

NORMATIVA GENERAL

VERSIÓN: 27 AGOSTO 2025



FUTURE ENGINEERS

RESUELVE UN RETO CON
ROBÓTICA AVANZADA

AGE GROUPS:

14-22

WRO® 2025 SELF-DRIVING CARS

WRO international premium partner



WRO international gold partners



INTRODUCCIÓN

La robótica educativa es una plataforma maravillosa para aprender las habilidades del siglo XXI. Esforzarse por encontrar una solución a retos robóticos fomenta la innovación y desarrolla la creatividad y las habilidades de resolución de problemas en los estudiantes. Debido a que en la robótica convergen múltiples materias curriculares, los estudiantes deben aprender y aplicar sus conocimientos de ciencia, tecnología, ingeniería, matemáticas y programación.

La parte más gratificante del diseño de robots es que los estudiantes se diviertan. Deben trabajar juntos como un equipo e ir descubriendo sus propias soluciones. Los entrenadores les guían a lo largo del camino, pero deben dejar que ellos solos consigan sus propios aciertos y errores. Los estudiantes prosperan si encuentran un ambiente de apoyo y aliento de la propia responsabilidad. De esta manera el aprendizaje ocurre de manera tan natural como el respirar.

Al final de una competición justa, los estudiantes deberían poder decir que lo hicieron lo mejor que pudieron, que aprendieron y que se divirtieron.

WORLD ROBOT OLYMPIAD

La World Robot Olympiad es una competición de robótica diseñada por la World Robot Olympiad Association. En España está gestionada por Fundación educaBOT, quien actúa como organizador nacional de la WRO Spain.

1. INFORMACIÓN GENERAL

Introducción

En el reto Future Engineers los equipos deben centrarse en todas las partes del proceso de ingeniería, documentando su trabajo y haciendo un repositorio público de GitHub. Cada año se introducen variaciones en el reto, que cambia de temática cada 4-5 años.

En el desafío del coche autónomo, un vehículo robótico debe conducir de forma autónoma en un circuito que cambia aleatoriamente en cada ronda.

Áreas de desarrollo

Cada reto de la WRO tiene un enfoque especial en el aprendizaje con robots. En el reto Future Engineers los estudiantes se desarrollan en las siguientes áreas:

- Utilización de visión artificial y fusión de sensores para estimar el estado del circuito y del propio vehículo.
- Desarrollo de un vehículo con hardware abierto (componentes, controladores electromecánicos...).
- Planificación de acciones y control de robots con partes móviles y cinemática avanzada.
- Desarrollo de estrategias óptimas para resolver la misión, incluida la fiabilidad en la resolución.
- Trabajo en equipo, comunicación, resolución de problemas y gestión de proyectos.

Para ayudar a los equipos que se inician en el reto, se ha creado la guía Getting Started (accesible en <https://world-robot-olympiad-association.github.io/future-engineers-gs>) que explica más sobre los requisitos del vehículo, la posible solución técnica y posibles errores.

El aprendizaje es lo más importante

En la WRO queremos inspirar a los participantes hacia materias relacionadas con las STEM y queremos que los estudiantes desarrollen sus habilidades a través del aprendizaje lúdico. Es por ello que los siguientes aspectos son clave:

- Los entrenadores, padres u otros adultos pueden ayudar, guiar e inspirar al equipo, pero no está permitido que construyan o programen el robot.
- Los participantes y entrenadores aceptan los Principios Rectores y el Código Ético de la WRO, los cuales ayudan a hacernos conscientes de lo que significa una competición justa y llena de aprendizaje.
- En un día de torneo, los equipos y entrenadores respetan las decisiones de los árbitros y trabajan con los otros equipos y árbitros en una competición justa.

El Código Ético de la WRO se encuentra en www.wroboto.es/wp-content/uploads/Codigo-etico-WRO.pdf.

Cambios relevantes respecto de la normativa de 2024

Los cambios más importantes son:

- Ampliar la edad permitida a 22 años
- Eliminar el giro en la última ronda
- Ajustar las reglas sobre el estacionamiento (en paralelo)

2. DEFINICION DE EQUIPO Y GRUPOS DE EDAD

- 2.1. Un equipo consta de 2 o 3 participantes.
- 2.2. Un equipo es guiado por un entrenador.
- 2.3. Un participante y un entrenador no se consideran un equipo y no pueden participar.
- 2.4. Un equipo sólo puede participar en un único torneo local y reto.
- 2.5. Un participante solo puede formar parte de un equipo.
- 2.6. La edad mínima para ser entrenador es de 18 años.
- 2.7. Los entrenadores pueden trabajar con más de un equipo.
- 2.8. Los participantes pueden tener de 14 a 22 años (año de nacimiento de 2003 a 2011). Dichas edades reflejan la edad que el participante cumple durante el año, no su edad en el día del torneo.

3. RESPONSABILIDADES Y TRABAJO PROPIO DEL EQUIPO

- 3.1. Un equipo debe jugar limpio y ser respetuoso con los otros equipos, entrenadores, jueces y organizadores de la competición. Al competir en la WRO, los equipos y entrenadores aceptan el Código ético de la WRO, que se puede encontrar en www.wroboto.es/wp-content/uploads/Codigo-etico-WRO.pdf.

- 3.2. Todos los miembros del equipo y el entrenador deben firmar el Código Ético de la WRO.
- 3.3. La construcción y programación del robot solo puede ser realizada por el equipo. La tarea del entrenador es acompañar al equipo y apoyarlos en caso de dudas o problemas, pero no hacer la construcción ni la programación del robot. Esto aplica tanto al día del torneo como durante la preparación.
- 3.4. Durante un torneo un equipo no tiene permitida la comunicación de ninguna manera con personas fuera del área de competición. Si la comunicación fuera necesaria, se realizará bajo la supervisión de un juez.
- 3.5. Los miembros del equipo no pueden traer y usar teléfonos móviles o cualquier otro dispositivo de comunicación en el área de competición.
- 3.6. No está permitido destruir o alterar los tableros de competición, así como materiales o los vehículos de otros equipos.
- 3.7. No está permitido participar con una solución (hardware y/o software) que sea:
 - Igual o muy similar a las soluciones vendidas o publicadas en línea, entre ellos vehículos construidos a partir de kits modulares
 - Igual o muy similar a otra solución presente en el torneo
 - No producto del trabajo del equipo.Es decir, todo el código ha de haber sido programado directamente por el equipo. Por tanto, no se admite el uso de bloques, código, subrutinas o funciones de programación desarrollados por personas ajenas al equipo.
- 3.8. Si se sospecha el incumplimiento de las reglas 3.3 y/o 3.7, los jueces podrán entrevistar a un equipo o miembros individuales del equipo sobre el robot y/o el programa.
- 3.9. A partir de la información obtenida, los jueces pueden decidir sobre una o más de las siguientes consecuencias:
 - No permitir que el equipo participe en alguna ronda o en todo el torneo.
 - Permitir que el equipo participe, pero sin obtener puntuación.
 - Asignar el 50% de la puntuación obtenida.
 - No calificar para un torneo de nivel superior (nacional, internacional).

We would like to highlight some recurring rule violations that have led to penalties in previous competitions. Please keep these points in mind to avoid unnecessary delays for adjustments during the competition and to prevent penalties:

- Drive Systems: The drive wheels must be physically connected, for example, through a gearbox. It is not allowed to use one motor per side (see rules 10.3 and 10.5).
- Starting Procedure: The robot must follow the starting procedure as outlined in the rules: one button to turn the robot on and another button to start the program. Additional interactions are not permitted (see rules 8.10 and 8.11).
- GitHub Repositories: GitHub repositories must remain online and publicly accessible for at least one year after the event. If this requirement is not met, the repository will be republished by the WRO Association (see chapter 6).
- Independent Robot Development: Robots must be developed independently by each team (see chapter 3). Joint development of robots with minor adjustments to make them appear different at first glance is not allowed. Such robots will still be classified as identical. This behavior is considered deliberate deception and constitutes a violation of the Ethics Code.

4. DOCUMENTOS DE LOS RETOS Y JERARQUÍA DE REGLAS

- 4.1. Cada año, la WRO Association publica nuevos documentos con las reglas para los retos y sus categorías. Estas reglas son la base para los torneos internacionales de la WRO.
- 4.2. Durante la temporada se pueden publicar en el apartado WRO Questions & Answers (accesible en <https://wro-association.org/competition/questions-answers>) respuestas que pueden aclarar, extender o redefinir reglas en los documentos inicialmente publicados.
- 4.3. Los documentos de los retos pueden ser diferentes en un país debido a adaptaciones locales a través de su organizador nacional. El presente documento define la normativa general para el reto Future Engineers de la WRO Spain y es la que se aplicará en los torneos que organice.
- 4.4. En los torneos internacionales solo es relevante la información que ha publicado la WRO Association. Los equipos que se clasifiquen para cualquier torneo internacional de la WRO deben informarse sobre las posibles diferencias con su normativa local.
- 4.5. En los torneos organizados por la WRO Spain se aplicará la siguiente jerarquía de reglas:
 - La normativa general del reto (este documento).
 - Las preguntas y respuestas (Q&A's), siempre que no contradigan directamente algún aspecto incluido en la normativa general.

Los árbitros tienen la última palabra en la interpretación y aplicación de la normativa y, por tanto, en cualquier decisión que afecte a la competición.

5. GAME DESCRIPTION AND GAME FIELD

The self-driving car challenges in this season are Time Attack races: there will not be multiple cars at the same time on the track. Instead, one car per attempt will try to achieve the best time by driving several laps fully autonomously. The two challenges are the following:

Open Challenge: The vehicle must complete three (3) laps on the track with random placements of the inside track walls.

Obstacle Challenge: The vehicle must complete three (3) laps on the track with randomly placed green and red traffic signs. The traffic signs indicate the side of the lane the vehicle must follow. The traffic sign to keep to the **right side** of the lane is a **red pillar**. The traffic sign to keep to the **left side** of the lane is a **green pillar**. The vehicle should not move any of the traffic signs. After the robot completed the three rounds, it has to find the parking lot and has to perform parallel parking.

The starting direction in which the car must drive on the track (clockwise or counterclockwise) will vary in different challenge rounds. The starting section of the car as well as the number and location of traffic signs are randomly defined before the round (after the check time). The following graphic shows the game field with the game objects.

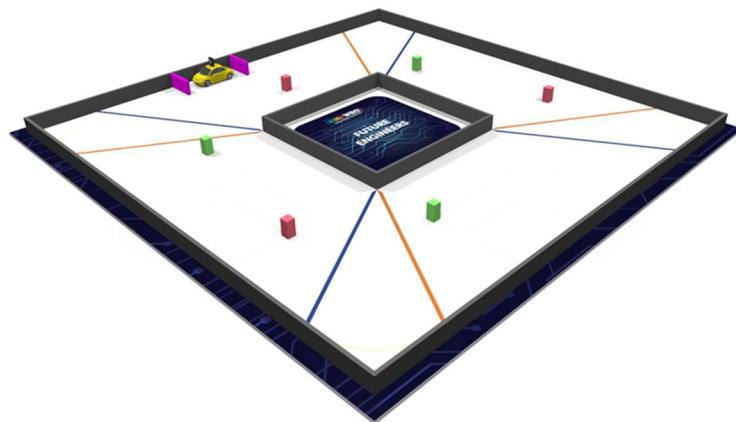


Figure. Detailed game field.

The game field represents a racetrack where traffic signs (represented by the coloured obstacles - pillars) are set up.

The track consists of eight sections: four corner sections and four straightforward sections. Corner sections are marked with red dashed lines on the Figure 2. Straightforward sections are marked with blue dashed lines.

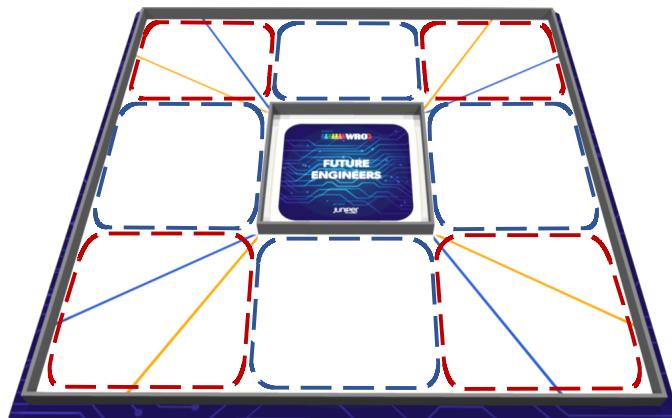


Figure. Different types of sections on the game field

Every straightforward section is divided into 6 zones. Six internal zones within the section are for starting position of the car. 4 T-intersections and 2 X-intersections are used to position the traffic signs. The places where the traffic signs can be set up are called traffic signs' seats.

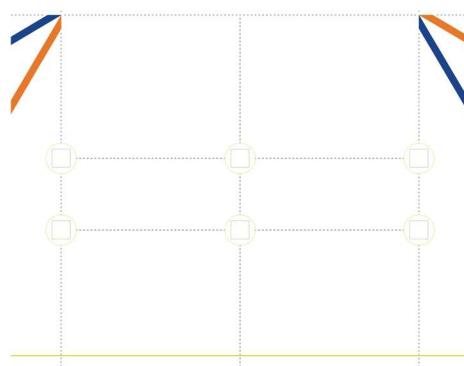


Figure. Zones and traffic signs' seats in the straightforward section

In the obstacle challenge a parking lot is placed in the straight forward section that is used to start the robot. The width of the parking lot is always 20 cm. The length is variable and calculated: $1,5 * \text{length of the robot}$.

The parking lot is limited by two wood elements with 20 cm x 2 cm x 10 cm in magenta. The right element is placed right next to the dotted line. The position of the left one is defined as described above.

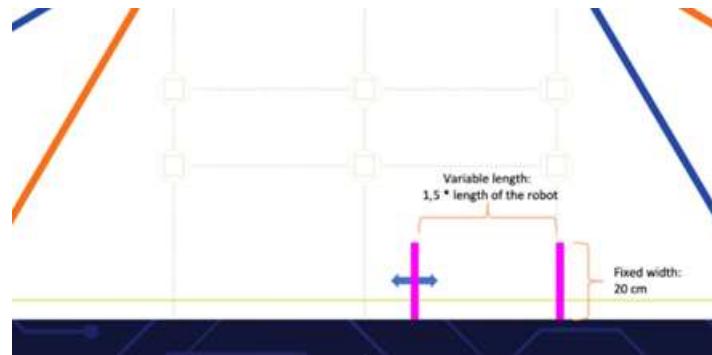


Figure: Definition of size of the parking lot

6. ENGINEER'S DOCUMENTATION

Real engineering is about learning or creating a solution and sharing with a community to bring the whole idea a step further. In addition to designing and programming the vehicle, teams must provide an engineering journal that presents their engineering progress and the final vehicle and code result. This journal must be uploaded to the GitHub public repository, and a hardcopy must be submitted at the international final. Details about the scoring of the documentation can be found in Chapter 14 of this document. For the international competition, all information and documentation on GitHub must be done in English.

Each team must provide the following:

- Discussion, information and motivation for the vehicle's mobility, power and sense, and obstacle management.
- Photos of the vehicle (from every side, from top and bottom), and a team photo.
- URL to YouTube (should be either public or accessible by link) showing the vehicle driving autonomously. That part of the video where driving demonstration exists, must be at least 30 seconds in length. One video for each challenge must be provided.
- Link to a GitHub **public** repository with the code for all components which were programmed to participate in the competition. The repository may also include the files for models used by 3D printers, laser cutting machines and CNC machines to produce the vehicle elements. The history of commits should contain at least 3 commits:
 - the first commit not later than 2 months before the competition – it must contain not less than 1/5 of the final amount of the code.
 - The second commit not later than 1 month before the competition.
 - The third commit not later than 2 weeks before the competition.
 - More commits are allowed.

The repository must contain a README.md file with a short description in English (not less than 5000 characters) of the designed solution. The goal of the description is to clarify which modules the code consists of, how they are related to the electromechanical

components of the vehicle, and what is the process to build/compile/upload the code to the vehicle's controllers. A template for the GitHub repos is available on <https://github.com/World-Robot-Olympiad-Association/wro2022-fe-template>.

The repository has to be public from the moment when it is submitted for an international competition and has to stay public at least 12 months after the competition. The idea of Future Engineers is to encourage new teams and support them in finding existing solutions and get inspired by them. If a repository is not public before the event, the team will get reduced points for the documentation. WRO Association has the right to republish the repository at any time.

- GitHub repositories must be set for public viewing and the content must be visible.
- Code provided on GitHub and Hard Copy must be well documented with comments in the code. Judges might not have access to the specific programs used by teams to develop their code, e.g. EV3, Spike or Scratch.

7. CHALLENGE ROUNDS

There will be two types of challenge rounds, Open Challenge and Obstacle Challenge. The direction for each challenge round, the starting position and the layout of the track will be chosen randomly by tossing a coin after the check time. The direction in which the vehicle must move during the challenges is defined as the challenge driving direction.

Open Challenge rounds

During Open Challenge rounds, the racetrack will have no traffic signs.

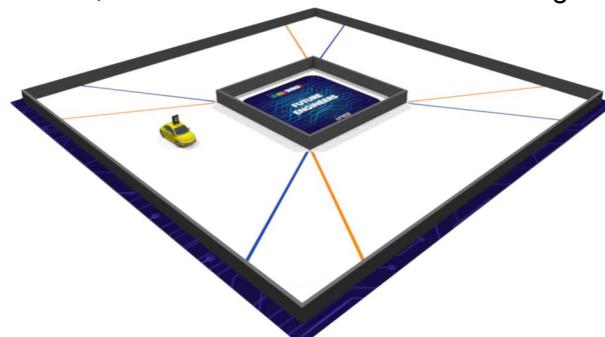


Figure. The game field for Open Challenge rounds

The distance between the track borders could be either 1000 mm or 600 mm (+/- 100 mm).

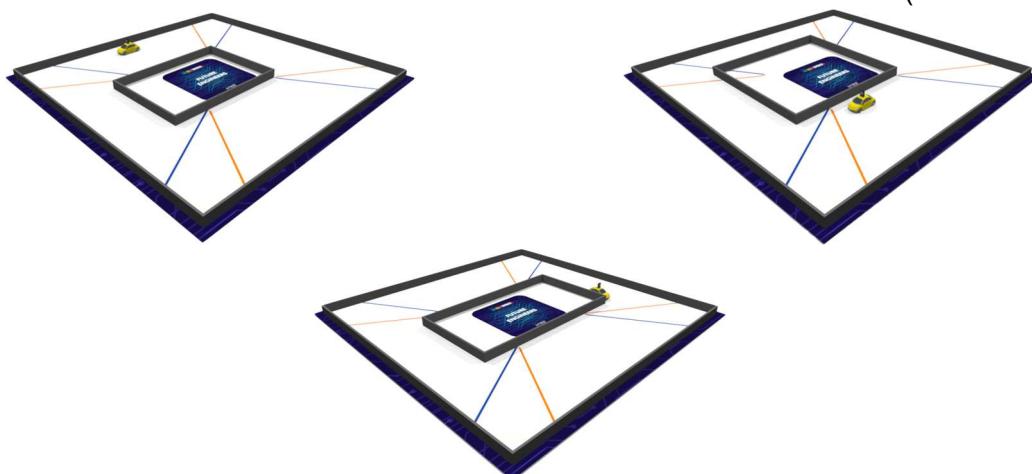


Figure. Examples of the game field variation for Open Challenge rounds

Obstacle Challenge rounds

During Obstacle Challenge rounds, the red and green pillars will be set up on the racetrack as the traffic signs. In addition, two boundaries will be placed and form a parking lot. The distance between the track borders will be always 1000 mm (+/- 10 mm).

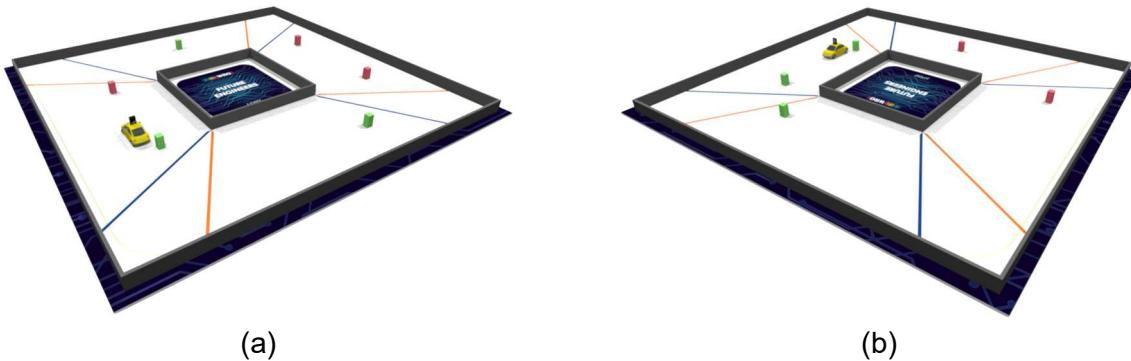


Figure. Examples of the game field for Obstacle Challenge rounds

In the straight section with the parking lot, no traffic signs can be placed on the positions close to the outer wall. This avoids, that traffic signs block the access to the parking lot.

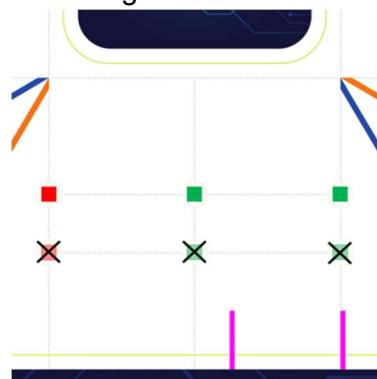


Figure: Allowed and forbidden positions for traffic signs near a parking lot

Randomization

Multiple randomizations with the layout for Open and Obstacle Challenge rounds will be prepared. One of them will be drawn after the robot check, directly before the round.

The following configurations are randomized:

- Open Challenge: driving direction, starting position, placement of the inner walls
- Obstacle challenge: driving direction, starting position, number and positions of the traffic lights, position of the parking lot

8. SPECIFIC GAME RULES

Challenge Round Timing

- 8.1. Open Challenge rounds will be three minutes in length.
- 8.2. Obstacle Challenge rounds will be three minutes in length.

Start Configuration

- 8.3. The direction to drive the track is chosen randomly before Open Challenge round in the series, after the check time.
- 8.4. The starting position of the vehicle and the field configuration are determined before starting every round, after the check time.
- 8.5. The direction to drive, starting position, and the field configuration remain the same for all teams during the same round.

Round Start

- 8.6. The vehicle is placed in the starting zone totally switched off.
- 8.7. The position of the vehicle in the starting zone must be so the projection of the car on the game mat is completely within the start zone.
- 8.8. The vehicle must be oriented so that the two wheels on the front axle (the judges must ask the team in advance which is axle is a front one) are located closer to the next corner section in the round driving direction whereas other two wheels are located closer to the corner section in opposite direction.
- 8.9. Physical adjustments can be made (this is part of the preparation time). However, it is not allowed to enter data to a program by changing positions or orientation of the vehicle parts or to make any sensor calibrations on the vehicle. It is not allowed to enter data by changing the switches configuration, if any. If a team does enter data through physical adjustments, it will be disqualified for that round.
- 8.10. The vehicle is then switched on. Only one switch is allowed to switch the vehicle on.
- 8.11. After vehicle is switched on, the vehicle should then be in a waiting state. Waiting for a Start button to be pressed. The Start button could be on the main SBC/SBM or a separately installed Push Button. Only one Start button is allowed. On a LEGO EV3, only one program will be allowed. The run button must be pressed to start the last program that was run on the EV3. The EV3 must then wait for a start button to be pressed. The start button on the EV3 can be a touch sensor or the right arrow button. On a LEGO Spike robot only Slot One can be used. The same procedure for the EV3 must be followed.
- 8.12. It is the responsibility of the team to check the layout of the racetrack and make sure it is correct. The judge will ask if the team is ready. The team must answer "Yes" to show their acceptance of the racetrack layout. No re-starts will be allowed if the team realised after the start, that the racetrack layout was not correct.
- 8.13. A judge gives the signal to start the vehicle. Judge will count "Three, two, one, Go". On the "Go" command the starting button is then pressed and the time for the attempt is started. The vehicle will have the amount of time to complete the round that is mentioned in the Game Rules.
- 8.14. Pressing the start button must start the vehicle action to attempt the challenge round and the vehicle should start moving.

Additional Pieces

- 8.15. The vehicle is not allowed to leave additional pieces on the game field or leave marks that are not removable (e.g. paint) during the round intentionally. If the vehicle violates this rule, the round will be stopped and the vehicle must be stopped by one of the team's members. The score for this round will be zero and the time mark will be the maximum. The judges have the right to inspect the team's code if they suspect such a situation.

During the Round

- 8.16. The vehicle must drive in the direction that was defined as the challenge driving direction before the challenge start.
- 8.17. The vehicle's dimensions must not exceed 300x200 mm and 300 mm in height.
- 8.18. The vehicle is not allowed to *move* the walls (if they are not completely fixed on the field). The vehicle that violates this rule will be stopped by one of the team's members, the score for this round will be zero and time mark will be the maximum. If the vehicle touches or bumps on the walls, and the walls are *not moved*, the vehicle may continue the round, and no penalties will be incurred. If the vehicle bumps or touches the walls and the vehicle stops as a result of bumping or touching, a repairing action can be done, and penalties will be incurred. During the open challenge rounds the vehicle may not touch the outer boundary wall.
- 8.19. The vehicle must pass the traffic sign represented by the red pillar on the right (the picture a) and the traffic sign represented by the green pillar on the left (the picture b). The chapter 13 section 5 defines, when a traffic light was passed on the wrong side and how it is scored.

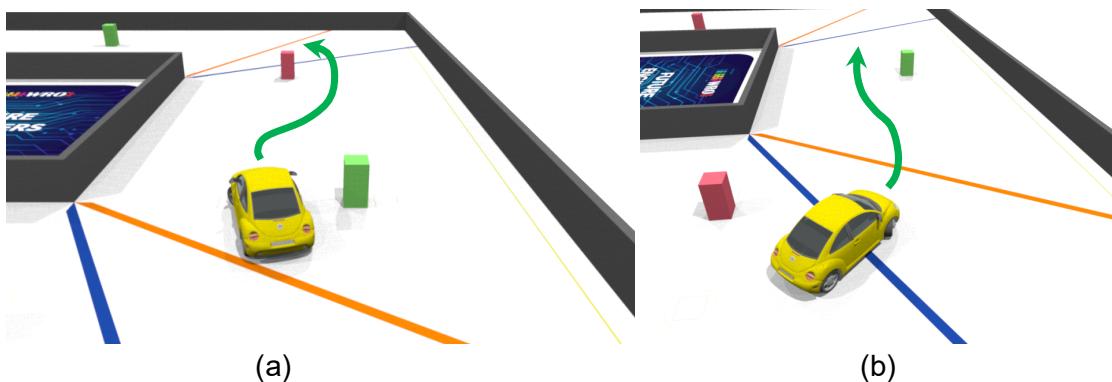


Figure. The rules to pass the traffic signs

- 8.20. The vehicle is allowed to touch, move or knock down the traffic signs (coloured pillars) while the projection of the traffic sign is within the circle drawn around the traffic sign's seat. For more details refer to Chapter 13, section 1.
- 8.21. The vehicle is allowed to drive in the direction opposite to the round driving direction for two sections only: the section where the direction was changed and the neighbouring section.
- 8.22. The vehicle must return to the starting section after driving three laps to get additional points. Note: as soon as the vehicle partially leaves the starting section this section also becomes the finish section.
- 8.23. Once per round the team can ask permission for repairing actions: to take the vehicle out, fix the issue with mechanical or electronic parts, and put the vehicle back to the track in the centre of the section the vehicle was taken out of. The vehicle may be switched off when it is removed from the track. The vehicle may be switched on after it is put down on the track. The vehicle may then be switched on and put into motion again by pressing the start button. The round timer will not be stopped for the repairing action. The permission can be granted only if the vehicle has stopped. Possible reasons for the stop, are issues with electronics/mechanics or because the vehicle hit the wall and is stuck, or the vehicle just stops for no reason. The permission will not be granted for a moving vehicle – if any

of its parts drives for approximately 50 mm in 5 seconds. The permission will not be granted if the vehicle has started the third lap (completely passed the corner section before the last lap). It is not allowed to upload programs on any controller of the vehicle as part of repairing actions. It is not allowed to enter any data. The team that violates these rules will be disqualified from this round: the score for this round will be zero and the time mark will be the maximum.

Round End

8.24. The round ends and time is stopped if any of the following conditions occurs:

8.24.1. The round timer expires.

8.24.2. In Open Challenge: After three complete laps the vehicle stops in the finish section so that the projection of the vehicle on the field is completely within the section. For more details refer to Chapter 13, section 2.

Note 1: the vehicle must stop in the finish section autonomously. If team participant forces the end of the round by using one of the methods described below when the vehicle is within the finish section, this will not be considered an autonomous stop and points for stopping in the finish section will not be assigned.

Note 2: to demonstrate a complete stop in the finish section, the vehicle must not continue driving after 15 seconds. If after the end of the round the vehicle continues moving, judges could find the behaviour of the vehicle ambiguous and may not assign a point for the stop in the finish section.

8.24.3. In Open Challenge: After three complete laps the vehicle passes the finish section so that its projection on the mat is completely within the corner section next to the finish section in the round driving direction. For more details refer to Chapter 13, section 3. The vehicle crosses section boundaries twice while driving in the direction which is opposite to the round driving direction. For more details refer to Chapter 13, section 4.

8.24.4. In Obstacle Challenge: After 3 rounds have been completed correctly, the vehicle stops. Either in the correct section or in the parking lot.

8.24.5. In Obstacle Challenge: After passing a traffic sign from the incorrect side, the vehicle completely crosses the line which goes from the inner border to the outer border and where this traffic sign is located. For more details refer to Chapter 13, section 5.

8.24.6. In Obstacle Challenge: The robot moved a traffic sign outside of the circle.

8.24.7. In Obstacle Challenge: The robot touches the parking lot limitations.

8.24.8. The vehicle's dimensions exceed the limit, after 3-minute repairing time.

8.24.9. Any team member touches the vehicle without the judge's permission for repairing actions.

8.24.10. Any team member touches the field mat and wall without the judge's permission for repairing actions.

8.24.11. Any team member touches the game elements.

8.24.12. The vehicle drives outside of the track (by moving the wall) or outside of the game field.

8.24.13. The vehicle or team member damages the field or a game element.

8.25. Notice that, according to the above rules, the team can stop their attempt (e.g. by touching the field wall or doing any of the above rules). However, they will not be able to resume the attempt after the stop and the round will be ended.

8.26. The judges will base their decisions on the rules and fair game play. They have the final decision on the competition day. If there is any uncertainty during the task completion, the judges will bias their decision to the worst outcome available for the context of the situation.

9. SCORING

- 9.1. The official score will be calculated at the end of each challenge round.
- 9.2. The maximum score is calculated as follow:
 - 9.2.1. 30 points for a Open Challenge round. ($1.1 + 1.2 + 1.3$)
 - 9.2.2. 62 points for a Obstacle Challenge round. ($1.1 + 1.2 + 1.3$ and either 1.4 (or 1.5) or 1.6 (or 1.7) + $1.8 + 1.9$)
 - 9.2.3. The engineering journal documentation will value 30 points (around 25% of the total maximum points)
 - 9.2.4. Maximum score is 122. ($\approx 75\%$ vehicle performance and $\approx 25\%$ documentation)

	Requirements	Point value	Total available
1.	Driving Open and Obstacle Challenge		
1.1	The vehicle drives from a section in the challenge driving direction. This is applicable for the starting section, but not applicable for the finish section and other section next after it.	1	24
1.2	The vehicle drives a full lap. 8 sections were passed successfully in the challenge driving direction. The starting section is included in the eight sections for the first lap. The lap is considered as completed if the vehicle completely drives out of the last (corner) section in the lap. So, the vehicle can start moving in the opposite direction after this and the lap will be still considered.	1	3
1.3	After the completion of three laps the vehicle stopped in the finish section.	3	3
	Additional points for Obstacle Challenge rounds:		
	Not completed three laps		
1.4	One or more traffic signs were moved in those sections which the vehicle passed through completely. Vehicle must complete at least one round to qualify for score.	2	2
1.5	The traffic signs were not moved in those sections which the vehicle passed through completely. Vehicle must complete at least one round to qualify for score.	4	4
	After the completion of three laps		
1.6	One or more traffic signs were moved.	8	8
1.7	No traffic signs were moved.	10	10
1.8.1	Vehicle started within the parking lot	7	7
1.8.2	Parking successfully (completely in the parking area and parallel)	15	15
1.8.3	Parking partly or not parallel in the parking area	7	7
2.	The team performed repairing actions by taking the vehicle out of the field even if the actions were not successful.	Total round points / 2	
3.	Engineering journal and vehicle documentation Chapter 14 for a breakdown of the engineering journal scoring.	30	

- 9.3. The time measured by a judge, the moment of the open challenge round ends, is written down and will be later used to identify the best round. If a team or vehicle was disqualified for the challenge round, the maximum time (3 minutes) is given for such a challenge round.
- 9.4. The score calculation is done by the judges at the conclusion of each challenge round. The team must verify and sign the score sheet after the round if they have no fair complaints.
- 9.5. The teams' ranks for Open Challenge rounds are based on points each team received in their best Open Challenge rounds. If a team has the same score in both rounds, the round with the smallest time will be chosen as the best Open Challenge round.
- 9.6. All teams will compete in both challenge rounds.
- 9.7. The teams' ranks for overall competition are built based on the sum of each team's points received in the best Open Challenge round, points received in the best Obstacle Challenge round and points received for the engineering journal and vehicle documentation. If a team has the same score in both Obstacle Challenge rounds, the round with the quickest time will be chosen as the best Obstacle Challenge round.
- 9.8. If there is a tie between two teams, ranking will be determined by considering the following results (the first in the list is the highest priority, the last in the list is the lowest priority):
 - Sum of points received in Open Challenge round, points received in the Obstacle Challenge round and points received for the engineering journal and vehicle documentation
 - Points of the best Obstacle Challenge round
 - Time for the best Obstacle Challenge round
 - Points of the second-best Obstacle Challenge round
 - Time for the second-best Obstacle Challenge round
 - Points for the engineering journal and vehicle documentation
 - Points for the best Open Challenge round
 - Points of the second-best Open Challenge round
 - Time for the best Open Challenge round
 - Time for the second-best Open Challenge round

10. VEHICLE MATERIAL & REGULATIONS

- 10.1. The vehicle's dimensions must not exceed 300x200 mm and 300 mm in height.
- 10.2. The weight of the vehicle must not exceed 1.5 kilograms.
- 10.3. The vehicle must be a 4 wheeled vehicle with one driving axle and one steering actuator of any type. It must be either front-wheel drive (https://en.wikipedia.org/wiki/Front-wheel_drive), rear-wheel drive (https://en.wikipedia.org/wiki/Rear-wheel_drive) or four-wheel drive (https://en.wikipedia.org/wiki/Four-wheel_drive). Teams with vehicles that use the differential wheeled base (https://en.wikipedia.org/wiki/Differential_wheeled_robot) will be disqualified.
Driving: making the vehicle move forward and backward.
Steering: turning the vehicle to the left or to the right.
- 10.4. The vehicle cannot use any kind of an omnidirectional wheel, ball caster or spherical wheel.

- 10.5. The use of an electronic differentials with one motor per side (like in a differential wheeled robot) is not allowed.
- 10.6. A vehicle must be autonomous and finish the “missions” by itself. Any radio communication, remote control, and wired control systems are not allowed while the vehicle is running. Teams in violation of this rule will be disqualified.
- 10.7. Participants are not allowed to interfere with or assist the vehicle while it is running (performing the "mission"). This includes entering data to a program by giving visual, audio or any other signals to the vehicle during the round. Teams that violate this rule will be disqualified at that round.
- 10.8. The controller used for the vehicle can be either Single board computer (SBC) (https://en.wikipedia.org/wiki/Single-board_computer) or Single board microcontroller (SBM) (https://en.wikipedia.org/wiki/Single-board_microcontroller) with no restriction on brand.
- 10.9. There could be more than one SBC/SBM on the vehicle.
- 10.10. Teams cannot use any kind of RF, Bluetooth, Wi-Fi or any kind of wireless communication components in their vehicles during the rounds. If it is built-in on the controller, it must be turned off and the judges can inspect the code and the vehicle in order to confirm that it is not used by any means.
- 10.11. Teams can use any sensors of their choice – there are no restrictions on brand, function or number of sensors used. Cameras are considered sensors. Smartphones can be used as cameras and to process image data.
- 10.12. Teams can use any electrical DC motors and/or servo motors of their choice – there are no restrictions on brand of motors and/or servos used.
- 10.13. A maximum of two motors may be used to make the vehicle move forward or backward (i.e., driving the robot, these are the driving motors). The driving motors must all be connected directly to the axle turning the wheels, or indirectly through a gearing system. The two driving motors may not be connected independently of each other to the driving wheels.
- 10.14. Teams can use any electronic components – there are no restrictions on the type, company, number or the purpose.
- 10.15. Teams can use any hydraulic pressure, barometric pressure equipment or solenoids.
- 10.16. Teams can use any battery of their choice – there are no restrictions on brand, function or number of batteries used.
- 10.17. Only wire connections are permitted for communication between vehicle electromechanical components.
- 10.18. Teams can use 3D printed elements, elements prepared with a CNC machine, elements cut from acrylic/wood/metal or any elements from any material – there are no restrictions on the purpose.
- 10.19. The vehicle can be built using any type of hardware kits and any material. There is no restriction on a specific type or a specific building system.
- 10.20. Teams can use electrical tape, elastic bands, cable wraps, nylon ties (tie wraps), etc. Any adhesive material is allowed to be used for any purpose.
- 10.21. Teams should bring enough spare parts. In the case of any accidents or equipment malfunction, WRO (and/or organizing committee) is not responsible for their maintenance or replacement.
- 10.22. Vehicles may be assembled before the tournament.
- 10.23. Control software can be written in any programming language – there are no restrictions on a specific language.
- 10.24. Contestants may prepare the program beforehand.

- 10.25. Teams should prepare and bring all the equipment, software and portable computers they need during the tournament.
- 10.26. The team is allowed to have only one vehicle for competition day. No spare vehicles are allowed inside the competition area.

11. COMPETITION FORMAT & RULES

Competition

- 11.1. The competition consists of several challenge rounds with practice time in between. After each practice time, there will be a vehicle check time to review the requirements.
- 11.2. Each team must work during practice time in their specified place until the check time, when the team's vehicle must be placed in a designated area (checking area).
- 11.3. On the day of the competition, there will be a minimum of 60 minutes of practice time before the start of the first round.
- 11.4. Teams cannot touch the designated competition areas before the start of the practice time is announced.
- 11.5. During practice time, the contestants may work in their places, or may queue with their vehicles to have one test attempt on the game field or may take measurements in the game field in so far as this does not interfere with other teams' test attempts. The maximum time allowed per team for one practice attempt is 4 minutes. After 4 minutes a team may fall in at the back of the que for another practice attempt. Teams are allowed to make changes to the program or to adjust the vehicle mechanically.
- 11.6. All vehicles must be placed on the reviewing table in the checking area for preparatory review (vehicle check) after the end of the practice period. All controllers of the vehicle must be powered off. No mechanisms or programs may be modified after this time.
- 11.7. Vehicles may take part in the competition only after they have passed the vehicle check. The check is concerning the requirements to the vehicle and materials used, as described in the sections above.
- 11.8. If a vehicle does not pass the vehicle check by the judges, the judges may provide a team up to 3 minutes to address issues found. Only one three minutes period can be provided by judges for a team per each check time slot.
- 11.9. If eventually a vehicle does not pass the vehicle check by the judges, the vehicle may not be used in the competition.
- 11.10. The team cannot exceed 90 seconds for preparation as soon as they are called by judges for participating in a particular challenge round, and once started, individual rounds may not exceed the challenge round time specified in the Game Rules.

12. GAME TABLE AND EQUIPMENT

Game Table & Field

- 12.1. Size of the game mat is 3200 x 3200 mm (+/- 5 mm). The internal square within the game mat is the race track with inner size 3000 x 3000 mm (+/- 5 mm).
- 12.2. The main colour of the track is white.
- 12.3. The track is surrounded by (exterior) walls with inner height 100 mm.
- 12.4. The inner colour of the exterior walls is black. The outer colour of the walls is not defined.

- 12.5. There exist additional (interior) walls surrounding the internal section of the track with the height 100 mm.

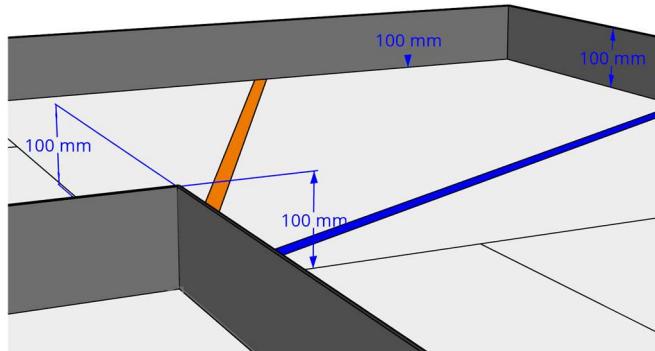


Figure. Height of the exterior and interior walls

- 12.6. The outer colour of the interior walls is black. The inner colour of the walls is black. The colour of the top edge of the walls is black.
- 12.7. The thickness of both exterior and interior walls is not defined.
- 12.8. The distance between exterior and interior walls depends on the match type and is specified in the Game Alternatives section.
- 12.9. There are orange and blue lines on the track. The thickness of the lines is 20 mm. The colour of the orange lines is CMYK (0, 60, 100, 0). The colour of the blue lines is CMYK (100, 80, 0, 0).
- 12.10. There are dashed lines with thickness 1 mm on the field to bound the vehicle's starting zones. The colour of dashed lines is CMYK (0 0 0 30).
- 12.11. The size of every starting zone is 200 x 500 mm.
- 12.12. There are squares to identify places where traffic signs could be located. The line thickness of the traffic sign seat is 1 mm and the colour of the line is CMYK (0 0 0 30).
- 12.13. The size of every traffic sign seat is 50x50 mm.
- 12.14. The area to evaluate if a traffic sign is moved is specified as a circle around the corresponding traffic sign's seat. The thickness of the circle line is 0.5 mm. The colour of the lines is CMYK (20 0 100 0).

- 12.15. The diameter of the circle is 85 mm.

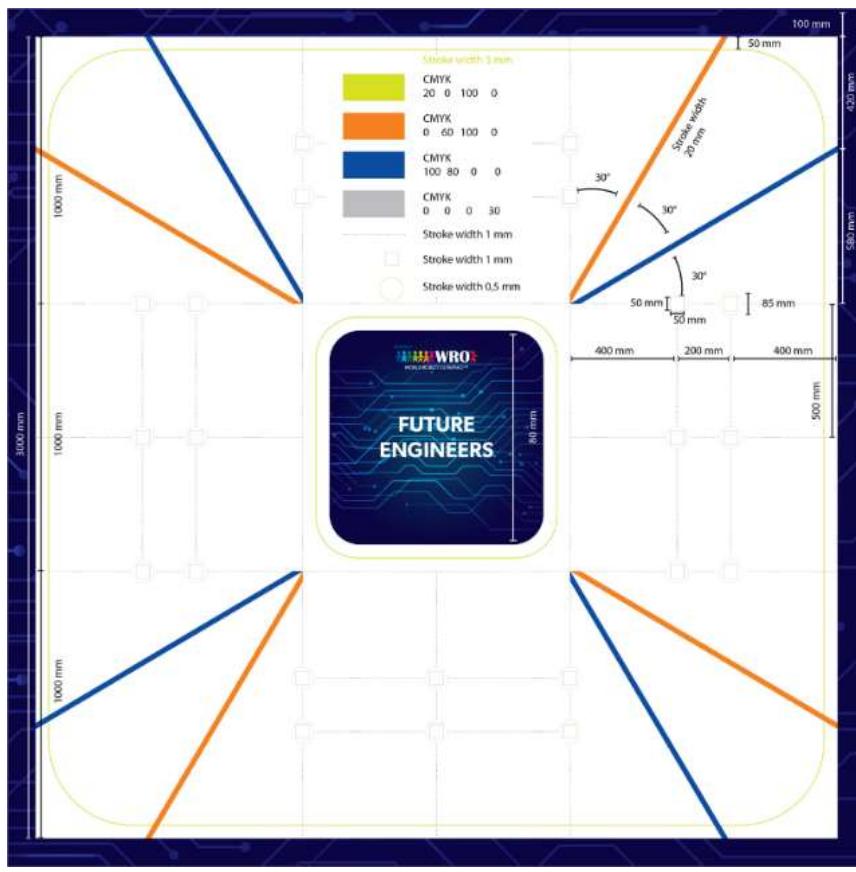


Figure . The game field map with sizes

Walls configuration

- 12.16. The inner walls will be placed in a square or rectangular shape according to the draw. The outer walls will be fixed in a square shape and will not change during challenges.
- 12.17. The colour of the walls will be black.
- 12.18. Although everything will be done by the organisers get the colours of the field mat and field objects as close as possible to the CMYK specification, differences might still appear. Teams will have the opportunity to calibrate and fine tune their vehicles to the colours on the board and field objects during testing rounds.

Traffic Signs

- 12.19. Every traffic sign is a rectangular parallelepiped with dimensions 50x50x100 mm.
- 12.20. Depending on the randomization process before every match there could be: up to 7 red parallelepipeds and up to 7 green parallelepipeds.
- 12.21. The colour of the red traffic signs is RGB (238, 39, 55).
- 12.22. The colour of the green traffic signs is RGB (68, 214, 44).
- 12.23. The material of the traffic sign is not defined.
- 12.24. The weight of the traffic sign is not defined.

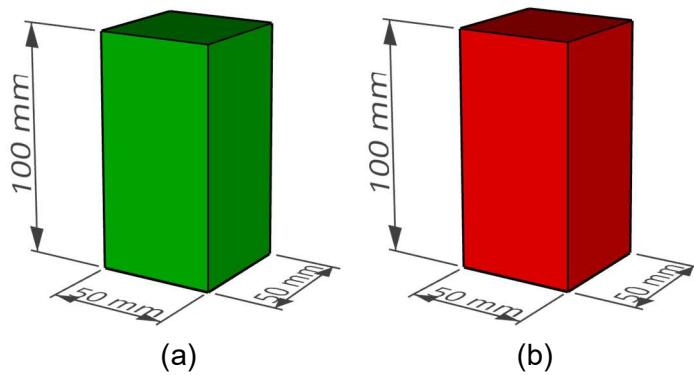


Figure. Dimensions of the traffic signs

Parking lot limitations

- 12.25. Every parking lot limitation is a rectangular parallelepiped with dimensions 200x20x100 mm.
- 12.26. One parking lot with two parking lot limitations is in each obstacle challenge round placed on the mat.
- 12.27. The colour of the parking lot limitation is magenta / RGB (255, 0, 255).
- 12.28. The material of the traffic sign is not defined.
- 12.29. The weight of the traffic sign is not defined.

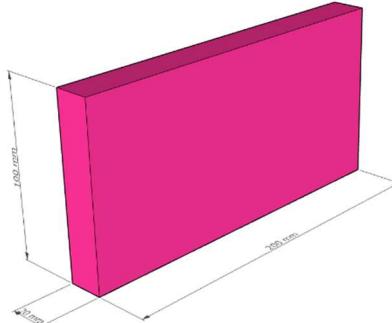


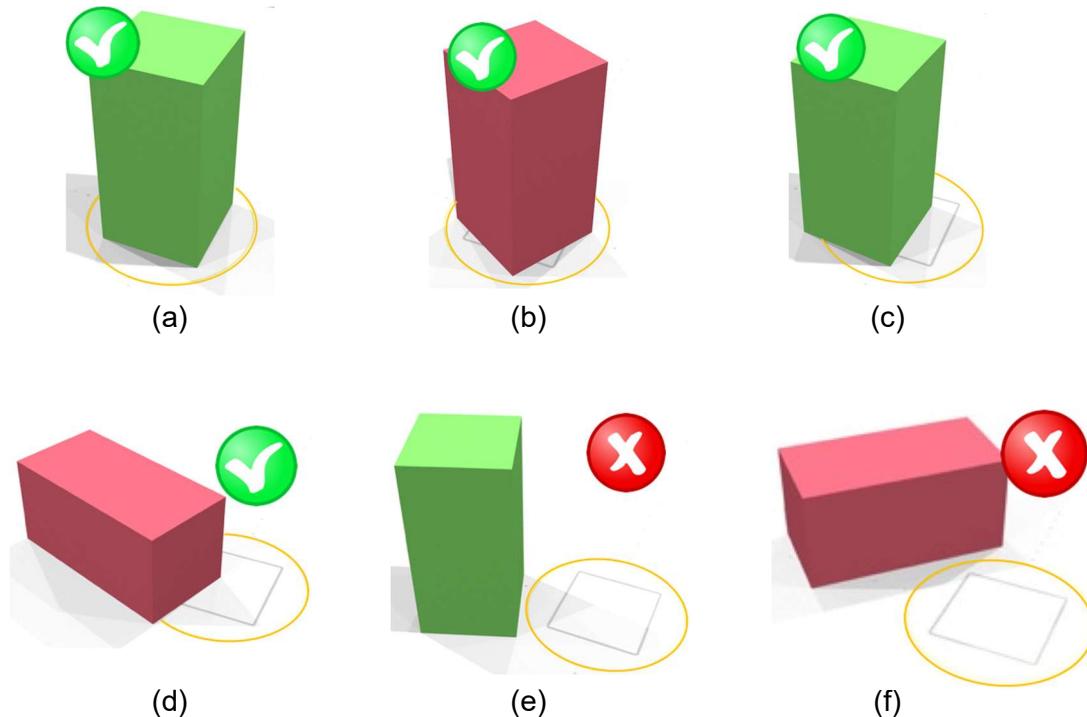
Figure: Dimensions of the parking lot limitations

13. EXPLANATORY SCHEMES

13.1 Meaning of moved or knocked down traffic sign

On the schemes below the traffic signs are considered as:

- (a) – not moved: initial position of the traffic sign at the match start
- (b) – not moved: the traffic sign is not on the seat but still within the circle
- (c) – moved but does not cause the match stop: the traffic sign is partially outside of the circle and considered as moved
- (d) – knocked down but does not cause the match stop: knocked down traffic sign is partially outside of the circle
- (e) – moved and causes the match stop: the traffic sign is moved completely outside of the circle
- (f) – knocked down and causes the match stop: knocked down traffic sign is completely outside of the circle



13.2. Conditions to get points for finishing in the starting section

To identify if the vehicle finished within the starting section or not, the projection of the vehicle on the mat is used after full stop. If any part of the projection is outside of a straightforward section where the starting zone is located, the vehicle is considered outside of the starting section.

Consideration if the vehicle is within the starting zone or not is possible only if the vehicle stopped and has not moved for at least 30 seconds.

The starting zone on the schemes below is marked by the green colour.

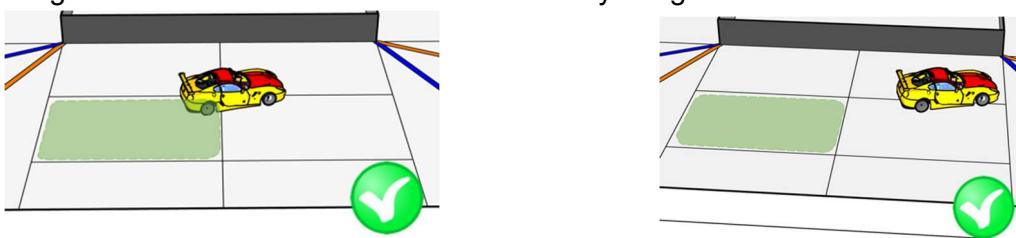


Figure. The vehicle finished completely within the starting section

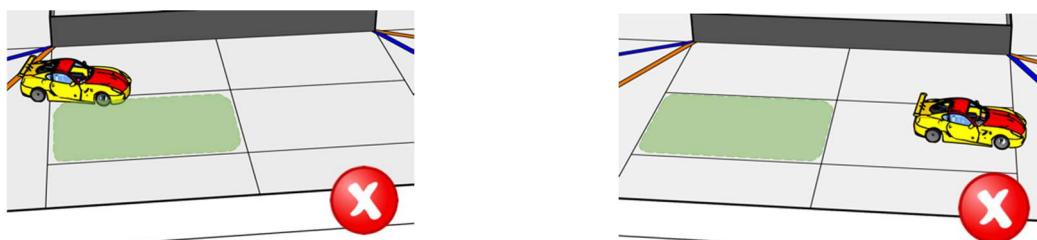
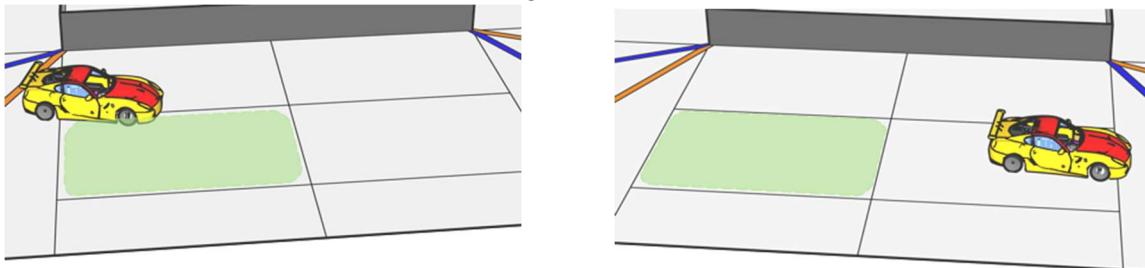


Figure. The vehicle finished outside of the starting section

13.3. Passing the starting section after three laps

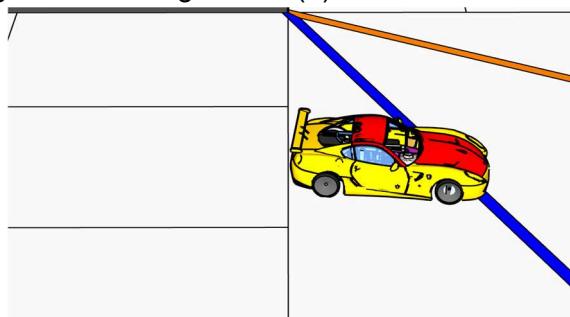
The judges will end the round as soon as the vehicle passes the starting section after driving three laps.

When three laps are completed, the following phases are possible:



(a) the vehicle is driving to the starting zone

(b) the vehicle is driving out of the starting zone

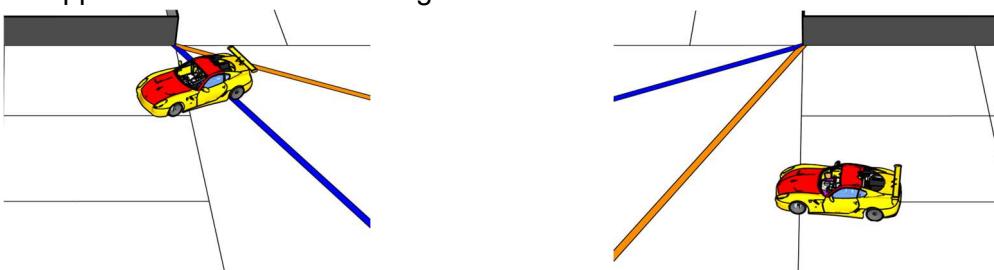


(c) the vehicle has passed the starting zone

Figure. Phases of passing the starting zone by the vehicle moving CCW

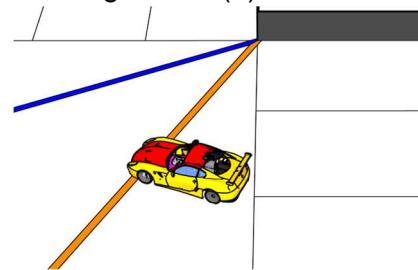
If the vehicle is still moving the judge will not stop time at the phases (a) and (b). But as soon as the vehicle is completely in the corner zone, the phase (c), the match will be ended.

The same is applicable if the match driving direction is clockwise.



(a) the vehicle is driving to the starting zone

(b) the vehicle is driving out of the starting zone



(c) the vehicle has passed the starting zone

Figure. Phases of passing the starting zone by the vehicle moving clockwise

13.4. Driving in the opposite direction

During the match the vehicle is allowed to drive in the direction opposite to the match driving direction for two sections only: the section where the direction was changed and the neighbour section.

Case 1: the vehicle started driving in the opposite direction and stopped completely within the neighbouring section

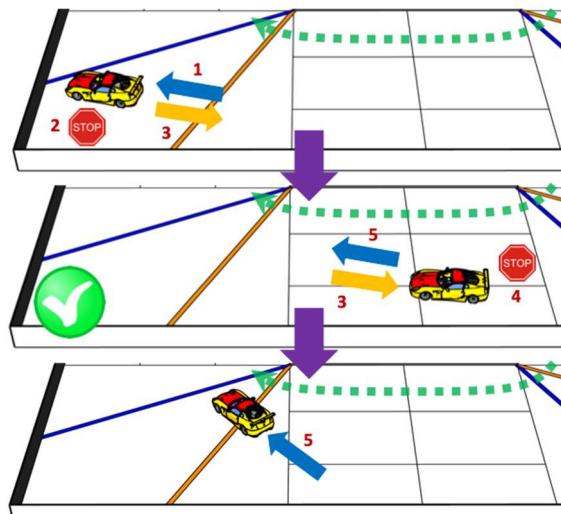


Figure. Allowed driving in the opposite direction from the corner section

On the figure above the match driving direction is clockwise (presented by the green dotted arrow near to the wall):

- phase 1: the vehicle arrived in the corner section
- phase 2: it stopped
- phase 3: it started driving back
- phase 4: the vehicle stopped in the straightforward section *without crossing the section boundary with the next section*
- phase 5: it continued driving in the match driving direction.

Such manoeuvre is allowed.

Case 2: the vehicle started driving in the opposite direction and stopped on the line between two sections

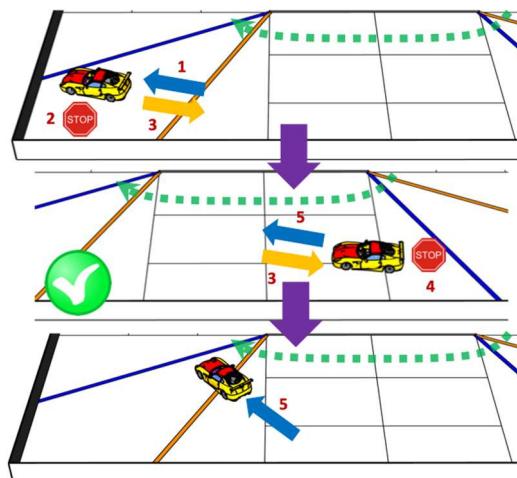


Figure. Allowed to stop at the boundary between the next section and the section after it while driving in the opposite direction

On the figure above the match driving direction is clockwise (presented by the green dotted arrow near to the wall):

- phase 1: the vehicle arrived in the corner section
- phase 2: it stopped
- phase 3: it started driving back
- phase 4: the vehicle stopped *at the boundary between the next section and the section after it*
- phase 5: it continued driving in the match driving direction.

Such sequence of movements is also allowed

Case 3: the vehicle started driving in the opposite direction and moved completely outside the neighbouring section

If the vehicle passes the boundary between the neighbour section and the section after it, the match will be stopped.

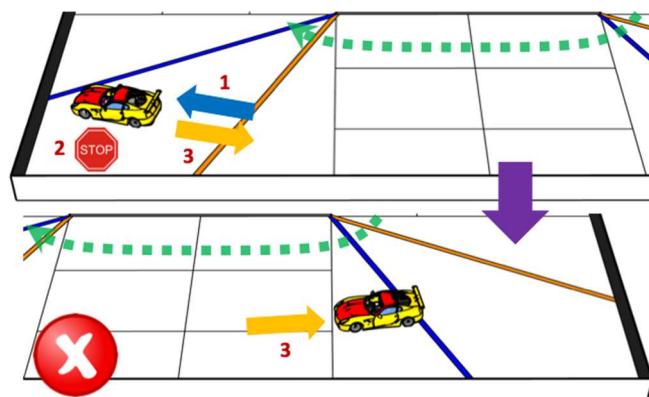


Figure. Moving completely outside of the neighbour section while driving in the opposite direction is not allowed

On the figure above:

- phase 1: the vehicle is initially moving in the match driving direction which is clockwise (presented by the green dotted arrow near to the wall)
- phase 2: it stopped

- phase 3: it started driving in the opposite direction and crosses two sections as so it is completely outside of the neighbouring section.

Case 4: the vehicle changed the direction on the border between two sections

If the vehicle changed the direction when its projection on the field crossed the line between two sections, the forward section is considered as the first one to determine the farthest section which is allowed to drive in the opposite direction.

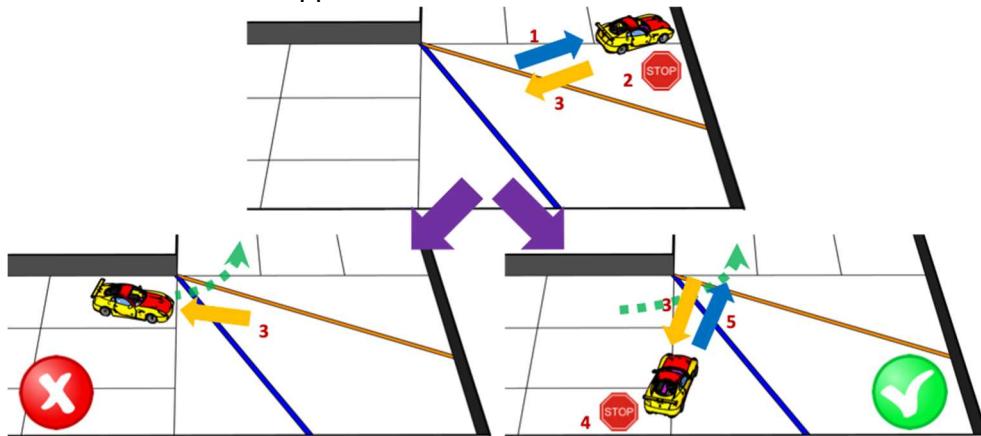


Figure. The farthest section to drive in the opposite direction when the vehicle stopped partially in the section

On the left side of the figure above the final of the following scenario is considered:

- phase 1: the vehicle initially drove through track CCW (reflected by the green dotted arrow near to the wall)
- phase 2: it stopped on the line between two sections – the forward section in the match driving direction is considered as the section where the direction was changed
- phase 3: it continued driving in the opposite direction and passed completely the section which is the neighbour to the section where the direction was changed.

Such behaviour will lead to the immediate stop of the match.

The scenario in which the match continues is considered:

- phase 1: the vehicle initially drove through track CCW (reflected by the green dotted arrow near to the wall)
- phase 2: it stopped on the line between two sections – the forward section in the match driving direction is considered as the section where the direction was changed
- phase 3: it changed the direction and started moving in the opposite direction
- phase 4: the vehicle stopped at the border of two sections
- phase 5: it continued driving CCW

Since the vehicle's projection is still partially in the neighbouring section the match is not stopped.

Case 5: changing the direction several times

The vehicle is allowed to change the direction several times but the farthest section to drive in the opposite direction is considered based on the closest to the finish section where direction was changed the first time:

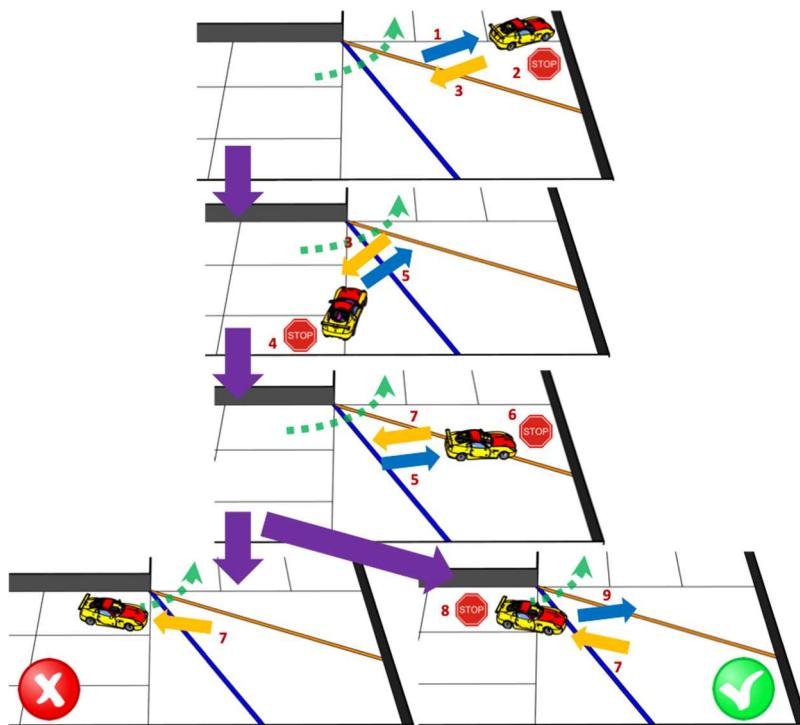


Figure. Allowance of changing the direction several times considered based on the closest to the finish section

The figure above allows to consider different outcomes for the case when the vehicle is changing the direction several times:

- phase 1: the vehicle initially drove through track CCW (reflected by the green dotted arrow near to the wall)
- phase 2: it stopped on the line between two sections – the forward section in the match driving direction is considered as the section where the direction was changed
- phase 3: it changed the direction and started moving in the opposite direction
- phase 4 and 5: the vehicle stopped in the neighbouring section – next to the section where the direction was initially changed then continued moving in the correct direction
- phase 6 and 7: the vehicle changed direction one more time but this is not taken into account since the previous section where the direction was changed to opposite is closer to the finish
- if the vehicle completely goes out of the neighbouring section driving opposite the math will be stopped (the left side of the figure)
- if only part of the vehicle's projection is in the section next to the neighbouring section, this will not be considered as a reason to stop the match (the right side of the figure)

Case 6: Driving back-to-front

Driving back-to-front is allowed if the vehicle is being moved in the round driving direction.

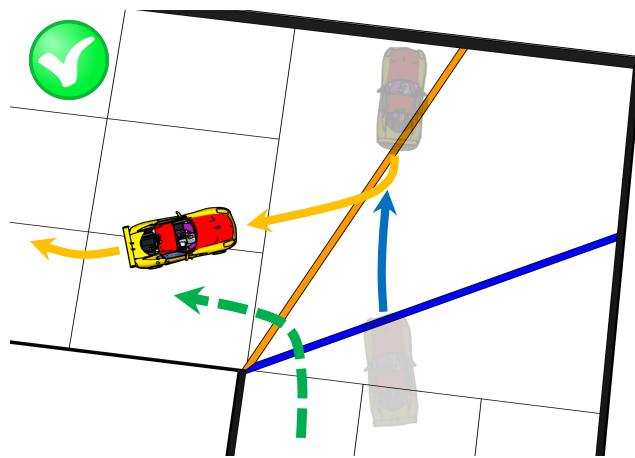


Figure: Back to front driving in the round driving direction

In this direction the rules to pass the traffic signs are applied to the vehicle in the same manner: the red pillar must be passed from the right; the green pillar must be passed from the left.

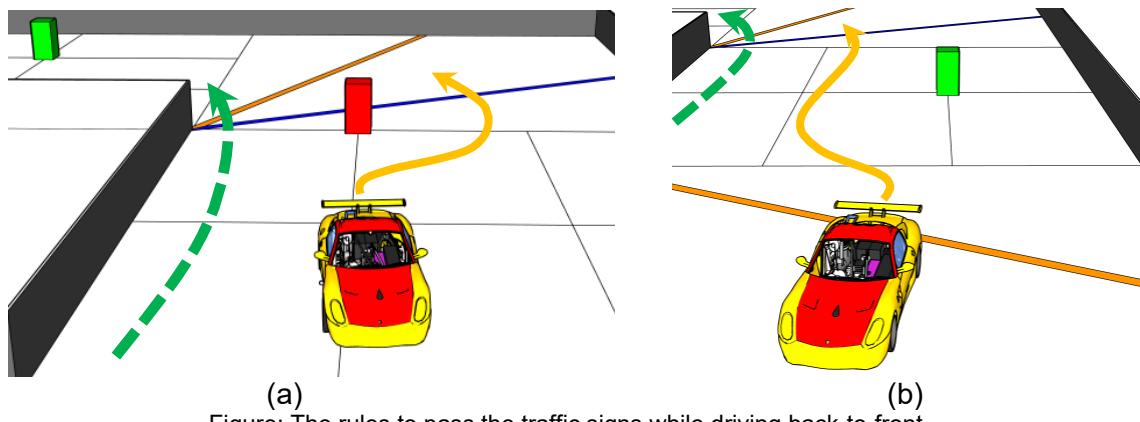


Figure: The rules to pass the traffic signs while driving back-to-front

13.5. Passing traffic signs from the incorrect side

Although it is not allowed to pass traffic signs from the incorrect side, a threshold exists that can be used by the vehicle to recognize the fault state and fix the behaviour.

If the vehicle started passing the traffic sign improperly the time will not be stopped if the vehicle does not pass completely the line that goes from the interior wall to the exterior wall (later, – radius) and where the traffic sign is located.

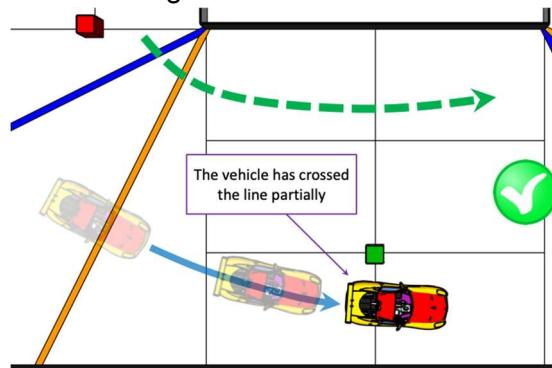


Figure. The vehicle does not pass the radius while driving from the right of the green pillar

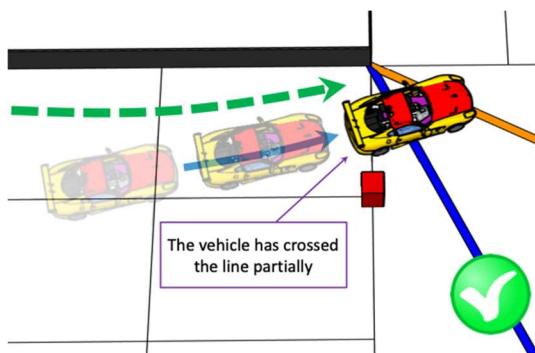


Figure. The vehicle does not pass the radius while driving from the right of the red pillar

As soon as the radius is completely crossed by vehicle judges will stop the match

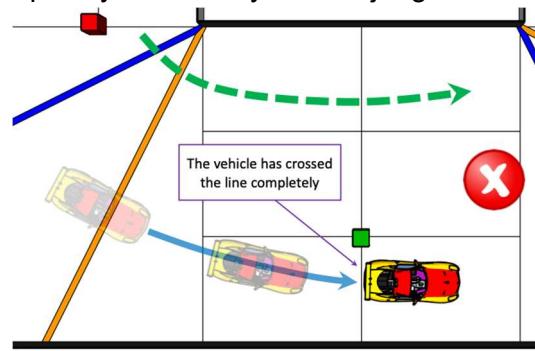


Figure. The vehicle completely crosses the radius from the right side of the green pillar

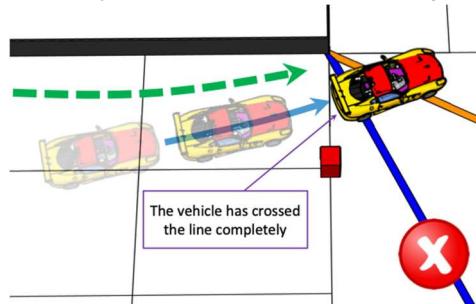


Figure. The vehicle completely crosses the radius from the left side of the red pillar

The same is applicable for the case when the vehicle is moving back-to-front in the match driving direction

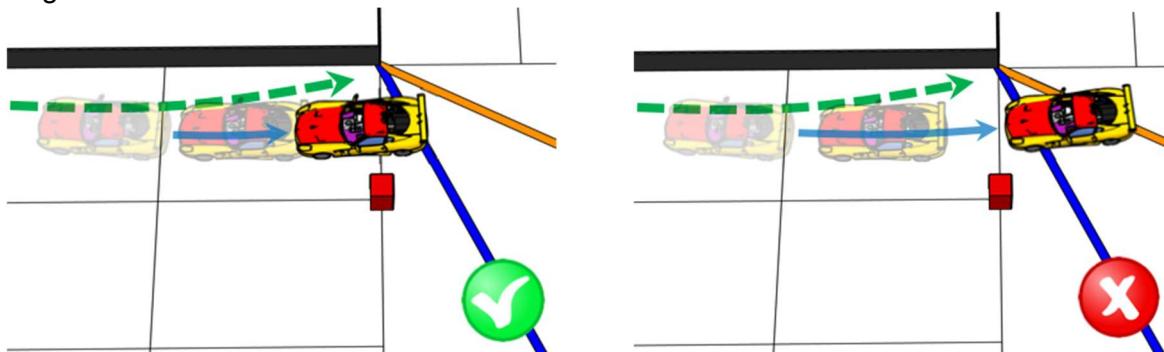
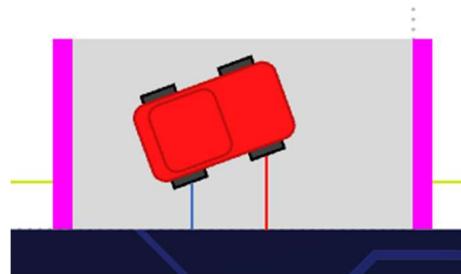
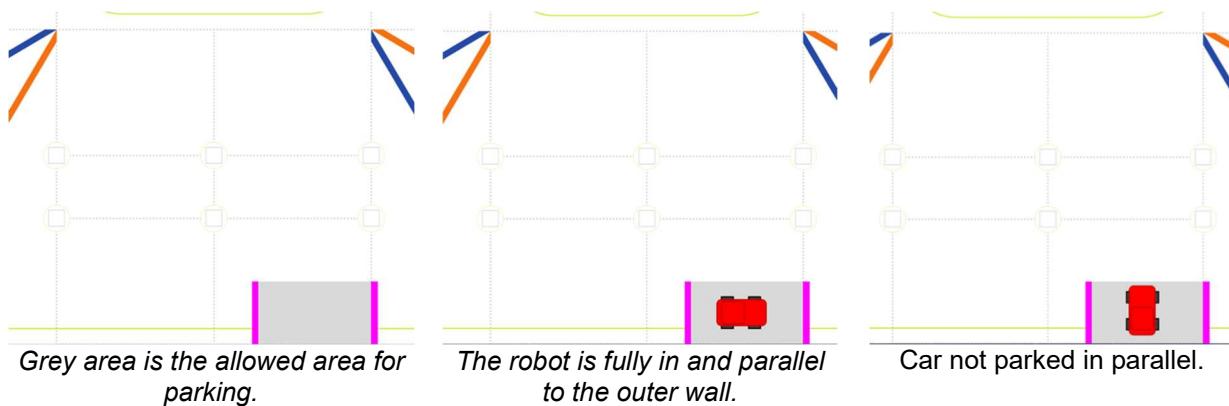


Figure. The vehicle passes the radius while driving back-to-front

In the Obstacle challenge traffic signs only have to be obeyed on the three official laps. On the subsequent route to the parking lot, they can be bypassed to the right or left as desired. Moving them is still not permitted.

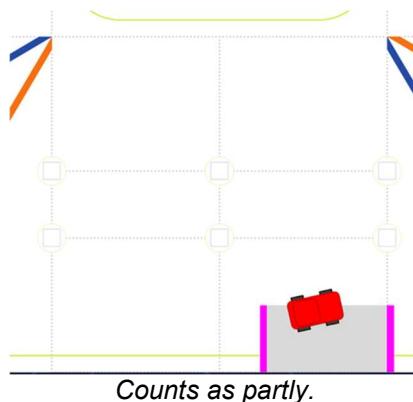
13.6. Parking in the parking lot

A robot is considered fully parked, when the projection of the robot on the mat is fully inside the rectangle between the two markers of the parking lot (marked in grey in the pictures) and the robot is parked in parallel to the wall of the game field. The robot is considered to be parallel if the distances between the two wheels on one side and the wall do not differ by more than 2 cm.



If it is unclear whether the robot has been parked parallel, the distance between the wheels on one side and the wall is measured. The two main driving wheels will be used for measurements. If the difference between the two distances is greater than 2 cm, the robot is not considered to be parked parallel.

The robot is considered partly parked, when the projection of the robot on the mat is only partly inside the parking lot.



The parking lot limitations cannot be touched by the robot. When they are touched, the robot is stopped and no points for the parking can be scored.

14. ENGINEERING JOURNAL EVALUATION

The following guideline will be used to evaluate the engineering journal and vehicle documentation. Below is the list of scoring items and criteria for every item:

Scoring Area	Maximum Score
1. Mobility Management	4
2. Power and Sense Management	4
3. Obstacle Management	4
4. Pictures – Team and vehicle	4
5. Performance videos	4
6. GitHub utilization	4
7. Engineering Factor	4
8. Overall Judge impression	2
Total Score	30

The process to perform the vehicle documentation evaluation could be the following:

1. There are at least three judges which who will evaluate the documentation.
2. Every judge gets familiar with the vehicle documentation and provides his evaluation for every scoring item as per described criteria. The judge is not allowed to skip any scoring item. No discussion between judges is allowed at this moment. The evaluation of the item is based on the judge's understanding of the criteria and his feeling about how the corresponding criteria is reflected in the documentation – this is not a comparison of documentation materials provided by several teams between each other.
3. Average value for every scoring item is calculated based on the judges' marks.
4. The sum of all averaged scoring items is the total for the vehicle documentation for any particular team.

Rubric scale explanation

No evidence or discussion provided	Nothing provided
Inadequate	Too little information or information provided is not understood.
Needs improvement	Sufficient information is provided but it is clear that the effort cannot be duplicated.
Meets expectations	An exact duplication by another team can be made effortless from the information provided
Exceeds expectations	Not only can an exact duplication be made from the information provided, but information on improvements is also provided.

Rubric for judging engineering documentation

1	Mobility Management	
	Mobility management discussion should cover how the vehicle movements are managed. What motors are selected, how they are selected and implemented. A brief discussion regarding the vehicle chassis design /selection can be provided as well as the mounting of all components to the vehicle chassis/structure. The discussion may include engineering principles such as speed, torque, power etc. usage. Building or assembly instructions can be provided together with 3D CAD files to 3D print parts.	
	No evidence or discussion provided	0
	Inadequate	1
	Needs improvement.	2
	Meets expectations.	3
	Exceeds expectations	4

2	Power and Sense Management	
	Power and Sense management discussion should cover the power source for the vehicle as well as the sensors required to provide the vehicle with information to negotiate the different challenges. The discussion can include the reasons for selecting various sensors and how they are being used on the vehicle together with power consumption. The discussion could include a wiring diagram with BOM for the vehicle that includes all aspects of professional wiring diagrams.	
	No evidence provided or discussion provided	0
	Inadequate	1
	Needs improvement.	2
	Meets expectations.	3
	Exceeds expectations	4

Support information for wiring diagrams:

1. <https://www.edrawsoft.com/wiring-diagram.html>
2. <https://www.smartdraw.com/wiring-diagram/>
3. <https://www.doityourself.com/stry/3-different-types-of-electrical-wiring-diagrams-explained>
4. <https://www.allaboutcircuits.com/projects/build-your-own-robot-design-and-schematic/>

3	Obstacle Management	
	Obstacle management discussion should include the strategy for the vehicle to negotiate the obstacle course for all the challenges. This could include flow diagrams, pseudo code and source code with detailed comments.	
	No source code or discussion provided	0
	Inadequate	1
	Needs improvement.	2
	Meets expectations.	3
	Exceeds expectations	4

4	Pictures – Team and vehicle	
	Pictures of the team and robot must be provided. The pictures of the robot must cover all sides of the robot, must be clear, in focus and show aspects of the mobility, power and sense, and obstacle management. Reference in the discussion sections 1, 2 and 3 can be made to these pictures. Team photo is necessary for judges to relate and identify the team during the local and international competitions.	
	No Team or vehicle pictures provided	0
	Inadequate	1
	Needs improvement.	2
	Meets expectations.	3
	Exceeds expectations	4
5	Performance videos	
	The performance videos must demonstrate the performance of the vehicle from start to finish for each challenge. The videos could include an overlay of commentary, titles or animations. The video could also include aspects of section 1, 2 or 3.	
	No video evidence provided	0
	Inadequate	1
	Needs improvement.	2
	Meets expectations.	3
	Exceeds expectations	4
6	GitHub utilization	
	Git and GitHub are available for opensource project management and file version control. As part of the design and development process, teams must use this platform to document their progress, coding development and share files. Judging the platform will include how complete the information provided is, how information is structured and how often commits were done. Teams can use this platform to provide additional information on their engineering design and coding of their vehicle as well.	
	No evidence provided of GitHub use	0
	Inadequate	1
	Needs improvement.	2
	Meets expectations.	3
	Exceeds expectations	4

Support information for GitHub utilization:

1. <https://careerfoundry.com/en/blog/web-development/what-do-developers-use-github-for-heres-why-its-vital/>
2. [What is GitHub?](#)
3. <https://apiumhub.com/tech-blog-barcelona/using-github/>
4. <https://kinsta.com/knowledgebase/what-is-github/>
5. <https://en.wikipedia.org/wiki/GitHub>
6. <https://www.howtogeek.com/180167/htg-explains-what-is-github-and-what-do-geeks-use-it-for/>
7. <https://www.simplilearn.com/tutorials/git-tutorial>

7	Engineering Factor	
	No evidence provided or no description of design.	0
	Standard "Off the shelf" RC or modular construction kit with no design changes.	1
	Standard "Off the shelf" RC or modular construction kit with little design changes.	2
	Standard "Off the shelf" RC or modular construction kit with design changes and team added own designed components such as sensor mounts.	3
	Own Design and manufacturing of vehicle and components, with off the shelf electrical components, such as motors and sensors	4

8	Overall Judges impression	
	Info on GitHub is weak and poor communication of vehicle design and coding. Efforts cannot be duplicated.	0
	Info on GitHub is average communication of vehicle design and coding. Duplicating the efforts will not be easy.	1
	Info on GitHub is excellent communication of vehicle design and coding. It will be easy to duplicate the efforts.	2

15. MINIMAL SET OF ELECTROMECHANICAL COMPONENTS

The list below represents the list of equipment which can be used for electromechanical parts of the vehicle. This is suggestion rather than the requirements. Teams are on their own to follow these suggestions or not.

- a single board computer: it will be used for real time video processing, analysing sensor data, sending/managing signals to the motor controller.
- a single board microcontroller + a motor shield: this combination of equipment receives managing signals from the main SBC and operates with motors correspondingly.
- a wide-angle camera
- two distance sensors
- two light sensors
- servomotor: it controls steering
- DC-motor with gearbox: it controls the vehicle's velocity
- at least one encoder: it allows the vehicle to measure angular velocity of a DC motor
- IMU (inertial measurement unit) – this is usually a combination of gyroscope and accelerometer: it can be used to improve the vehicle navigation
- two batteries: one is for SBC and SBM, another is for motors
- a voltage stabilizer: it is required to provide adequate power supply for the SBC/SBM
- two switches to connect batteries to the power consumers: SBC/SBM, motors
- push button: it could be used as a trigger to start the round

An example vehicle configuration could be:

- Chassis from a Remote Controlled (RC) Car
- The main controller -- Raspberry Pi 3 (<https://www.raspberrypi.org/products/raspberry-pi-3-model-b-plus/>), and a MicroSD card to keep an operating system and programs.
- Camera module (<https://www.raspberrypi.org/products/camera-module-v2/>) with extra wide-angle lens

- The motor and sensor controller -- Arduino UNO (<https://store.arduino.cc/arduino-uno-rev3>) with a prototyping shield (<https://store.arduino.cc/proto-shield-rev3-uno-size>)
- DC Motor Controller (<https://www.robotshop.com/en/cytron-13a-5-30v-single-dc-motor-controller.html>)
- DC Motor to drive the vehicle (could be part of the chassis),
- Servo Motor for steering (could be part of the chassis)
- IMU sensor (<https://www.sparkfun.com/products/13762>)
- 2 Ultrasonic Distance Sensor (<https://www.sparkfun.com/products/15569>)
- 2 Analog Line sensors (<https://www.sparkfun.com/products/9453>)
- Rotary Encoder (<https://www.sparkfun.com/products/10790>)
- An external USB Battery with a hub to split the consumption between Raspberry Pi and Arduino
- Additional battery applicable to power the DC motor (could be part of the chassis)

16. CÓDIGO DE CONDUCTA

16.1. Comportamiento

- Durante todo el torneo se espera de los participantes y entrenadores un comportamiento adecuado al espíritu de la competición y al Código ético.
- Las reglas se aplicarán a discreción de los árbitros oficiales y los organizadores del torneo. No se permitirá el uso de interpretaciones de las reglas poco claras para tener ventaja.

16.2. Faltas graves

Cualquier falta grave puede comportar la descalificación del equipo del torneo:

- La destrucción de mesas, mobiliario, materiales o robots de otros equipos.
- Uso de objetos o acciones que puedan crear o causar interferencias a otros robots.
- Uso de palabras y/o comportamientos inapropiados hacia otros miembros del equipo, otros equipos, jueces, voluntarios o público.
- Voluntad de saltarse la normativa.
- Cualquier otra situación que los jueces puedan considerar como intromisión o violación del espíritu de la competición.

16.3. Competición justa

- Al competir en la WRO, los equipos y entrenadores aceptan sus Principios Rectores:
 - Se anima a los equipos a aprender y dominar nuevas habilidades mientras se divierten juntos.
 - Los entrenadores y padres están para guiar a los equipos, no para hacer el trabajo por ellos.
 - Participar y aprender son más importantes que ganar.
- Los equipos deben firmar el Código ético de la WRO y entregarlo antes de cada torneo.
- Si se rompe o infringe alguna de las reglas mencionadas en el Código ético, los árbitros pueden decidir según consideren:
 - No permitir que un equipo participe en alguna ronda o en todo el torneo.

- Permitir que el equipo participe, pero sin obtener puntuación.
- Asignar el 50% de la puntuación obtenida.
- No calificar para un torneo de nivel superior.

16.4. Copia de diseños y/o programación

Las siguientes faltas, que se consideran graves, comportarán la descalificación del equipo de un torneo:

- Presentar una solución (construcción y/o programación) que ha sido obtenida a través de Internet (venta o publicación).
- Presentar la misma solución (construcción y/o programación) que otro equipo. Se analizará cual de los equipos es el diseñador de la solución original y se decidirá si dicho equipo puede continuar en la competición.
- Presentar una solución (construcción y/o programación) en la que la ayuda por parte del entrenador o cualquier otra persona ajena al equipo ha ido más allá del lógico acompañamiento durante el proceso de aprendizaje.