# RoboCupJunior Rescue Maze – Rules 2016

**RoboCupJunior Rescue - Technical Committee 2016**

*Fredrik Löfgren (Sweden) CHAIR, fredrik@eaproduktion.se*
*Roberto Bonilla (Mexico), rbonilla@mytech.zone*
*Naomi Chikuma (Japan), mymama_8888@yahoo.co.jp*
*Kai Hannemann (Germany), kai.hannemann@gmail.com*
*Phil Wade (Australia), phil@ThreatVectorX.com*

These are the official rules for RoboCupJunior 2016. They are released by the RoboCupJunior Rescue Technical Committee. The English rules have priority over any translations. **Changes from the 2015 rules are highlighted in red.**

## Scenario

The land is simply too dangerous for humans to reach the victim! Your team has been given the most difficult tasks. It must be able to carry out the rescue mission in fully autonomous mode with no human assistance. The robot must be strong and smart enough to navigate through a treacherous terrain with hills, uneven lands and rubble without getting stuck. The robot needs to seek out the victims, dispense rescue kit, and signal the position to the rescuers so the humans can take over.

Time and technical skills are the essential! Come and prepare to be the most successful Rescue Response Team.

## Summary

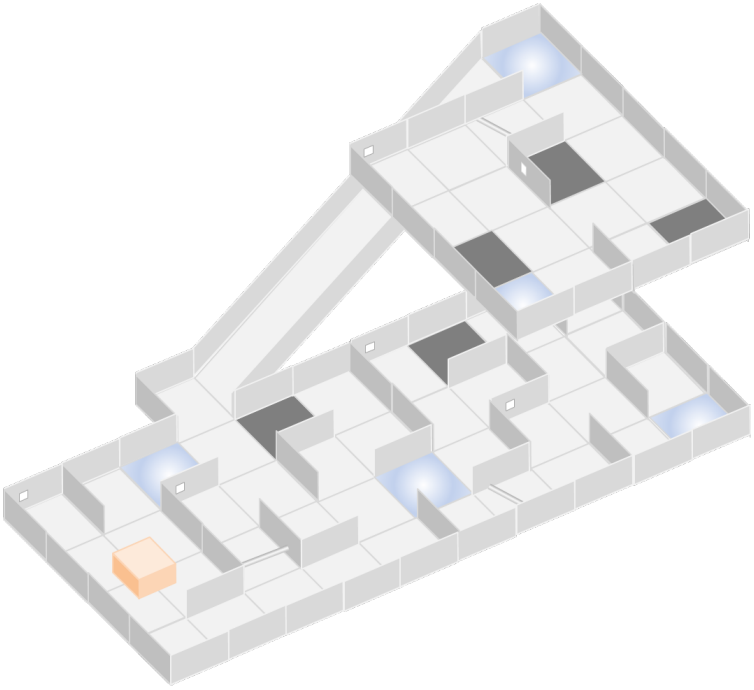
The robot needs to search through a maze for heated victims. I.e. the robot should not find the fastest path through the maze, instead it should explore as much as possible of the maze. The robot will get 10 or 25 points for each victim found. If the robot can also deliver an item (designed by the team themselves) close to the victim it will earn an additional 10 points. The robot should avoid areas with black floor.

If the robot is stuck in the maze it can be restarted at the last visited checkpoint. The checkpoints are indicated with reflective floor so the robot can save its map (if it uses a map) to a non-volatile medium and restore it in case of a restart.

If the robot can find its way back to the beginning after exploring the whole maze it will receive an exit bonus. The robot will also earn a reliability bonus if the robot didn't need so many restarts.

There are also some obstacles where the robot can earn additional points:

- 5 points for each tile with speed bumps
- 10 points for going down a ramp
- 10 points for each visited checkpoint
- 20 points for going up the ramp



Contents

# 1. Arena

## 1.1 Description

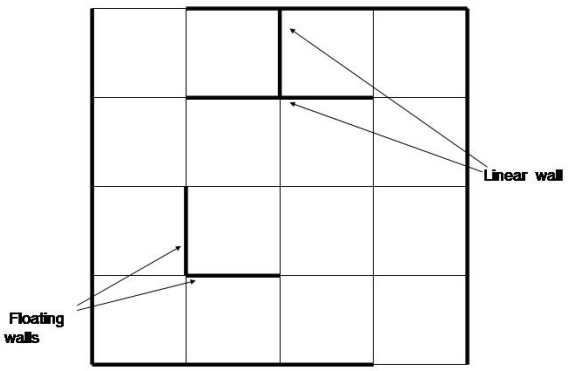
1.1.1 The maze may consist of multiple distinct areas. Areas will have a horizontal floor and a perimeter wall.
1.1.2 Areas may be joined together by doorways or ramps.
1.1.3 Walls that make up the maze are at least 15 cm high.
1.1.4 Doorways are at least 30 cm wide.
1.1.5 Ramps will be at least 30 cm wide and have an incline with a maximum of 25 degrees from horizontal surface. The ramp is always straight.

## 1.2 Floor

1.2.1 Floors may be either smooth or textured (like linoleum or carpet), and may have steps of up to 3 mm height at joints. There may be holes in the floor (about 5 mm diameter), for fastening walls.
1.2.2 Through the arena, there may exist black tiles that represent “no go” spaces. Black tiles will be placed randomly at the start of each round. Black tiles may not be completely fixed on the floor.
1.2.3 There may also exist silver tiles that represent checkpoints (see 3.6.2). Silver tiles may not be completely fixed on the floor.
1.2.4 A tile is defined as a 30x30 cm space, which is aligned to the grid made up by the walls.

## 1.3 Path

1.3.1 Walls may or may not lead to the entrance/exit. Walls that lead to the entrance/exit are called linear walls. The walls that do NOT lead to the entrance/exit are called "Floating Walls".
1.3.2 Paths will be approximately 30 cm wide with, but may open into foyers wider than the path.
1.3.3 One of the outermost tiles is the starting tile, where a robot should start and exit the run.
1.3.4 The starting tile is always a checkpoint.




## 1.4 Debris, Speed Bumps and Obstacles

1.4.1 Speed bumps are fixed to the floor, and have a maximum height of 2cm.
1.4.2 Debris will not be fixed on the floor, and have a maximum height of 1cm.
1.4.3 Debris may be spread towards or adjacent to walls.
1.4.4 Obstacles may consist of any large, heavy items and its shape can be anything from rectangular, pyramidal, spherical to cylindrical.
1.4.5 Obstacles have minimum height of 15 cm.
1.4.6 Obstacle must not prevent a robot from discovering routes in the maze. An obstacle may be placed in any location where at least 20 cm is left between the obstacle and any walls.
1.4.7 Obstacles that are moved or knocked over will remain where they are moved to/fall and will not be reset during the run.

## 1.5 Victims

1.5.1 Victims are heated sources located near the floor of the arena (centered approximately 7 cm above the floor).
1.5.2 Each victim has a surface area greater than 16 sq cm.
1.5.3 The organizers will try to keep enough difference (minimum of 10 degrees Celsius) between victims' temperatures and the indoor temperature. The temperature of the victim simulates human body temperature between 28oC to 40oC.
1.5.4 There will be a minimum of five (5) active victims in any round.
1.5.5 There may be objects that resemble victims in appearance, but are not heated. Such objects are not to be identified as victims by robots.
1.5.6 Victims will never be located on black tiles or on tiles with obstacles.

## 1.6 Rescue Kits

1.6.1 A Rescue Kit represents a basic health package distributed to a victim caught in a natural disaster. It symbolizes tools or devices used in the rescue process, such as GPS Transponders or even something as simple as light source providers.
1.6.2 A Rescue Kit should preferably contain a lit-up LED, but could contain other electronics, weights or magnets.
1.6.3 Each Rescue Kit must have a minimum volume of 1 cubic cm.
1.6.4 Each team can only carry a maximum number of 12 of those kits.
1.6.5 Some sample instructions for creating the rescue lit-up kit can be found the end of this document. Each team is encouraged to design their own versions.
1.6.6 Each team is responsible for the whole Rescue Kits system (the maximum of 12 kits), including bringing the rescue kits to the competition. Team captain is responsible for loading their own Rescue Kits on their robots and cleaning the field with the referee's/judges' authorization after the game is called to end.

## 1.7 Environmental Conditions

1.7.1 Teams should expect the environmental conditions at a tournament to be different from the conditions at their home practice field.
1.7.2 Teams must come prepared to adjust their robots to the conditions at the venue.
1.7.3 Lighting and magnetic conditions may vary along the course in the rescue arena.
1.7.4 The arena may be affected by magnetic fields (e.g. generated by under floor wiring and metallic objects).
1.7.5 Teams should prepare their robots to handle unexpected lightning interference. While the organizers and referees will try their best to minimize external lighting interference, it is not possible for them to foresee all unexpected interferences such as camera flash from spectators.
1.7.6 The Organizing Committee (OC) will try their best to fasten the walls onto the field floor so that the impact from regular robot's contact should not affect the robot. (Refer to 6.1)
1.7.7. All measurements in the rules have a tolerance of 5%.
1.7.8. Objects to be detected by the robot will be distinguishable from the environment by their color or heat signature.

# 2. Robots

## 2.1 Control

2.1.1 Robots must be controlled autonomously. The use of a remote control or manual control, or passing information (by sensors, cables, wirelessly, etc.) to the robot is not allowed.
2.1.2 Robots must be started manually by the team captain.
2.1.3 Robots may utilize various maze navigation algorithms. Pre-mapped type of dead reckoning (movements predefined based on known locations before game play) is prohibited.
2.1.4 A robot must not damage any part of the arena in any way.
2.1.5 Robots should include a stop/pause button so they may be easily stopped/paused by humans to avert any potentially damaging or illegal robot actions.

## 2.2 Construction

2.2.1 The height of a robot must not exceed 30 cm.
2.2.2 Robots may not have any sensor or devices that enable it to 'see' over the walls.
2.2.3 Any robot kit or building blocks, either available on the market or built from raw hardware and materials, may be used, as long as the design and construction are primarily and substantially the original work of the students (see section 2.5. below).
2.2.4 Any commercially produced robot kits or sensors components that are specifically marketed to complete any single major task of RoboCupJunior Rescue will be disqualified. If there is any doubt, teams should consult the Technical Committee (TC).
2.2.5 For the safety of participants and spectators, only lasers of class 1 and 2 are allowed. This will be checked during inspection.
2.2.6 Bluetooth Class 2, 3 and ZigBee communications are the only wireless types allowed in RoboCupJunior. Robots that have other types of wireless communications on board have to be either removed or disabled for possible interference with other leagues competing in RoboCup. If the robot has equipment for other forms of wireless communication, the team must prove that they have disabled them. Robots that do not comply may face immediate disqualification from the tournament.

## 2.3 Team

2.3.1 Each team must have only one robot in the field. (This rule can be modified in a Super Team Competition such that robots from different teams are are deployed together and have to cooperate in completing given tasks.)
2.3.2 Each team must have a minimum of 2 members.
2.3.3 Students will participate in ONLY ONE (1) of the three (3) divisions: Primary Rescue Line, Secondary Rescue Line or Rescue Maze.
2.3.4 Eligibility for the international event is:

- Rescue Line Primary: Open to students between 11 and 14 years old. Age is calculated as of July 1 for the international RCJ event each year.
- Rescue Line Secondary: Open to students from age of 11 up to and including 19 years of age. Team members may compete in Secondary Rescue twice at most (2 international events). After competing twice they must move to Rescue Maze.
- Rescue Maze: Open to students from age of 11 up to and including 19 years of age.

2.3.5 The number of team members per team is limited to 6 members maximum but a team should choose their team size in a way that the learning experience of each member is maximized. Mentors/parents are not allowed to be with the students during the competition. The students will have to self-govern themselves (without mentor's supervision) during the long stretch of hours at the competition.
2.3.6 Every team member can be registered in only one team, and every team can compete in only one RoboCupJunior league and division.

## 2.4 Inspection

2.4.1 The robots will be examined by a panel of referees before the start of the tournament and at other times during the competition to ensure that they meet the constraints described.
2.4.2 It is highly unlikely that a team will be able to legally use a robot identical to another team's robot from previous or the current year, or use a robot that is identical to another team's robot.
2.4.3 It is the responsibility of teams to have their robots re-inspected, if their robots are modified at any time during the tournament.
2.4.4 Students will be asked to explain the operation of their robots, in order to verify that construction and programming of the robot is their own work.
2.4.5 Students will be asked about their preparation efforts, and may be requested to answer surveys and participate in video-taped interviews for research purposes.
2.4.6 All teams must fill a web form that will be provided once the team is officially registered, and should be submitted at least one week prior to the competition. The purpose of this document is to allow judges to be better prepared for the interviews. For sample documentation, please refer to the "Description of Materials Template" at the official RCJ website under Rescue rules. Information about how to submit your document will be announced prior to the competition to the teams.
2.4.7 All teams have to submit their source code prior to the competition. The source code is never shared with other teams without the team's permission.

## 2.5 Violations

2.5.1 Any violations of the inspection rules will prevent the offending robot from competing until modifications are applied.
2.5.2 However, modifications must be made within the time schedule of the tournament and teams must not delay tournament play while making modifications.
2.5.3 If a robot fails to meet all specifications (even with modification), it will be disqualified from that round (but not from the tournament).
2.5.4 No mentor assistance during the competition is allowed. See 6. Code of Conduct.

# 3. Play

## 3.1 Pre-round Practice

3.1.1 Where possible, competitors will have access to practice arenas for calibration, testing and tuning throughout the competition.
3.1.2 Whenever there are dedicated independent arenas for competition and practice, it is at the organizers' discretion if testing is allowed on the competition arena.

## 3.2 Humans

3.2.1 Teams should designate one of its own team members as 'captain' and another one as 'co-captain'. Only these two team members will be allowed access to the practice/competition arenas, unless otherwise directed by a referee. Only the captain will be allowed to interact with the robot during a scoring run.
3.2.2 The captain can move the robot only when s/he is told to do so by the referee.
3.2.3 Other team members (and any spectators) within the vicinity of the rescue arena have to stand at least 150 cm away from the arena while their robot is active, unless otherwise directed by the referee.
3.2.4 No one is allowed to touch the arenas intentionally during a scoring run.

## 3.3 Start of Play

3.3.1 A run begins at the scheduled starting time whether or not the team is present/ready. Start times will be posted prominently around the venue.
3.3.2 Once the scoring run has begun, the playing robot is not permitted to leave the competition area for any reason. Each run lasts a maximum of 8 minutes.
3.3.3 Calibration is defined as the taking of sensor readings and modifying a robot's program to accommodate such sensor readings. Once the clock has started, a team may calibrate their robot at as many locations as desired on the arena, but the clock will continue to count down. A robot is not permitted to move using its own power while calibrating.
3.3.4 Calibration time is not for pre-mapping the arena and/or victims location. Pre-mapping activities will result in immediate robot disqualification for the round.
3.3.5 Before a scoring run begins, a dice will be rolled to determine the location of the black and silver tiles. The position of the black tiles will NOT be revealed to the team until when they are ready to start a scoring run (see 3.3.6). Referees will ensure the combination of black tile placements in a maze is 'solvable' before a robot begins a scoring run.
3.3.6 Once the robot is started, a referee will place the black and silver tiles (determined by roll of dice as per 3.3.5).
3.3.7 Once a scoring run has begun, no more calibration is permitted (this includes changing of code/code selection).

## 3.4 Game play

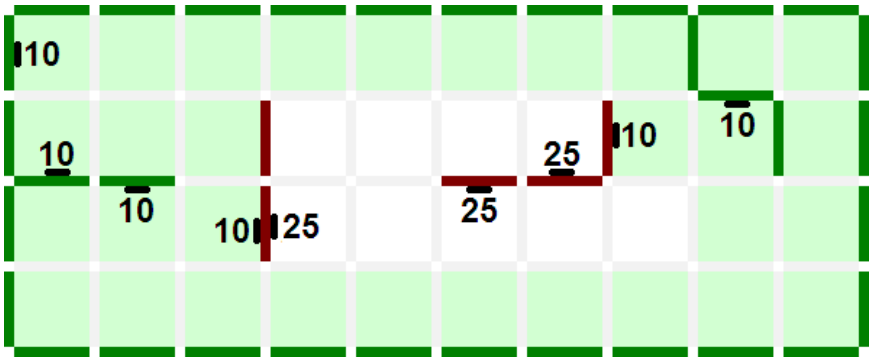
3.4.1 Modifying a robot during a run is prohibited; which includes remounting parts that has fallen off.
3.4.2 All parts that the robot is losing intentionally or unintentionally will be left in the arena until the run is over. Neither the team nor the judge are allowed to remove parts from the arena during a run.
3.4.3 Teams are not allowed to give a robot any advance information about the field. The robot is supposed to recognize the field by itself.
3.4.4 A "visited tile" means that more than half of the robot is inside the tile when looking down from above.

## 3.5 Scoring

3.5.1 Successful Victim Identification. Robots are rewarded points for each Successful Victim Identification in the arena:

a) 10 points per "victim" located at a tile adjacent to a linear wall (even diagonally), i.e. all victims at the 6 tiles around a linear wall.

b) 25 points per "victim" at other walls.




In the above diagram, red lines mean floating walls while the green ones represent linear walls.
Note that some of the victims on the floating walls are worth 10p, this is because the 10p victims are located in a tile near a linear wall. The colors on the diagram are just for illustrative purposes.

To identify a victim, a robot must stop within 15 cm of the victim while flashing a lamp on and off for five seconds, and/or release a Rescue Kit before moving on. When a robot completes both, it counts as one victim identification and one rescue kit deployment (see below).

3.5.2 Successful rescue kit deployment. Robot should drop a rescue kit on the tile where the victim is, and the deployment point needs to be within 15 cm proximity of the victim. The robot is awarded 10 points per successful rescue kit deployment. There are no extra points for multiple kit deployments per victim.

3.5.3 Reliability Bonus = the number of 'successful victim' identification" x 10 + the number of 'successful rescue deployment' x 10, minus the number of 'Lack of Progress' x 10. However, Reliability Bonus score can only be reduced down to the minimum of 0 points.

3.5.4 Successful Speed Bump Crossing. For each tile with speed bumps passed, a robot is awarded 5 points.

3.5.5 Successful Up Ramp Negotiation. A robot is awarded 20 points for a successful climb of the ramp. To successfully climb up the ramp, a robot needs to move from the bottom horizontal tile before the ramp to the top horizontal tile after the ramp.

3.5.6 Successful Down Ramp Negotiation. A robot is awarded 10 points for successfully landing at the bottom of the ramp. A robot needs to move from the top horizontal tile of the ramp to the bottom horizontal tile of the ramp. A successful landing means that the robot can leave the tile without assistance.

3.5.7 Successful Checkpoint Negotiation. A robot is awarded 10 points for each visited checkpoint. Refer to 3.4.4 for definition of visited tile.

3.5.8 Successful Exit Bonus. A successful exit bonus is awarded when a robot successfully finishes a round on the start tile. It needs to stay there at least 10 seconds (this is to simulate the retrieval of a robot from the disaster zone). The points awarded will be 10 points per victim successfully identified.

3.5.9 Ties at the end. Ties in scoring will be resolved on the basis of the time each robot took to complete the run.

3.5.10 No duplicate rewards. For example, if a robot successfully crosses a tile with speed bumps multiple times, only one Successful Speed Bump Crossing will be rewarded per tile. Same result applies to all other scoring rules.

## 3.6 Lack of Progress

3.6.1 A Lack of Progress occurs when

A) The team captain declares a Lack of Progress.

B) A robot fails to retreat from 'visited' black tile. For a successful retreat it needs to back up without turning inside the black tile (it has to move straight backwards inside of a black tile). See definition of visited tile on rule 3.4.4.

C) A robot or a team member damages the arena.

D) A team member touches the arena or their robot without permission from a referee.

3.6.2 If a Lack of Progress occurs, the robot must be returned to the last visited checkpoint. The robot can be placed in any direction. Refer to 3.4.4 for definition of visited tile.

3.6.3 After a Lack of Progress, the team captain may reset the power supply (turn the robot off and on) and because of this the program is restarted. He is not allowed to change the program or give any information about the maze to the robot.

Reset Power OFF & ON Change program

## 3.7 End of Play

3.7.1 The team captain may declare an "end of round" if the team wants to stop the round early. The team will be awarded all points achieved up to the call for end of round.

3.7.2 The round ends when:

A) The time expires.

B) The team captain calls end of round.

C) The robot returns to the start tile and gets the exit bonus.

# 4. Open Technical Evaluation

## 4.1 Description

4.1.1 Your technical innovation will be evaluated during a dedicated time frame. All teams need to prepare for an open display during this time frame.
4.1.2 Judges will go around interacting with teams. It will be set up as more like a casual conversation or "questions and answers" atmosphere.
4.1.3 The main objective of the Open Technical Evaluation is to emphasize the ingenuity of innovation. Being innovative may mean technical advance as compared to the existing knowledge, or an out-of-the-ordinary simple but clever solution to existing tasks.

## 4.2 Evaluation Aspects

4.2.1 A standardized rubric system is used focusing on:
a) creativity
b) cleverness
c) simplicity
d) functionality
4.2.2 "Your work" can include (but is not limited to) one of the following aspects:
a) creation of your own sensor instead of a pre-built sensor
b) creation of a "sensor module" which comprises of various electronics to provide a self-contained module to provide a certain special functionality
c) creation of a mechanic module which is functional, but out of the ordinary
d) creation of a new software algorithm to a solution
4.2.3 Teams must provide documents that explain their work. Each invention must be supported by concise but clear documentation. The documents must show concise inventive steps.
4.2.4 Documents must include one poster and one engineering journal (see the Engineering Journal Template on official RCJ website for more details). Teams are expected to be readily prepared to explain their work.
4.2.5 Engineering Journal should demonstrate your best practice in your development process.
4.2.6 The poster should include name of team, country, league, robot description, robot capabilities, controller and programming language used, sensors included, method of construction, time used for developing, cost of materials and awards won by the team in its country, etc.
4.2.7 Guidelines may be provided at the official RCJ website under Rescue rules (Engineering Journal Template).

## 4.3 Awards

4.3.1 Awards may be divided into several categories.
a) Innovation:
- Mechanical innovation
- Electronic innovation
- Algorithm innovation

b) Robust Design:
- Mechanical design
- Electronic design
- Algorithm design

c) Team work – demonstration of great collaborations within the team.
d) Best Practice (in development) – demonstration of the best development practice from

brainstorming, designing, prototyping, development, test plan, quality assurance plan, etc.
4.3.2 Awards will be given in the form of a certification.

### 4.4 Sharing

4.4.1 Teams are encouraged to review other's posters and presentations.
4.4.2 The awarded teams are required to post their documents and presentation online if the TC asks them.

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# 5. Conflict Resolution

### 5.1 Referee and Referee Assistant

5.1.1 All decisions during game play are made by the referee or the referee assistant who are in charge of the arena, persons and objects surrounding them.
5.1.2 During game play, the decisions made by the referee and/or the referee assistant are final.
5.1.3 At conclusion of game play, the referee will ask the captain to sign the score sheet. Captain should be given maximum 1 minute to review the score sheet and sign it. By signing it, the captain accepts the final score on behalf of the entire team; in case of further clarification, the team captain should write their comments in the score sheet and sign it.

### 5.2 Rule Clarification

5.2.1 If any rule clarification is needed, please contact the International RoboCupJunior Rescue Technical Committee.
5.2.2 If necessary even during a tournament, a rule clarification may be made by members of the RoboCupJunior Rescue Technical Committee and Organizing Committee.

### 5.3 Special Circumstances

5.3.1 If special circumstances, such as unforeseen problems or capabilities of a robot occur, rules may be modified by the RoboCupJunior Rescue Organizing Committee Chair in conjunction with available Technical Committee and Organizing Committee members, if necessary even during a tournament.
5.3.2 If any of the team captains/mentors do not show up to the team meetings to discuss the problems and the resulting rule modifications described at 5.3.1, it will be considered as an agreement.

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# 6. Code of Conduct

## 6.1 Spirit

6.1.1 It is expected that all participants (students and mentors alike) will respect the aims and ideals of RoboCup Junior as set out in our mission statement.
6.1.2 The volunteers, referees and officials will act within the spirit of the event to ensure the competition is competitive, fair and most importantly fun.
6.1.3 ***It is not whether you win or lose, but how much you learn that counts!***

## 6.2 Fair Play

6.2.1 Robots that cause deliberate or repeated damage to the arena will be disqualified.
6.2.2 Humans that cause deliberate interference with robots or damage to the arena will be disqualified.
6.2.3 It is expected that the aim of all teams is to participate fairly.

## 6.3 Behavior

6.3.1 Participants should be mindful of other people and their robots when moving around the tournament venue.
6.3.2 Participants are not allowed to enter setup areas of other leagues or other teams, unless explicitly invited to do so by team members.
6.3.3 Teams will be responsible for checking update information (schedules, meetings, announcements, etc.) during the event. Update information will be provided on notice boards in the venue and (if possible) on the local competition website and/or the RoboCup or RoboCupJunior websites.
6.3.4 Participants who misbehave may be asked to leave the building and risk being disqualified from the tournament.
6.3.5 These rules will be enforced at the discretion of the referees, officials, tournament organizers and local law enforcement authorities.

## 6.4 Mentors

6.4.1 Adults (mentors, teachers, parents, chaperons, translators and other adult team members) are not allowed in the student work area.
6.4.2 Sufficient seating will be supplied for mentors to remain in a supervisory capacity close to the student work area.
6.4.3 Mentors are not permitted to repair robots or be involved in programming of their team's robots.
6.4.4 Mentor interference with robots or referee decisions will result in a warning in the first instance. If this recurs, the team will risk being disqualified.
6.4.5 Robots have to be mainly students' own work. Any robot that appears to be identical to another robot may be prompted for re-inspection.

## 6.5 Ethics and Integrity

6.5.1 Fraud and misconduct are not condoned. Fraudulent acts may include the following:

a) Mentors working on the software or hardware of students' robot(s) during the competition.

b) "Higher league group" and/or more advanced group of students may provide advice, but should not do the work for "Lower league group". For example, a secondary group helped to fix its peer primary group's work,

software or hardware prior to and/or during the competition. This may risk the secondary group to be disqualified as well. See "Code of Conduct, 6.4.3 & 6.4.5“. This applies not just to mentors, but also to higher league (advanced) group of students as well.

6.5.2 RoboCupJunior reserves the right to revoke an award if fraudulent behavior can be proven after the awarding ceremony took place.

6.5.3 If it is clear that a mentor intentionally violates the code of conduct, and repeatedly modifies and works on the students' robot(s) during the competition, the mentor will be banned from future participation in RoboCupJunior competitions.

6.5.4 Teams that violate the code of conduct can be disqualified from the tournament. It is also possible to disqualify only a single team member from further participation in the tournament.

6.5.5 In less severe cases of violations of the code of conduct, a team will be given a warning. In severe or repeated cases of violations of the code of conduct, a team can be disqualified immediately without a warning.

## 6.6 Sharing

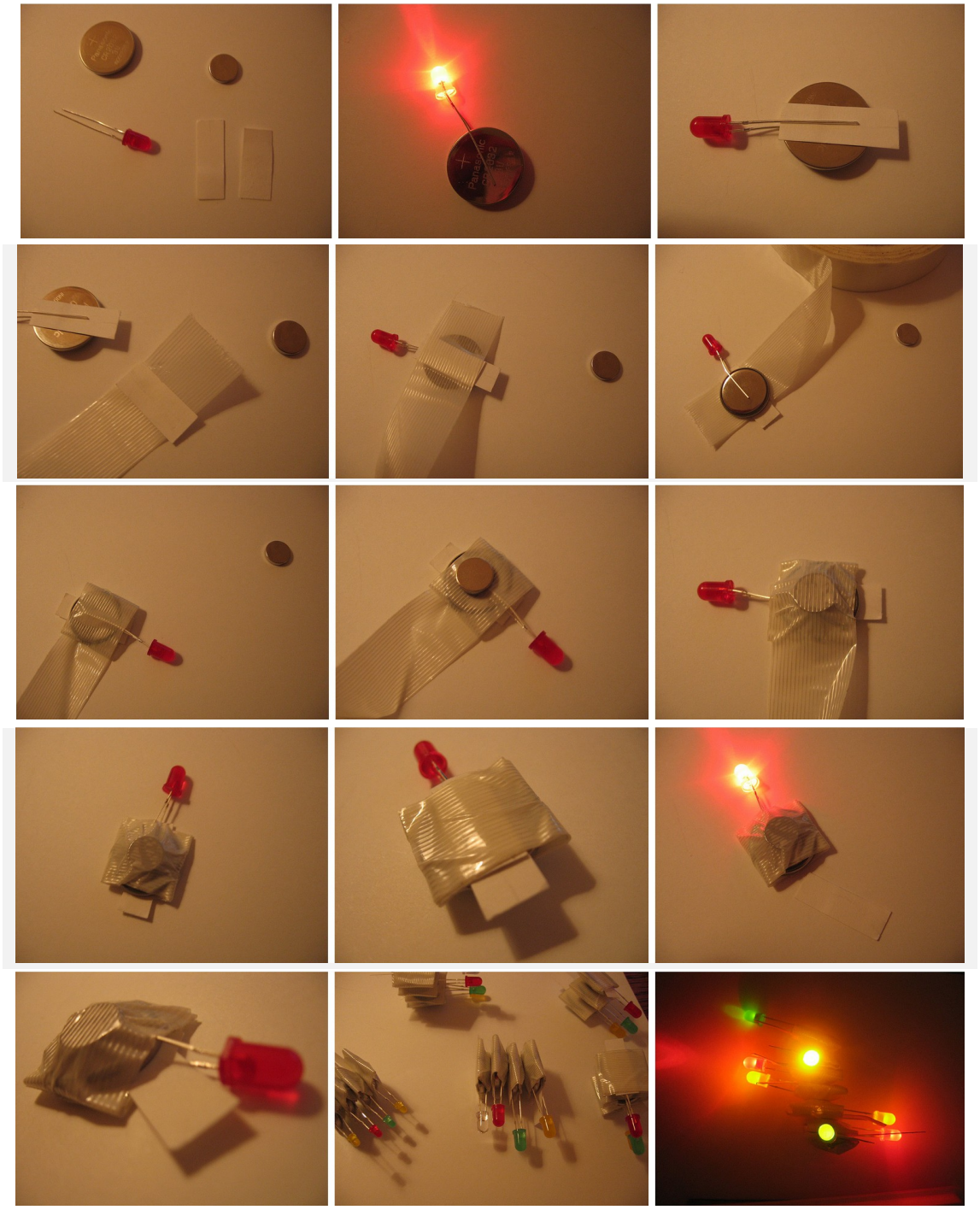
6.6.1 The spirit of world RoboCup competitions is that any technological and curricular developments should be shared with other participants after the tournament.

6.6.2 Any developments may be published on the RoboCupJunior website after the event.

6.6.3 Participants are strongly encouraged to ask questions to their fellow competitors to foster a culture of curiosity and exploration in the fields of science and technology.

6.6.4 This furthers the mission of RoboCupJunior as an educational initiative.

# A. Suggested instructions to build LED Throwies (Rescue kits)



## References


Joyce, A. (n.d.). *LED Throwies with On/Off Tab How-To.* Retrieved October 2013, from Flickr: http://www.flickr.com/photos/everythingdigital/sets/72057594069888500/