are written and delivered prior to the in-person competition. Ideally, these will clearly demonstrate the team's process in preparing for the competition (e.g. equipment used, design choices made, challenges, etc).

These shall be written with the RMRC open source mind-set. The intent is two-fold: demonstrate the team's preparedness for in-person competition, and assist upcoming teams in future competition. (e.g. A poorly written paper, that can not be understood, about a "perfect robot" will help future rescue teams **less** than a comprehensible paper on a "poorly performing robot" that clearly demonstrates to future rescue teams what pitfalls they should avoid!)

The TDMs will be read and judged prior to the competition, on a variety of factors, and a multiplier score will be awarded based on these documents.

Test

A test is a combination of an apparatus, procedure, and metric that evaluates the performance of the robot in a specific capability. A test may have multiple settings.

Time Slot

Each time slot is 10 minutes; this includes 5 minutes for operator set up/teardown and 5 minutes of mission time. Teams that demonstrate working autonomy during practice are allowed a double timeslot (although they will still only have 5 minutes to set up).

Work Area

This is the non-competition area, for competitor’s and mentor’s use. Tables, chairs, powerpoints, etc will be assigned to specific teams, based on space and equipment availability of the location.

Competition Logistics and Procedures

Before the competition

Qualification

All teams must go through the qualification process set by the organizing committee before the competition. It is typically conducted in the following order:

- Team Participation Form (TPF) submission
- Qualification Team Participation Form (TDM) submission
- Notification of qualification
- Updated TDM submission.
- RoboCup Competition and Symposium

Team Participation Form (TPF)

The first step in the qualification process is to complete and submit the TPF. Each team wishing to qualify must produce the following information. Note that this information (apart from contact information) may be released publicly.

- Team Name
- Organisation
- Country
- Contact person
- Email
- Telephone number
- Estimated number of students
- Estimated number of mentors
- Estimated number of robots

Please follow the specific and additional information required for each competition and year, as well as the method by which this information should be submitted to the organizing committee.

Team Description Materials (TDM)

All teams must share their resources during the qualification process, this competition is open source.
Participants must submit an updated TDM prior to the competition, which will be scored and included in the preliminary round score. The TDM describes both the team and the robot with the technical details. Note that this document will be publicly available.
The TDM should contain the following information:

- Logistical information
    - Team Name
    - Organisation
    - Country

    - Contact person
    - Team public contact email
    - Team website (if present)
- Introduction summarising
    - The team.
    - The technical aspects that it focuses on.
- Description of the system with the following components
    - Hardware
    - Software
    - Communications
    - Human-robot interface
- Description of the application
    - Setup and packing of your robot and operator station
    - Mission strategy
    - Experiments and tests that you have done or will do
    - How the particular strengths of your team are relevant to applications in the field.
- Conclusion, summarising
    - What your team has learned so far
    - What you plan on doing between now and the competition.
- Appendix
    - One table per robot outlining the components and estimated cost of your robot.
    - At least one picture, 3D rendering or technical drawing of your robot.
    - Be sure to highlight particular features of your robot.
    - A list of software packages, hardware and electronic components that you have used, or plan to use, particularly those from the Open Source community, through the Open Academic Robot Kit or otherwise.
    - A list of software packages, hardware and electronic components and designs that you have, or plan to, contribute to the Open Source community, through the Open Academic Robot Kit or otherwise.
- References (to other work you have used)

The TDM mirrors the Team Description Paper (TDP) goal from the Major competition, but in a form that allows for more flexibility, making it easier for students to participate. Teams may submit their materials in the form of a traditional TDP that follows the Major format (available at www.RoboCup.org). Specific information about deadlines and other TDM requirements can be found in the competition announcements - wür the World Cup at http://comp.oarkit.org.

At the competition

Inspection

The robots will be inspected by a panel of judges before the start of the competition and at other times during the challenge to ensure that they meet the constraints described in these rules. Participants will be asked to explain the operation of their robot in order to verify that

construction and programming of the robot is primarily their own work. Unlike in other Junior competitions, in RMRC, mentors are allowed to assist in the design and construction of the robots but the students still need to demonstrate both a working knowledge of the entire robot system as well as knowledge in at least one specific aspect of the robot's design, construction and/or operation.
All tests must be attempted with the robot in an identical configuration. For instance, running with an arm for dexterity tests and then removing it for mobility tests is not allowed. Teams who wish to make changes to their robot during the competition may request this of the OC on the understanding that, especially if the change is not due to damage sustained during competition, this may be considered a completely different robot and reset all scores achieved up until that point.

Preliminaries

The preliminaries consist of each team running their robot(s) through the test methods multiple times and collecting points (per robot). Each trial is for a single robot; while teams may wish to bring multiple robots be aware that this will split their available time slots. Entry into the finals is decided per robot so this may reduce their chances to enter the finals.

Time schedule

Each time slot of 10 minutes consists of 5 minutes preparation time and 5 minutes run time. The judge starts the run timer when the team leader declares that the team is ready, or at the latest after the preparation time has elapsed. This happens regardless of whether the team is ready or present. Time slots are not delayed.
The run will be stopped after exactly 5 minutes.

The testing schedule is determined at the team leader meeting prior to each half-day in the following way:

- Many teams run concurrently in separate test method apparatuses. This maximizes the amount of time available for teams to compete, demonstrate their capabilities and score points.
- During the team leader meeting, teams take turns nominating their run slots for the following day's preliminary competition and populating the scoreboard with their time slot nominations.
- In random order, teams take turns nominating a timeslot and test for a run.
- Nominations must conform to the following constraints:
    - Teams can only nominate once in each time slot.
    - The maximum number of nominations for a given time slot depends on the number of judges available.
    - Some apparatuses are shared between tests and thus a team nominating for one precludes another team nominating for the other in the same time slot.
- Nominations end when no team wishes to nominate for any more time slots or there are no more timeslots left that satisfy the above constraints.

- At any time during competition, up to 10 minutes prior to a timeslot, two team leaders may approach the OC and request to transfer or swap a timeslot. This will be noted on the scoreboard.
- At any time during the competition, up to 10 minutes prior to a timeslot, a team leader may approach the OC and request to swap a time slot to a different test as long as the apparatus is available and the above constraints are satisfied.
- Each time slot is 10 minutes and includes 5 minutes for operator setup/teardown and 5 minutes of operation.

Scores

- The goal is to score as many points as possible in the test methods. In general, you get one point for getting from the start zone to the end zone and another point for the way back from the end zone to the start zone (and so on). See individual test details for the scoring metric.
- At the end of each run, both the judge and operator must sign off on the score reached by the judge. Any concerns in scoring are to be raised immediately with the judge and a member of the OC.
- Every team can repeat a test, as often they want if it is available and the team has a free time slot available. Only the best result will be kept for the task and team.
- All scores will be normalized per test method, so that the best team in that test gets 100 points. This calculation is done after all teams have completed all tests in the preliminary round. The other teams get points proportionally. Example: For test method Dexterity 1: If team A scored 20 points and team B scored 10; then at the end of the preliminaries the score of team A will be set to 100 and the score of team B to 50. This way, for each test method the best team gets 100 points.
- This scoring method balances the difficulty level across differing tests. If a test is so difficult that only one team attempts it, the team will receive 100 points. Conversely, to score well in an easier test that everyone can do, teams must be close to the best.
- The sum of all points of all tests of a team is then multiplied by the updated TDP score to decide the qualification for the final round.

Finals

At the conclusion of the preliminaries, teams will be notified at a team leader meeting who has qualified for the finals and what factors went into this decision based on scoring as outlined in chapter “Preliminaries”. Note that qualification into the finals is per robot, not per team. Only one robot per team may enter the finals.
Finals are distinct from preliminaries.
Arena scores are gained by traversing obstacles and terrains. This represents the ability of a robot to get to where it needs to go to perform its task. In the finals arena, points can also be collected by sensor and dexterity tests. This represents the ability of a robot to perform its task. All points that have been collected completely autonomously are multiplied by 4. During the final, points can be collected both autonomously and in teleoperation.

The arena is rearranged into a closed maze of test methods. Robots start anywhere in the maze and score one point for traversing each terrain or obstacle in each direction (for a maximum of 2 per terrain or obstacle). Following the announcement of the finals-qualified teams, members from each finals-qualified team will collaborate to design and build the arena from the lanes used in the preliminaries such that all competing finalists are satisfied with the layout. OC members will work with teams to ensure each team´s opinion is equally considered.

Until the end of the preliminaries, we won't know how many teams qualify for the finals so we won't be able to fix the number and duration of finals runs until then. In general, each team will have 2 or 3 runs, each run being around 15-20 minutes long.
The 1st, 2nd and 3rd places are decided by the accumulated scores of finals runs only (not preliminaries).
The procedure for each arena round is as follows:

- Before your mission, move your robot and other equipment to one of the provided waiting tables.
- 5 minutes Setup phase: The operator sets up
- Run Phase: During the run phase, the robot starts at one end of any of the lanes in the arena and traverses through the arena from one lane to another. The robot scores one point for traversing each lane in each direction, for a maximum of two points per lane. (Subsequent traversals of the same lane, in the same direction, don't yield any additional points.) Teams should decide on their start point and proposed path through the maze carefully to best play to the strengths of their robot. The operator may draw and refer to a map of the arena during their run if they desire.
- If a reset occurs, the score is reset and the robot moves to one end of any lane nominated by the operator (it need not be the previous start point). As per the preliminaries, the best 'mini mission' is the one that counts.
- 5 minutes to clear the arena.

Note: If your robot has radio issues, a tether/cable to communicate with the robot is acceptable. In this instance you will be allowed a tether operator, however they are forbidden to communicate with the pilot during the run and must manipulate the tether without affecting the mobility of the robot. It is recommended that teams considering using tethers factor this into their input into the final arena design and into their planned route through the arena.

Team Challenge

A Team Challenge is offered as an option at the competitions. Similar to the finals, the tests and tasks are developed and discussed together.
In the Team Challenge, different teams are combined by lot, discuss their common strategy and solve the tests together.

Trophies and Certificates

For the RMRC, trophies and certificates will be awarded to teams based on a number of categories. These are:

RMRC Overall

The following trophies result from the total score of the arena rounds:

- First Place

The following certificates result from the total score of the arena rounds:

- Second Place
- Third Place

Best in class certificates

The team/robot with the highest score in a specific robot class wins the according Best in Class certificate.

- Only the runs in the preliminary rounds count for Best in Class.
- To win any Best in Class certificate, you need a positive, non-zero score in 80% of the available tests.
- It is possible that a team could win more than one Best in Class certificate.

A certificate will be awarded to the winner in each of the following categories:

- Best in Class Mobility
- Best in Class Dexterity
- Best in Class Sensing

Note that the Open Source Innovation award in previous years has been replaced by the Updated TDM multiplier.

Team Challenge

All teams that have won the team challenge will be awarded with a certificate.

Rules for Each Test

Introduction

There are a total of 10 different test scenarios. Each test has its own lane, which places different demands on a robot's capabilities. Most of the tests can be navigated with a mobile remote-controlled robot that has at least one sensor to transmit the environmental data to the driver. The drivers do not have eye contact with the robot.

The competition days are divided into preliminary rounds and a final. In the preliminary rounds, teams have to collect points in the test lanes. The test lanes may be used more than once if something goes wrong during a mission. The collected points of the preliminary rounds will be added up and the final participants will be determined.

For each test run, the team has 5 minutes to start up the robot and operator station in the operator booth of the respective test lane. After that, the team gets 5 minutes of mission time. The robot must be in physical contact with the start and the end wall to complete a lap. For each successfully completed lap, the judge scores one point. The conditions for successfully completing a lap are described below for each test.

The robot must not be touched during its mission. If the robot is touched, this counts as a reset. The points are then added up again. At the end of the entire mission time, the largest contiguous score is taken.

Incline and Center

Mission objective

This lane will be used to test how well the robot can navigate through narrow spaces. This also shows how well the remote operator can perceive the environment via the robot's sensors.

Lap preparations

- Set the width of the bottleneck so that it corresponds to 120 % of the diagonal of the robot.

Scoring points

- Completing a lap.

Lane settings

- Bay horizontal
- Bay inclined at 15 degrees

Sand and Gravel on Crossover Slope

Mission objective

This lane will be used to test how off-road capable the robot is in outdoor environments.

Lap preparations

- Smooth the sand and gravel surfaces.

Scoring points

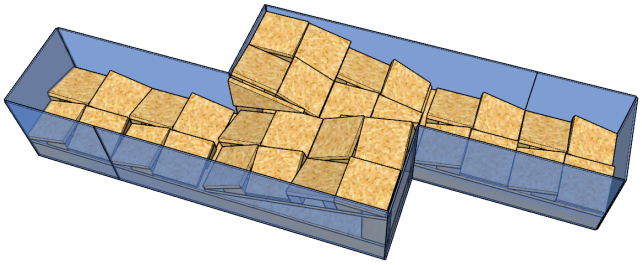
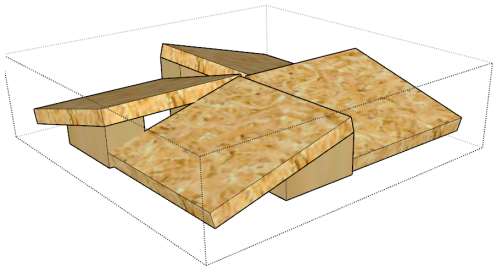
- Completing a lap.

Lane settings

- Bay horizontal

Ramps on Crossover Slope



Mission objective

This lane also tests the off-road capability over uneven terrain. The transition between two oppositely inclined levels is particularly challenging.

Lap preparations

- (none)

Scoring points

- Completing a lap.

Lane settings

- Continuous ramps (Bay horizontal)
- Pinwheel ramps (Bay horizontal)

Elevated Ramps

Mission objective
This lane simulates stepped terrain.

Lap preparations
- (none)

Scoring points
- Completing a lap.

Lane settings
- Bay horizontal

Stairs


Mission objective
This lane simulates a staircase.

Lap preparations
- (none)

Scoring points
- Overcome one step up or down.

Lane settings
- Horizontal

Align

Mission objective

This lane presents a challenge to the navigability of the robot. It must be driven over a simulated abyss with centimeter precision.

Lap preparations

- Adjust the gap of the abyss so that the wheels / tracks / legs of the robot rest only one centimeter on both sides.

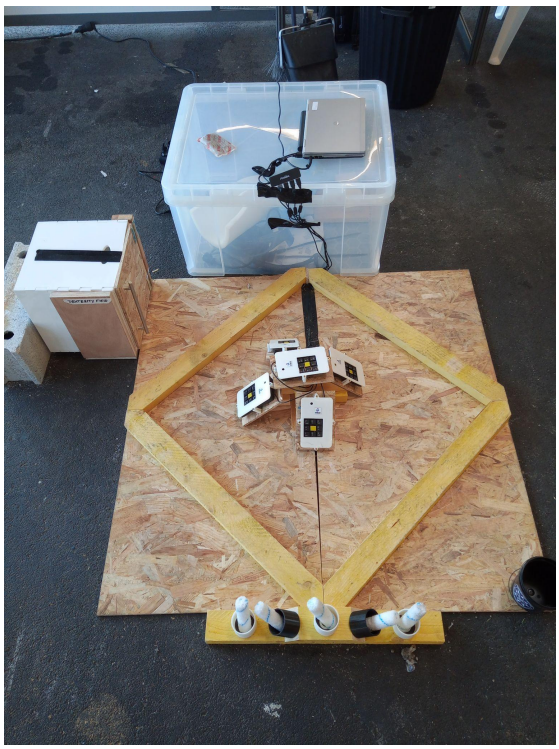
Scoring points

- Get from the start field to the end field, while crossing the abyss.

Lane settings

- Horizontal

Dexterity



Mission objective

This lane tests the robots' skill in manipulating objects. Usually the manipulation is done by a robot arm. Parts have to be gripped, pressed or opened. In a so-called sensor crate, additional points can be collected through sensor data processing.

Lap preparations

- Check if a connected notebook recognizes the keystrokes.
- Check if all manipulation objects are in the designated tubes.
- Check whether all tests in the sensor crate are functional or recognizable.
- Close the door of the sensor crate or open it if the team wants to skip the door opening task.

Scoring points

- Correct key press (center key) gives one point. Before hitting the same key again, another task has to be performed.
- Grabbing an object and placing it in the designated container scores one point.
- Opening the door gives one point.
    - Team may start with the door open, but won’t get this point.
- Successful inspection of a sensor test scores one point.

Labyrinth


Mission objective

This lane simulates an exploration task. Besides navigating through a meandering maze, some recognition tasks can also be solved. The recognition of QR codes, the inspection of a sensor crate and the possibility to register a map of the lane give additional points.

Lap preparations

- Check if the QR code sheets are still undamaged attached to the walls.
- Check whether all tests in the sensor crate are functional or recognizable.
- Close the door of the sensor crate or open it if the team wants to skip the door opening task.

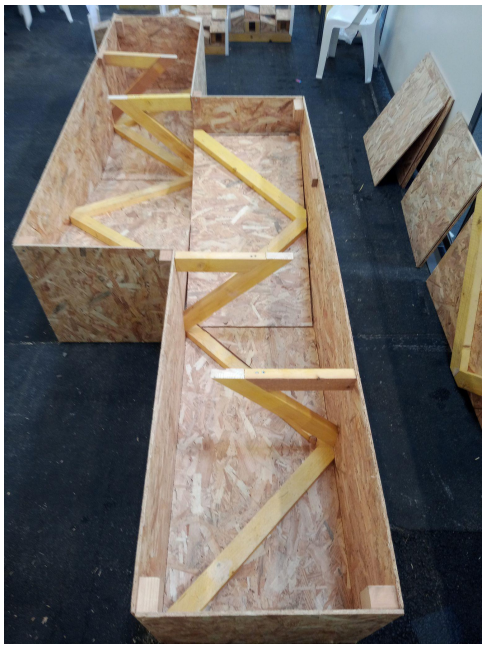
Scoring points

- Completing a lap.
- Correct detection of an QR code gives one point. Multiple detections are ignored (only one point per QR code). The information from the QR codes must be written to a file and given to the judges at the end of the run.
- Opening the door gives one point.
    - Team may start with the door open, but won't get this point.
- Successful inspection of a sensor test scores one point.

Lane settings

- Flat terrain
- K-rail terrain

K-Rails (on Crossover Slope)



Mission objective

This lane tests the mobility characteristics of the robot by requiring slanted beams to be crossed.

Lap preparations

- (none)

Scoring points

- Completing a lap.

Lane settings

- Horizontal (Flat setting)
- Crossover slope

Hurdle Terrain

Mission objective

This lane tests the mobility characteristics of the robot by requiring it to negotiate slippery tubes to reach a different height level.

Lap preparations

- (none)

Scoring points

- Completing a lap.

Lane settings

- Single layer tube configuration
- Double layer tube configuration (Double step height / Two tubes mounted one above the other)

Drop Test

(strongly recommended to be withheld until Final rounds)

Mission objective

Demonstrate the robustness of the robot. Survive, and continue to be capable of operation, after a sharp drop.

Lap preparations

- For the finals, an opening can be made in a raised lane (on any side of the 30 cm section of either end of a lane) for the robot to exit through.
- The drop can be placed as an endpoint within the maze, or can be placed to be used as a short-cut.

Scoring points

- Exit through the opening, land, and continue operation afterwards.
- 1 point for surviving a 15 cm drop.
- 2 points for surviving a 30 cm drop.

Lane settings

- 15 cm drop height.
- 30 cm drop height.

Final Parcours and Team Challenge

A complete course is built from the individual lanes for the final. The final will test which robot can cope with the most challenges.

In the Team Challenge, the difficulty of the obstacles is increased. In the Team Challenge, several teams compete together with their robots. It is recommended that the teams think about a strategy beforehand how they can help each other with their robots. It is allowed that robots push, carry or pull each other.

Code of Conduct

Spirit of Competition

It is expected that all participants (Competitors and Mentors alike) will respect the aims and ideals of RoboCup as set out in our mission statement. The Competition Lead(s), Judges, and other officials will act within the spirit of the event to ensure the challenge is competitive, fair, educational and fun.

Remember that the aim of this competition is for **all** Competitors to be competing against the **challenge.** In a real disaster situation, if multiple teams show up to help, they should **work together** to do the **best job possible.** This is an **open source** competition where we aim to all better ourselves and each other; please share and help each other grow!

Expectations

- All participants should review the most up-to-date rules of the competition (via http://list.oarkit.org/ and mailing list) before the competition, to ensure that everyone is participating fairly.
- All participants **must** wear **their own** badge, or be escorted by admin staff, while in the competition area. Badges **may not** be lent **or** traded between participants.
- All participants **must** wear close-toed shoes and secure any loose items/entanglement hazards.
- All participants should present at the venue early on setup day for Team Leader meetings, registration, arena walk through, rules clarifications, schedule updates, announcements, cover location-specific safety regulations, radio restrictions, etc.
- All participants **must** move safely through the entirety of the RMRC area (no running, climbing on equipment, obstructing footpaths, or other activities that could lead to the harm of self or others.)
- Competing teams have priority over tables, bays/lanes, and associated thoroughfares.
- **Only** Competition Lead(s), Judges, and Admin staff shall communicate with the Robot Pilot in preparation for, and during a competition run.

Competition Lead

- The Competition Lead(s) will keep time and overall score, without bias to any one individual or Team.
- At least one up-to-date copy of the Rules will be printed and available for clarification.
- At least one copy of the most recently submitted TDMs will be printed and posted for general review.
- Provide enough score sheets for the Judge's use.
- If there is any dispute, the Competition Lead(s) will make the final decision, with the appropriate committees brought in (as time and resources allows).

- At the beginning of each Session, the Competition Lead(s) will call for volunteers to Judge and Team Leaders to gather and schedule their runs.
- At the end of each run, the Competition Lead(s) will receive and record scores from Judges.
- Ensure that **all** Judges, Mentors, and Team Leaders are familiar with safety risks and locations of firefighting equipment (e.g. buckets of sand, fire blankets and extinguishers for class A, B, C and D).

Judges

- At the beginning of each Session, the Competition Lead(s) will call for volunteers to serve as Judges.
- The number of Volunteer Judges will dictate how many Teams may run concurrently.
- (Recommended to reduce the number by 1 or 2, e.g. 9 Volunteers means 7 or 8 Judges, so that there is always a spare Judge to assist.)
- Judges may be volunteered from Mentors, (badged) Parents, and adult competitors from the Major league. (If a Major team volunteers to assist in judging, ensure they are aware of their own competition schedule, and count the entire team as One Judge, to ensure coverage in the event of Major chaos.)
- A Judge should avoid scoring for their own Team.
- Judges will keep score, without bias.
- At the end of each Run, the Judge will verify the score with the Team's Pilot (who will sign/initial scoresheet).
- Once the score is verified, the Judge will bring up the score sheet to the Competition Lead(s).
- (Recommended for the Judge to initial these scores on the scoreboard, along with the scoresheet, both to track scores if there is a question, and for the Judge to verify that the correct number was recorded.)

Mentors

- Each Team may have up to two badged Mentors assisting in the competition.
- **Only** registered, badged Mentors are allowed in the competition area.
- Mentors are encouraged to assist in operation of the challenge (e.g. as judges, suite manufacturer, scoring, etc).
- Mentors are permitted to build, repair, or be involved in the programming of their Team's robots in a limited capacity. (However, the Robots must be **mainly** the Competitor's own work!)
- Mentors may **not** interfere with Robots, Teams, or Judges.
- Supervise students; there shall be **no** unsupervised students in the work or competition area.
- Ensure that **all** equipment directly connected to power outlets follows event-location safety standards (rated appropriately, tagged as necessary, etc.)

- Ensure that **no** items are left charging/connected to power outlets **unsupervised** or **overnight.**

Competitors

- Each Team will be composed of up-to 6 students.
- Competitors should be capable of explaining their role within the Team.
- Competitors **must** be familiar with inherent safety risks of the Team's Robot (e.g. pinch, crush, burn, fire, explosion risks, etc).
- Ensure that there is **at least** one Mentor from your Team if any member of the Team is in the work or competition area.
- At the end of each run, verify the score with the Judge and sign the score sheet.
- **Any** dispute **must** be brought to the Competition Lead(s) before the next Team Leader Meeting/Session (at which point, all scores on the scoreboard will be considered finalized.)
- At the end of each run, Team will **remove** Robot and associated equipment in a safe, but efficient, manner, to allow the next Team to set up.
- Do **not** distract or interfere with other Teams or Judges while they are competing.
- Do **not** enter other Team's work areas, unless explicitly invited to do so.

Robots

- Any Robot that appears to be identical to another Robot, or appears to be factory standard, may be prompted for re-inspection.
- Tethers **must** be managed in a safe manner (e.g. avoid tripping hazards, damage to the arena, etc). Event-organizer-approved tape, carpet squares, etc may be utilized.
- Robots **will not** deliberately or repeatedly damage or destroy any testing apparatus.

Parents

- **Unless** a Parent is a Badged, Registered Mentor, they **shall** remain outside the competition and student work area.
- Parents shall **not** interfere with, or distract, **any** Team.

Guests

- Guests and Audience members are **welcome** in the viewing area.
- Guests and Audience members are **not** allowed in the Team work area or competition area.
- Guests and Audience members shall **not** interfere with, or distract, **any** Team.

Penalties

Rules will be enforced at the discretion of Competition Lead(s), Judges, officials, competition organizers and local law enforcement authorities. These individual(s) will decide if the penalties will only be levied on one individual, or the entire Team. Separate penalties may apply for disruption during the finals and/or for teams with no more competition runs.

The Competition Lead(s) may, at any time, question a participant on their familiarity with any relevant matter of safety, particularly if a dangerous or potentially dangerous situation is brought to their attention. They may make **immediate** penalty judgment(s), **without warning**, if they see unsafe practices, or severe/repeated violations of the code of conduct.

Strike One

- A verbal, or written, warning will be issued.

Strike Two

- Removal from current Session, or removal from the RMRC area for 4 competition hours, whichever is longer.
- Scores from the current Session will be struck from the board.
- Any **unsupervised** equipment, or Robots, physically present (e.g. on a table, in a lane, in a thoroughfare) will be impounded until the end of the next run.
- Any **unsafe** equipment, or Robots, physically present (e.g. on a table, in a lane, in a thoroughfare) will be impounded and removed from the field of competition until it has been deemed safe to return to the competition.
- RoboCup reserves the right to revoke an award if fraudulent behavior can be proven after the award ceremony takes place.

Strike Three

- Disqualification from the **entire** competition.
- Requested to leave the venue.
- If it is clear that a Team, or Team member, intentionally violates the code of conduct, the person or entire Team may be banned from future participation in RoboCup competitions.

Please post any questions and comments to the mailing list, http://list.oarkit.org/ , for group discussion.

Appendix A: Printable Resources

Score Sheets (cut into quarters)

ROBOCUPRESCUE
RAPIDLY MANUFACTURED ROBOT CHALLENGE

Day: Time:

Test:

Team:

Judge:

Tally:

Signature:

Final Score:

ROBOCUPRESCUE
RAPIDLY MANUFACTURED ROBOT CHALLENGE

Day: Time:

Test:

Team:

Judge:

Tally:

Signature:

Final Score:

ROBOCUPRESCUE
RAPIDLY MANUFACTURED ROBOT CHALLENGE

Day: Time:

Test:

Team:

Judge:

Tally:

Signature:

Final Score:

ROBOCUPRESCUE
RAPIDLY MANUFACTURED ROBOT CHALLENGE

Day: Time:

Test:

Team:

Judge:

Tally:

Signature:

Final Score:

(This is an old version, to be updated with a place for the autonomous tally.)