JeuxDeGénie 2017

MACHINE DESIGN SPECIFICATION – 2017 ENGINEERING GAMES

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POLYTECHNIQUE MONTRÉAL

WORLD-CLASS ENGINEERING

VIDEO GAMES

TAKE CONTROL

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1. INTRODUCTION

This manual is intended to inform you about the machine design competition and its objectives. Considering the introduction of several new concepts in the rules of the game and its development, please read this manual seriously, paying particular attention to all sections. Refer to this manual at all times. Furthermore, if any disparities were to occur between the French and English version of this manual, the French version prevails on the English version.

This year, the difficulty of the machine design competition has been taken to the next level from a technical point of view. We therefore offer you a competition in which the machine teams from each delegation will compete two against two. This whole new challenge was designed to ensure that every team plays a minimum of 4 matchs during the machine design competition. Every machine team will be able to demonstrate the full potential of their design to everyone.

We hope that the challenge of the machine design competition will stimulate you and fuel your ingenuity to the best of your abilities.

The 2017 Engineering Games Team

1. INTRODUCTION

1.1 CONTEXT

Did you know that Princess Peach is a crazy Harry Potter fan? To better seduce her, Mario decided to organize a big tournament inspiring himself on the rules of Quidditch while keeping some habits he has in the Mushroom Kingdom.

Bowser, who is a big fan of robots himself, proposed to use mechanical equipments to replace the Quidditch players, which have to throw balls into the hoops. Furthermore, Mario proposed to climb a pole like when he declares his love for Princess Peach at the end of each Mario World level.

All of Peach and Mario's friends were therefore invited to participate in this fun challenge!

1.2 COOPERATION

The Engineering Games team worked hard to create for you a game of the highest standards, with multiple aspects and challenges, involving expertise in all engineering disciplines. In order to promote the creation of more elegant, functional and innovative machines, we wish that all teams participate actively in order to meet the challenge as it should be, and perform brilliantly.

We do not want a machine team trying to win the game by being "innovative" with their understanding of rules of the competition, but rather by being innovative with the mechanical concepts they use and the technical knowledge acquired throughout their studies. Consequently, we created a rule system involving penalties for a machine team that willfully infringes the rules of the game using questionable strategies and/or unsportsmanlike behavior.

Let's be clear, we do not want to have to apply these rules and distribute penalties during the matches, and we rely on the cooperation of each and every of the machine teams in order to achieve this goal.

1.3 DESCRIPTION OF THE CHALLENGE

This year, the challenge will take place on a rectangular field of 120 by 60 inches. Matches, with a duration of 2 minutes 15 seconds each, will be played by two machine teams against two other machine teams. Each alliance of two machine teams will have its own area in which they will be able to collect Quaffles (game balls), in order to mark goals in the offensive zone.

The goals will consist of three main poles having at their peak variable diameter rings, inspired by the hoops of the Quidditch game. In the middle of the field, in the neutral zone, the machines of each alliance will have to sneak under a central beam, or lower drawbridges, to cross in the enemy area or come back in their own area to recover more Quaffles.

A match begins with an autonomous period of 15 seconds, where robots will have the possibility to perform various preprogrammed actions to obtain a maximum of points. Four ball games will initially be arranged by the alliances along their middle line, which is one of the lines between the neutral zone and their own area.

The table below describes the score during this period :

Table 1 – Autonomous Period Score

Actions	Points
The robot gets to the neutral zone	1
The robot gets to the offensive zone by passing under the beam through the secret passage	1
The robot gets to the offensive zone by using the drawbridges	3
The robot puts a ball in one of the lower hoops	4
The robot puts a ball in the central hoop	6

1. INTRODUCTION

When the autonomous period ends, drivers can then take control of their robot using their remote control and control system, and thus begin to score as many points as possible by putting quaffles in the goals of the opposing alliance. In the controlled period, the points are distributed as follows :

Table 2 – Controlled Period Score

Actions	Points
The robot gets to the offensive zone by using the drawbridges	2 points by passage, for a maximum of 2 passages by robot by match
The robot puts a ball in one of the lower hoops	2
The robot puts a ball in the central hoop	3

In the last 25 seconds of the match, robots can make contact with one of the two poles located in one of the corners of their own area to climb it. If one of the robots is successful in rising from the ground by itself and by not touching anything else but the pole, as Mario does when capturing a flag, the alliance gets extra points. If that same robot manages to lift itself off the ground and gets over the mark on the pole, the alliance gets more extra points. The alliance with the most accumulated points at the end of the match wins.

Table 3 – Climbing Score

Actions	Points
The robot lifts itself off the ground and is touching nothing but the pole	6
The robot lifts itself off the ground, exceeds the mark on the pole and is touching nothing but the pole	12

1.4 VIDEO PRESENTATION

Like every year, each team will have to produce a video presentation of their machine. This video will count for 5 points on the final score of the competition. This video must be delivered to the organizing committee at the arrival of the delegation to the 2017 Engineering Games.

The evaluation criteria of the video presentation are the following :

Table 4 – Evaluation Criteria for the Video Presentation

Criteria	Points
Presentation of your team members and their role	0,5
Global presentation of your machine	1
Presentation of an innovative and original concept or idea	0,5
Originality of the video	1,5
Quality of the video	1,5

In addition, all delegations must give in their video according to the following requirements:

Format : USB Flash drive
Encoding : MPEG-4
Duration : 4 to 6 minutes

Please note that any video that does not respect the requirements set out above will be assigned the mark of 0/5, and will not be shown in public.

1.5 MID-TERM REPORT

As usual, a mid-term report must be submitted by November 29 at noon. This report must be sent by email in pdf format, to the following email address :

machine@jeuxdegenie.qc.ca

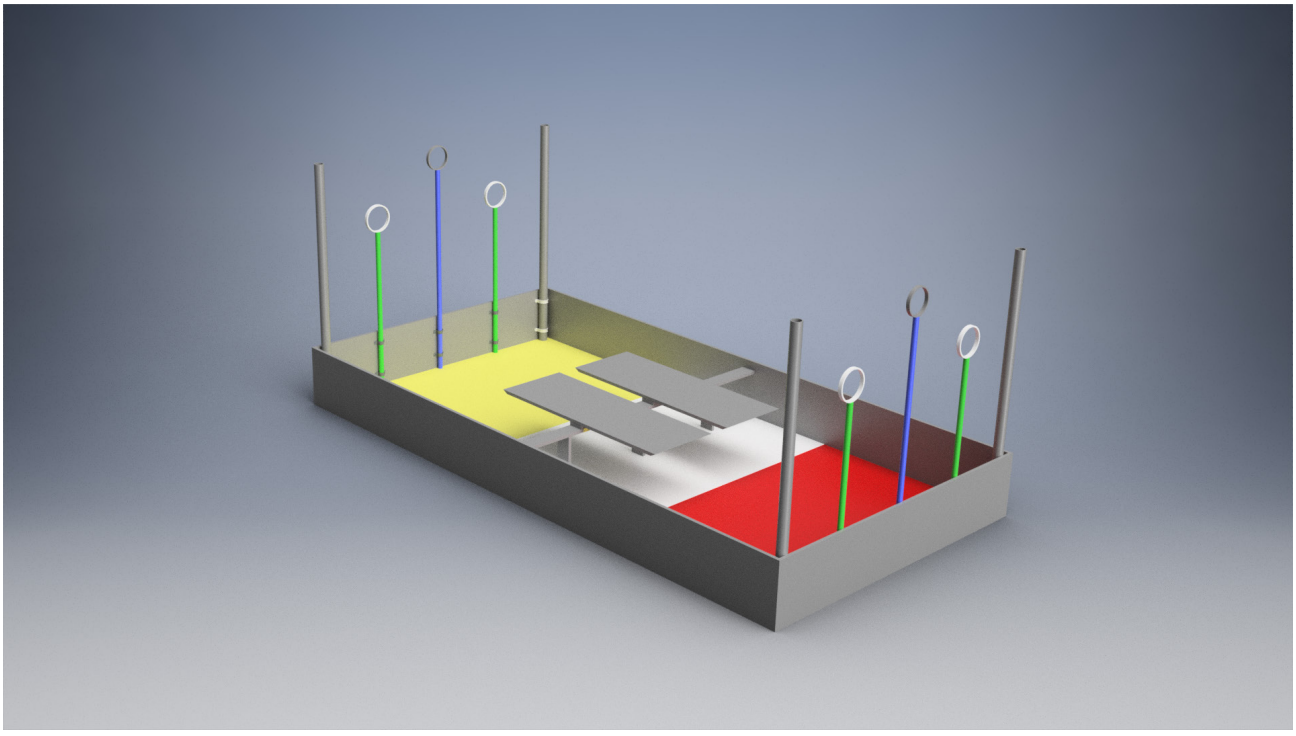
This report will count for 5 points on the final score of the machine competition, and will be evaluated by the organizing committee. This report will allow the organizing committee to have an overview of different ideas and concepts that emerge amongst the teams. This report shall contain the following :

Table 5 – Elements to be contained in the report

Elements	Points
Drawings of the machine	1
Diagrams of the different mechanisms considered to achieve the challenge	1
Match strategies that have been developed until now	2
Approximate dimensions and estimated weight	1

2. THE GAME FIELD

This section describes in detail the different parts of the field and contains all the necessary information for the construction of a field identical to the one that will be used in the official competition. An additional document, called the Material List, will give you information on the product numbers and suppliers used. Informative pictures and a 3D drawing with the exact dimensions of the field will also be provided. This drawing contains the official measures you will need to reproduce for your practice field.



2. THE GAME FIELD

2.1 AREA AND DELIMITATION

The 120 x 60 inches field is separated into three distinct areas: the alliance zone, the neutral zone and the enemy zone. It is to be noted that the alliance zone and the enemy zone is reversed for each team, which means that the area where an alliance starts is the alliance zone and the area in which their opponents start becomes the enemy zone (and vice versa for the second alliance).

These areas are delimited by two black adhesive tape strips of two inches wide which go across the width of field. These strips are called the middle lines. Each area measures 40 x 60 inches. The game field is made of ⅝'' thickness plywood, covered with a layer of paint.

2.1.1 ALLIANCE ZONE

The alliance zone is simply the area belonging to your alliance. It is where your robot will start the game. Moreover, it is in this area that a member of your alliance will provide the game balls to the robots. This zone may be yellow or red, depending on the game you play. There is no importance given to color other than to differentiate the zones easily.

2.1.2 ENEMY ZONE

The enemy zone is the area opposite to the alliance zone. They are separated from each other by the neutral zone. It is in the enemy zone, and in the neutral zone on the enemies side that the robots of your alliance will throw Quaffles into the enemies rings to score points. If you throw a Quaffle in a hoop from a location that is not one of these two zones, the point will simply not be granted.

2.1.3 NEUTRAL ZONE

The neutral zone is the area that separates the enemy zone from the alliance zone. In this area are located the different obstacles to cross from one area to another. This area is the central area. It will be painted white.

A robot can throw a Quaffle in the opponent's hoop from the neutral zone, on the opposing alliance's side and score the point. If the Quaffle is thrown in one of the hoop from a different zone than the enemy zone or the neutral zone in the opposing alliance's side, the point will simply not be granted.

2.1.4 DELIMITATION

The field is delimited by four walls located on its perimeter. These walls are made of ⅝" thickness plywood.

2.1.5 DISTRIBUTION OF QUAFFLES

The balls, or Quaffles, will be inserted in the field from holes, which we'll call dispensers, carved in the walls of the field. The center of these holes, which have a diameter of 3-½ inches, are located 12 inches from the end wall on each side walls. They are at a height of 3-¾'' from the gaming floor. Each alliance thus has two dispensers at its disposal, one on each side of its alliance zone.

2.2 OBSTACLES AND HOOPS

2.2.1 QUIDDITCH HOOPS

The Quidditch hoops, or goals, are directly attached to the walls delimiting the end of the field. There are three of these goals, two at the same height, on both extremities, and a central hoop, a little higher. The diameter of both lower rings differs from the diameter of the uppermost ring.

2.2.2 CENTRAL BEAM

The central beam is a ⅝" thick and 3'' wide wood beam, located in the middle of the neutral zone. Its center is located 60 inches from one of the two side walls of the field. This beam will be fixed 9 inches from the ground.

2.2.3 SECRET PASSAGES

Secret passages are simply areas of 11'' wide by 9'' height located directly below the central beam, on the sides of the central area. Robots therefore can easily pass under the beam by these two ground-level passage.

2.2.4 DRAWBRIDGES

Drawbridges are located in the center of the neutral zone on the central beam. These bridges are 40 inches long and 14 inches wide. They are balanced on the beam, which means they need to be lowered on one side or the other of the neutral zone before it is possible to cross to the other side of the neutral zone. The outer end of the bridges are located 14 inches from the sides of the field.

2.2.5 TOWERS

The towers, commonly called poles, are ABS poles located at the four corner of the field. These posts have a 1-⅞" outer diameter. They are 48 inches tall. They are located inside the field.

2.3 QUAFFLES

The Quaffles, also called game balls, are 2” ¼ diameter balls made of foam.

3. THE GAME

This section of the manual is the core of the machine challenge because it describes the various rules of the game and sets the game frame for the competition. It is essential to know the multiple rules stated in this section, because your robot and your developed strategies must respect all the regulations contained in here.

3. THE GAME

3.1 DETAILS OF THE GAME

A game is a match opposing two alliances, each formed by two machine teams. Alliances will be formed randomly, and will change every game. Thus, each machine team will have to play many matches, against alliances each time formed by different machine teams, and with another machine team at its side that will change every game.

Example: The Sherbrooke machine team is playing their first game with the Polytechnique machine team. In this game, they will face an alliance formed by the machine teams of Laval and McGill. In their second game, the Sherbrooke machine team will be matched with McGill machine team, and they will have to face an alliance formed by the teams of ETS and Concordia.

Each machine team will play only once with the same machine team and once against the same machine team. Which means that, for example, if UQTR plays with Concordia during a match, UQTR will not play a second match with Concordia, but might have to play against them in another game. If UQTR does play against Concordia in their second match, it will not play at all with nor against Concordia in its two remaining matches.

During each game, 4 referees will be present to record the points of each alliance and assign penalty points if needed. To know what penalties might be assigned during a game, please refer to section 3.3.

The referees will have at their disposal an iPad or an Android tablet with an application specifically designed for the machine competition that will allow the display of the score on a screen in real time during the competition. Note that a log of points awarded and penalties given during the game will be available after each game for review by machine teams in case of a disagreement with the final score.

3.1.1 PILOT TEAM

An alliance is formed by two machine teams. During a match, each machine team on the field shall be composed of three people:

- A pilot, the one who is responsible for the control of the robot of his machine team.
- A distributor, the one that will be responsible for the return of the game balls on the field.
- A technical assistant, the one that will help start the robot, give advice to the driver, etc. The task of this third person is left to the discretion of each machine team. The technical assistant may also control the robot and act as a distributor if required.

This means that a machine team can have two drivers or two distributors in a game.

Note that for available space reasons, the other members of the machine team who are not part of the pilot team will have to watch the game from the area that will be reserved for them without interfering with the pilot team. Moreover, only the pilot teams of the machine teams that are competing in the match may be present in the competition area, meaning the area containing the field. This area will be clearly marked in the tournament.

3.1.2 MATCH DURATION

The duration of a match is 2 minutes and 15 seconds. The match starts with an autonomous period of 15 seconds, used for running an autonomous program. The remaining two minutes are used for remote period, during which pilots take control of their robot in order to score as many points as possible.

Please note that the last two games of the tournament, or the final games, where only two teams will face off one against one, will last 3 minutes. Which means 45 seconds will be added to the timer because each machine team will play by itself in the final, and that strategies could be brought to change. Please refer to section 5 of the manual for more information about the tournament.

3.1.3 PREPARATION PERIOD

After the end of each match and just before the start of another one, there will be a brief period of time during which the machine teams on the field can remove their robot. Machine teams playing the next game can then place their own robot on the field, pre-load their robot of a ball if necessary, place their extra balls on their respective middle line and prepare for the referee's signal. Indeed, alliances will have the choice to put a maximum of 4 extra balls along the middle line between their area and the neutral zone. It will therefore be the responsibility of both machine teams in the alliance to decide what they will do with their balls. They can put all 4 on the middle line, wherever they like along the width of the middle line, on it, but they can also decide not to put any of the balls on the field. In case of a disagreement within the alliance, it is important to note that each delegation will be responsible for two balls each.

3.1.4 CLIMBING THE TOWERS

During the last 25 seconds of the match, all the robots on the field will be allowed to make contact with one of the two towers in the area of their respective alliance. To get the points associated with the climbing of a tower, the robot will first have to rise from the ground without making contact with anything but the pole and / or fasteners that hold it up. Then it shall remain suspended and / or attached while being in contact only with the pole on which it is suspended and / or attached for a minimum of 5 seconds after the end signal of the match. A robot is considered to have climbed the tower if and only if the robot is lifted completely from the ground, leaving no other parts or mechanism on the ground. This robot must support and lift its own weight by itself without assistance from another machine team, another robot or an object from outside or inside the field. For additional points related to climbing the pole, the complete robot must be located above the mark on the pole, and remain so for a minimum of five seconds following the end signal of the match. Doing so it shall always be only in contact with the post on which it is suspended and / or attached. The robot of a machine team must obviously also meet the criteria set out in the paragraph above, in addition to have all of the physical space it occupies as well as all of its mass above the mark. The mark will be located at a height of 25 inches from the ground, and will be identified with a red electrical tape strip. The robot that climbs the tower and holds its elevated position during 5 seconds following the end game signal can continue to receive an electrical current through its circuits to help it when it holds its position. However, no pilots from the machine team participating in the match can touch their control system during the 5 seconds as it is after the end of the game. The electrical current must come from a state of the robot and be applied continuously without external help.

3.1.5 THROWING THE QUAFFLES IN THE HOOPS

A ball shall be considered for the score if and only if the ball was thrown into the ring by a robot either in the enemy zone or in the neutral zone on the enemies side. The ball has to pass through the hoop from the side facing the interior of the field to the side facing the outside of the field.

A robot is considered to be in the neutral zone on the enemies side if and only if the whole robot is fully in contact with the ground, on the side of the central beam that's on the enemy's side of the neutral zone. The robot may also be in between the neutral zone on the enemy's side and the enemy zone in order to try scoring points. They will then actually be in contact with the middle line separating the enemy's zone and the enemy's side of the neutral zone.

3.1.6 PASSING ON THE DRAWBRIDGES

We consider that a robot has made a passage on the drawbridge if and only if this robot has crossed the drawbridge starting from its side of the neutral zone, and ending up on the opposing side of the same area. The same robot must have stayed fully in contact with the drawbridge and only with the drawbridge as it is crossing it. However, it may have been helped by another robot to lower the drawbridge, or can be pushed by another robot once on the drawbridge to cross it or to climb on it.

Moreover, if two robots of the same alliance pass through at the same time (one pushing the other, following each other, they go through side by side, etc.), both robots will get the points associated to their passage, if there is any points to get.

3.1.7 SCORING POINTS IN AUTONOMOUS PERIOD

We consider that a robot goes into the neutral zone if and only if all of the robot is in the neutral zone and is not in contact with its alliance area. Similarly, it is considered that the robot is in the enemy zone if and only if it is located completely in this area. If a robot goes into the enemy zone and then comes back to its own area during autonomous mode, the team will still get its points for going. Its final position does not need to be in this area to get the corresponding points.

3.1.8 BEEPS (SOUND SIGNALS)

During a match, 4 distinctive tones will be used to inform the machine teams and the spectators on what stage of the match we are at. The sound signals used are described in the informative table below

Table 6 – Meaning of the different beeps

Éléments	Points
Starting Signal	This signal is used to indicate to the machine teams that the match has begun. It is at this point that they will have to start the autonomous mode of their robot.
Transition Signal	This signal marks the end of the autonomous period, and the start of the remote period. It is from this moment on that machine teams can take control of their robot using their remote control and control system.
Signal for the last 25 seconds	This signal announces to the machine teams that there are only 25 seconds left to the match. The robots of each machine team can therefore go to their towers to climb it.
End Signal	This signal marks the end of a match. The machine teams must absolutely stop to control their robot at that time.

We mean by control or take control of the robot, the action from someone via a wireless system to make react, to create movement, to change the state of a robot, either the physical or the software state (the state of a variable in the code, the state of the robot etc.). No other form of control is considered or allowed in a game.

It should be noted that throughout the competition, background music will be present to add some atmosphere to the tournament. The sound signals will obviously be heard even through the background music, but the machine teams must pay special attention to them. The organizing committee of the engineering games will make available as soon as possible a .mp3 files of these different signals.

3.2 SCORE

There are two types of score: the game score, which is the total points accumulated during a game, and the ranking score, which is the total ranking points obtained based on the wins and losses of each machine team.

The match score in the autonomous period and in the controlled period is described in Tables 1 and 2 of Section 1.3. Details on how to make points will follow in the following sections.

The ranking score and its operation are described in section 5 of this manual.

3.2.1 POINT VALUE

The match score will determine the winning alliance of this match. The alliance with the highest total points will be named winner of the match, and get a certain number of ranking points. Please refer to section 5 of the manual for details on how the ranking points work.

3.2.2 PENALTY SYSTEM

A penalty system will be set up during the competition. This system will allow referees to enforce the rules set out in section 3.3 of the manual. When a team member and / or a robot violates a regulation, the machine team in question will be given a penalty based on what rule they violated. There are three types of penalties :

1 - Penalties causing a loss of points to the offender's machine team
2 - Penalties causing the obtainment of a yellow card to the offender's machine team
3 - Penalties causing the obtainment of a yellow card and causing a loss of points to the offender's machine team

The yellow and red card system works as follows: when a machine team member of an alliance gets a yellow card, he keeps it for the duration of the tournament. A yellow card is always given to a member of a machine team, not to the alliance as a whole.

The abuse of any regulation normally not leading to getting a yellow card may result in getting one.

If a machine team gets a third yellow card, it automatically gets a red card. This has the effect of automatically disqualifying the whole machine team for the match, not giving them any ranking point. The opposing alliance therefore wins the match and ranking points that come with the victory. The announcement of the red card and the disqualification of the team will be at the end of the match so there is no interruption of the course of the match.

The game is still played to the end, but the offending machine team will not see its total points added to its cumulative points. However, the non-offending team of the alliance will see its total point added to its cumulative points. Please refer to the manual section 5 in order to know the value of the cumulative points.

If a machine team gets two red cards in the tournament, it will be automatically disqualified from the competition and not receive any points for the machine competition. This machine team will no longer have the right to participate in the game, whether in eliminations or finals. In case this machine team was still playing elimination matches, the machine team that was supposed to form an alliance with the disqualified team will have to play alone. In case this machine team had to play final matches, a replacement must be found. The machine team with the highest ranking that didn't get to the final automatically becomes the alternate team machine.

3.3 RULES OF THE GAME

This section of the manual describes all the behaviors that are not allowed during the tournament, and the penalties associated with failure to conform to each of the regulations. Penalties related to these regulations will be distributed by the officials present at each of the tournament games.

3.3.1 SECURITY RULES

R1 : The robots with an unsafe design or operation will not be accepted on the field.

Penalty : The robot will not be allowed on the field for the game.

A robot considered dangerous is:

- A robot with cutting parts, poorly attached or posing a risk to detach, which may well become a projectile
- A robot with totally uncontrolled and brutal movements, and that cannot be stopped by the pilot team
- A robot having an unreliable electrical system which may cause a fire and / or sparks
- A robot containing or carrying something vegetal, animal, dead or alive, etc.

R2 : The members of the pilot team cannot put any part of their body, themselves or any object inside the perimeter of the field once the game started, except if a referee asks a machine team to put their robot back in place on the field.

Penalty : 5 penalty points by mistake.

R3 : The game balls cannot be thrown on whoever intentionally and / or elsewhere than at the goals to score points, and they can only be thrown by robots. Once on the field, the game balls can only be handled by the robot. Only the balls placed in the goals by the robot itself can be granted points.

Penalty : 5 points per ball thrown

The referees understand that the robots can miss their shots and send the ball elsewhere than in the goals, but the balls need to be send towards the goals to score points.

3.3.2 BEFORE AND AFTER MATCH RULES

R4 : Once on the field, the robot must:

- Be in the alliance zone and not touch the neutral zone
- Not deploy any extension out of its initial perimeter
- Be pre-loaded with a maximum of one ball game
- Not be in contact with the game balls arranged on the middle lines
- Be the only object left by the delegation on the field
- Meet the robot criteria set out in Section 4

Penalty : The offending team will have to correct the situation within a reasonable period. If they cannot do so, they will have to remove their robot from the field and will not be allowed to participate in this game.

Note : It is considered that the robot is in a particular zone when its entire peripheral frame and its extensions do not exceed the perimeter delimited by the lines that define the zone.

R5 : Pilot teams cannot disturb the good proceedings of the tournament.

A disturbance can be, but is not limited to:

- Arriving late for the match
- Initiating repairs once the robot is on the field
- Being present in the competition area or leaving the robot on the field if you are not part of an alliance that is about to play.

Penalty : Yellow card

It should be noted that the referees will tolerate delays because of various setbacks. However, for the sake of making the machine design competition show interesting and dynamic for everyone, each machine delegation shall commit to solve their problem as quickly as possible and to be on time for their matches.

R6 : Pilot teams should be behind their pilot station, in the area marked out by the referees, and should not be in contact with it before the match, with the exception of the technical assistant that will need to be there to start the autonomous program of his robot at the referee's signal.

Penalty : Yellow card

3.3.3 GENERAL RULES

R7 : Strategies aiming to make the opponent alliance break a rule intentionally will not be tolerated. The victim of this strategy will not be given a penalty for the committed act.

Penalty : 5 penalty points and yellow card

R8 : Strategies aiming to intentionally break the rules, unsportsmanlike strategies and strategies considered abusive and out of the frame of the competition are prohibited

Penalty : Yellow card and penalty for the unrespected rule

R9 : The following actions are prohibited :

- Try by one way or another to sabotage the robot from another machine team
- Interfere with communications between pilots and robots of other machine teams
- Break, damage, alter or modify the field, one of its components and / or game balls, either with the robot or human intervention

Penalty : Red card - Automatic disqualification of the match

R10 : The use of game elements, the game balls and / or the field to increase the difficulty of the challenge during the match is prohibited.

This includes, but is not limited to :

- Putting a lot of game balls in the alliance area to slow or block the passage of robots from the opposing alliance
- Using game balls to block the secret passage
- Using game balls to block the access to the drawbridges
- Using game balls to keep the drawbridges up

Penalty : 5 penalty points for every 10 seconds, until the situation has been corrected

3.3.4 RULES DURING THE AUTONOMOUS PERIOD

R11 : Robots of the machine teams from the same alliance cannot take the secret passage and the drawbridge to their right in the autonomous period.

Penalty : 5 penalty points per offending robot

During the autonomous period, the machine teams of the same alliance have the opportunity to position their robot anywhere in their alliance zone, but if one or both robots of their alliance want to cross to the enemy area, these robots will need to take the secret passage to their left or the drawbridge to their left, to make sure that the robots of the opposing alliance can make their own way.

R12 : The machine teams can never come in contact with their robot, their control station, their controller or other elements of the field after the beginning of the autonomous period unless the referee indicates otherwise, for reasons of security or to stop a robot that is currently executing its autonomous program.

Penalty : Yellow card

This regulation implies that machine teams will provide a simple mechanism to start the autonomous program of the robot at the beginning of the match. If the engagement of this mechanism cannot be done by wireless communication, it will be tolerated that the technical assistant manually starts the autonomous program using a switch on the robot.

If the technical assistant manually activates the autonomous program, it shall in no case affect the operation of other robots and he must withdraw from the field as quickly as possible.

However, if the engagement of the autonomous program is through wireless communication, the pilot can activate the program using his remote control. He shall no longer touch the remote control for the next 15 seconds of the game, until he hears the official transition sound signal from the referees.

3.3.5 RULES CONCERNING THE ROBOTS

R13 : If two robots from the same alliance are overturned, a short break of less than 10 seconds will be given to the machines teams whose robots are overturned to put their robots back on their wheels in the same place they previously were. If the situation occurs more than 3 times, the robots shall remain down, and the game will continue until its end.

Note : An overturned robot is a robot that is not able to move because its mobility system no longer makes contact with the ground.

3.3.6 RULES CONCERNING THE INTERACTION BETWEEN THE ROBOTS

R14 : A robot may not block another robot for more than five seconds. A robot is considered to be blocked when an opposing robot is in contact with him in such a manner to prevent movement from the other robot.

Thus, when a robot comes into contact with an opposing robot, the blocking will be considered finished when both robots have been separated by a distance of at least 2 feet. If a robot immobilizes another robot for 5 seconds, it must move back at least 2 feet for a minimum of 3 seconds before resuming its blockade again.

If a robot uses a game field element to immobilize another robot, this action will also be considered as a block. If the robot that just got blocked makes contact immediately after with the robot blocking it before, the blocking robot will not be penalized.

Penalty : 5 penalty points for every five seconds, until the situation is corrected. If the block is considered excessive or affecting the development of the match, a yellow card will be given.

R15 : Any strategy aiming to break, to damage, to overthrow or to make unusable or dysfunctional another robot on the field is not allowed.

Penalty : Red card - Automatic disqualification of the match

R16 : Overthrown robots attempting to raise by themselves or with the help of the other robot of the alliance enjoy an immunity period of 15 seconds during which the opposing robots can never come in contact with them.

Penalty : 5 penalty points by contact from an opposing robot during the 15 second period

R17 : During the last 25 seconds of the match, robots located in their own alliance zone can't be touched by opposing robots.

Penalty : If the robot is in his zone, but is not in contact with one of the two towers, 5 penalty points by contact of the opposing robot will be given. If the robot is in contact with the tower and is hit by an opposing robot, a yellow card will be given.

This rule is enforced to encourage the teams to climb the pole to score extra points without being interrupted by the opposing alliance.

3.3.7 RULES CONCERNING THE GAME OF THE ROBOT

R18 : With their robot, a machine team cannot attempt to interfere with the good proceedings of the game, regardless of the means used.

This includes, but is not limited to:

- Coordinating with its alliance partner to block access to the drawbridges, the secret passages, the hoops, the towers or any other area or element of the field
- Isolating the ball game of the opposite alliance
- Overthrowing themselves intentionally
- Adding a game ball in the perimeter of another robot
- attempting to get out of the field, or attempting to make another robot get out of the field as long as the match isn't done

Penalty : Yellow card

Note: Only one robot of an alliance blocking only one hoop, one secret passage or one drawbridge alone is not considered misconduct.

3.3.8 RULES CONCERNING THE GAME ELEMENTS

R19 : The robot of a machine team cannot control more than three balls at a time during the match, in the autonomous period as well as in the remote period.

Penalty : 5 penalty points by extra controlled ball.

Note : A ball is considered controlled when:
- It is found within the peripheral frame of the robot
- It is moved from one place to another intentionally, by a robot which pushes it.
- It is held against a component of the field by a robot trying to make it inaccessible or to block it
- It is pushed, held or restrained by the extension of a robot

R20 : The quaffles can only be introduced into the field during the remote period, by the distributors or the technical assistants, and using only the dispensers provided for this purpose on the side walls. The dispensers in the alliance zone can only be used by the members of this same alliance.

Penalty : Yellow card

Note : Any ball that was scored in a hoop can immediately be returned to the field. Additionally, teams will have more than enough balls to give to their robots. Finally, a ball recovery system will be set up so that teams can quickly put the balls back in play. This system will be communicated to all teams as soon as possible.

R21 : The machine teams do not have the right to deliberately hold game balls to cause a shortage. If there's no ball on the field, each alliance must immediately dispense 5 balls on the field.

Penalty : 5 penalty points every five seconds, until the situation is corrected.

R22 : A ball thrown by a robot from his alliance zone or from the neutral zone on his side of the field, and that goes through one of the Quidditch rings of the offensive zone, will not give any points to the alliance. It is imperative to throw the ball from the neutral zone on the opposing side or from the offensive zone in order to score points.

3.3.9 ZONING RULES

R23 : A robot may not go under a drawbridge or between the two drawbridges to move from one area to another.

Penalty : Yellow card

Note : A robot can pass balls below the drawbridge. It can also go underneath the drawbridge to retrieve balls, and can even be directly below the central beam. It's only if it intends to cross it that it shall use the secret passage or the drawbridge itself.

R24 : A robot shall not attempt to climb one of the towers before the last 25 seconds of the game, or when the appropriate signal will be issued by the referees

Penalty : Yellow card. In addition, the points related to climbing the tower will not be granted in this match.

Note : It is normal that an element of a robot, no matter the alliance, might come into contact with one of the towers during the game, and no penalty will arise from this action. This regulation simply states that a robot cannot begin its climbing of the tower before the last 25 seconds.

R25 : A robot may not attempt to climb one of the towers of the opposing alliance.

Penalty : Yellow card. In addition, the points related to climbing the tower will not be granted in the match.

3.4 Q & A SYSTEM

In order to answer questions from all delegations regarding this manual, the team of the Engineering Games has set up a forum in which each delegation may ask questions, precisions or may express any other concerns that may arise throughout the construction of the machine. Information regarding this forum will be sent to each delegation at the end of its implementation.

Although discussion and idea sharing are encouraged, only the VP-Machine answer will be considered official regarding any problem presented in the forum. The procedure for the change of regulations related to the discussions in the forum is described in section 3.5.

For fairness reasons, any questions should be asked on the forum so that all delegations have access to the same information..

3.5 UPDATES OF THE MANUAL

It is possible that the questions asked in the forum lead to the clarification of certain rules, turn of sentences in certain sections or even the creation of new rules to accommodate the requests and concerns of the participating teams. When this happens, a new version of the manual will be sent to all delegations. In addition, a second document simply called Update X will present all the changes made to this manual, to summarize important information that has changed.

4. THE ROBOT

This section describes the constraints to be respected when designing the robot to be used at the machine design competition of the 2017 Engineering Games.

4.1 CONSTRAINTS AND LIMITS

This section presents the physical constraints that the robot will have to comply to in order to be safe and to make sure that the designs of each delegation are fair.

4.1.1 GENERAL DESIGN OF THE ROBOT

1. The robot of the machine teams must be an electromechanical assembly containing all the basic systems to actively participate in the machine design competition of the 2017 Engineering Games. This means it shall have a power supply, a communication system, a control system, a mobility system, etc.

   We consider that a robot needs to be made of components and mechanisms. A component is a basic part that we can't disassemble unless we damage it permanently or destroy it completely. Following the same idea, a mechanism is an assembly of components that provides a function within the robot.

   Of course, the robot must also comply with all rules and statements contained in this manual. In addition, the design and construction of the robot must come from the delegation that will present it at the competition. It is also forbidden to :

   - Have more than one robot per machine team
   - Change more than 75% of the robot after the tournament has started
   - Do practice matches between or with one or more machine teams once the Engineering Games have started
   - To not respect the criteria stated below

   If a machine team violates any rule or any statement for the robot, it will be automatically disqualified from the tournament.

2. The robot must comply with the following dimensions constraints :
   a. The initial dimensions of the robot must not exceed 13 ½ inches x 13 ½ x 13 ½ inches. Initial dimensions are the dimensions of the robot just before the start of a match. Extensions can be deployed immediately after the start of a match.

   b. The weight of the robot must not exceed 25lb.

   c. The maximum length of any extension exceeding the frame of the robot is 12 inches. An extension is defined as any part of the robot out of the initial scope of 13 ½ inches x 13 ½ x 13 ½ inches. This extension must be contained within the initial frame when the robot is ready to start the game.

   Note : The robot must be equipped with a closed physical structure that will be called the peripheral frame. The robot will be defined by its peripheral frame. All of its mechanisms, subsystems and components must be contained within its peripheral frame. This device framework should be the physical limit of the robot, and must consist of component parts. Thus, a square robot will have at most a peripheral frame of 54 inches (four sides of 13 ½ inches).

   A robot cannot therefore be composed of two small robots where several distinctive parts connected together, whether by a rope or by any other type of mechanism. Only the extensions are allowed out of the peripheral frame, but they must be connected and cannot be detached. These extensions cannot, however, have their own mobility system, and therefore cannot be independent robots. These extensions can be robotic arms, rotary rods, mechanisms to pick up balls, etc.

   The extension can be used to help the robot climb the pole during the end of a match.

3. The parts of the robot must not be made from hazardous materials. They must be safe and must not interfere with the operation of the robots of other machine teams. Here are examples of prohibited materials and components :

   a. Screens, curtains or any other material or devices designed to cover or obstruct the view of the pilot team or impair their ability to control their robot safely.

   b. Speakers, sirens or other devices generating enough noise to distract the participants.

   c. All decorative device specially designed to affect the proper functioning of the robot's sensors, such as sonar, infrared proximity sensors, acoustic range sensors, etc.

   d. Flammable gases.

   e. Any device producing flames or using pyrotechnics.

   f. Fluids or hydraulic elements.

   g. Switches or contacts using liquid mercury.

   h. Any material that can scatter on the field during a game, such as sand or oil.

   i. Untreated or uncovered hazardous materials, such as lead weights. They are permitted if they are painted, wrapped or otherwise sealed to prevent contact.

   j. Tire Sealing.

4. Lubricant can only be used to reduce friction of internal parts of the robot. The lubricants must not contaminate the field.

5. The maximum air pressure inside the compressed cylinders used to activate any mechanism shall not exceed 80 psi.

6. For security reasons, an aerial machine will not be tolerated to participate in the machine competition of the Engineering Games.

4.1.2 POWER SUPPLY

1. The maximum voltage of the robot's circuits must not exceed **24V**.

2. A switch must be installed between the output of the battery and the rest of the electrical circuit of the robot to turn it on or off. This switch should be easily accessible by anyone in an emergency situation and shall be near the outside of the robot.

3. A green light device, not blinking, shall be installed on the robot to indicate whether it is working or not. This device should be easily seen by the referees at a distance of more than 5 meters.

4. The robot's battery should be well secured so that it cannot be detached if the robot were to be overturned or to be in an abnormal position.

5. All wiring and all electrical devices must be isolated from the frame of the robot. The fra me of the robot must not be used as electrical conductor.

6. Any form of mechanical energy is allowed except for thermal machines.

4.2 CONTROLS SYSTEMS

1. Only a wireless communication system is authorized to remotely control the robot.

2. If a machine team decides to use controllers similar or operating in the same way as remote car controllers, this machine team must bring several crystals in order to change the frequency and not enter into conflict with other machine teams during the competition. The referees will be allowed to request that a machine team changes the communication frequency they are using.

3. The machine teams must make necessary arrangements to allow everyone to control their robot without any interference. Machine teams should provide means for rapid and effective change of their radio frequency, WiFi, communication mode and other important adjustments as far as the hardware and the software.

4.3 EXTERIOR FINISH

Robots will need to have, on at least two of their sides, panels corresponding to the color of their alliance during the match. They will need to be able to change these panels depending on the color of their alliance, which can only be yellow or red. These panels must be a minimum size of 3 inches by 3 inches and they cannot be disposed under the robot. These panels can be rigid or flexible, or even fabric.

These panels are designed to help the referees distinguish the two members of each alliance during games.

4.4 EVALUATION AND CONTROL

During the 2017 Engineering Games, each machine team shall bring their robot where indicated, and as soon as they arrived. Nobody has the right to access their robot out of hours provided for this purpose. Periods of a few hours will be allocated once a day so that delegations can continue to work on their prototype.

During these periods, the field that will be used for the machine design competition will be available for the machine teams so that they can measure and test their prototype. A precise timetable setting out the field availability periods for each machine team will be made available. The teams will go to test their machine one at a time. The 2017 Engineering Games VP-Machine will also be present to answer questions from machine teams.

When working periods are over, all machines teams must imperatively stop working, store their equipment and leave the room.

5. THE COMPETITION

This section presents the machine design competition of the 2017 Engineering Games. It will first give an overview and explain the proceedings of elimination matches and final matches. It will finally end with an explanation of the general rules of this competition.

5.1 OVERVIEW

The machine design competition of the 2017 Engineering Games takes place in the form of matches during which four schools will oppose in alliance of two teams. A first round of playoffs, with alliances formed randomly, will determine an initial ranking based on a score defined in section 5.2.

Following these elimination matches, two alliances of two machine teams will be formed for a first final match. Both teams of the winning alliance of that first final match will then compete for one last game, one against the other. This procedure will allow to determine the 3rd, 2nd and 1st places. The elimination phase is very important because it allows the machine teams to get a classification and to note the strengths and weaknesses of their opponents with whom they may have the opportunity to play in the finals.

5.2 ELIMINATION MATCHES PROCEDURE (PLAYOFFS)

This section describes how the playoff round games will be executed and how the score will be calculated at the end of these matches.

5.2.1 MATCH PLANNING

The elimination matches have two goals: firstly to familiarize the teams with the game and the field of the 2017 Engineering Games machine design competition, and secondly to rank the teams according to a certain score and decide which of those teams will participate in the finals. All the machine teams are guaranteed a minimum of four games, since all the team will play the same number of match during the elimination phase of the competition. The four machine team which will finish in the top four of the ranking will be playing two additional game. The formation of the alliances of two machine teams will be done randomly, 1 hour before the start of the competition. Each school will have the opportunity to play with and against various machine teams.

5.2.2 RANKING OF THE MACHINE TEAMS

Machine teams will be classified according to the following score:

- Each **win** is worth **2** ranking points
- Each **tie** is worth **1** ranking points
- The **defeats do not grant any** ranking points.

In the event that two or more machine teams end up with the same ranking score at the end of the elimination matches, settling will be done according to the following rules, applied in order when a rule does not separate the machine teams :

1. The machine team with the **lowest number of penalties** accumulated will be considered as having a higher ranking.

2. The machine team with a **higher number of cumulative match points** shall be considered as having a higher ranking.

If after these rules the two machine teams are still equal (same number of penalties and same number of cumulative match points), a match between the two teams will settle the tie.

Note : The number of penalties is the number of penalties obtained, which means the number of breached regulations. It does not correspond to the number of points lost in a match by obtaining one or more penalties. Furthermore, the match points will be calculated in the following manner: Each machine team member of an alliance will posses their own individual match point total. This individual total will be comprise of the sum of the scored points and lost points due to various penalties. The match points total of the whole alliance will be comprise of the sum of each individual totals from each machine team forming that same alliance. However, each machine team will see its own individual match point total added to his cumulative match point total, and its own number of obtained penalties to his number of accumulated penalties.

For example, if Sherbrooke plays its first match with Polytechnique and loses that match 50 to 30 having made 25 points and obtaining no penalties, Sherbrooke will have 25 points added to its cumulative match points total, and Polytechnique will obtained 5 points to its number of cumulative match points total. If Sherbrooke then had to play with UQAR and won its second match 50 to 25, having scored 20 points (30 scored points and two penalties of 5 points each), they would now earn 2 ranking points, have a number of cumulative match points of 45 points and a number of accumulated penalties of two.

5.3 FINAL MATCHES PROCEDURE

This section explains how the final matches will work and how alliances will be formed.

Overall, three final matches will determine the podium: the first game will be 2 machine teams playing against 2 machine teams. It will determine who will participate in the consolation finale and who will participate in the grand finale. The winners of the first final match will face each other in the grand finale to win the 1st place. The losers of the first final match will play one against one for 3rd place.

5.3.1 MACHINE TEAMS SELECTION

Following the playoff matches, a ranking of each team will be established. Only the first four machine teams will be participating in the finals to determine 3rd, 2nd and 1st places.

The machine team that is first in the ranking after all the playoff matches will have the privilege to choose which machine team they will play with (as an alliance) for the first match of the finals. The two other teams will automatically form the second alliance.

5.3.2 BACK-UP MACHINE TEAMS

In the case where one of the first four machine teams could not play the final games, for example if their robot is not functional anymore, the next highest-ranked machine team will take their place to play in the final.

5.4 GENERAL RULES OF THE COMPETITION

This section explains the general rules of the machine design competition of the 2017 Engineering Games.

5.4.1 OFFICIAL FIELD OBSERVATION

During the hours provided for this purpose at the 2017 Engineering Games, the official field that will be used during the competition will be made available to machine teams so that they can take measures and test their prototype.

5.4.2 MATCH REPLAY

In some cases, the matches could be replayed to separate the machine teams. Here are some of the possible cases:

- In the case of ties in the ranking, two machine teams could be brought to play a match. See section 5.2.2.
- If there was any outside interference
- In the case of technical problems with the referees' scoring system
- In the case of an exceptional event that results in an interruption of the match (fire alarm, for example)

5.4.3 TIMEOUT SYSTEM

During the tournament, it is possible that some robots break during matches. The Engineering Games team has decided to introduce a timeout system that allows teams to get a 4 minutes period to repair their robot. Each machine team will therefore have, during the competition, 2 timeout coupon. If a machine team needs to go play their next game, but is not ready, they can warn the head referee at the end of the previous game, and give him one of their two coupons. They may also decide to use both their coupons at once, but they won't have any more timeouts afterward.

It is important to note that the coupons only allows the concerned team not come immediately on the field. The 3 other machine team taking part in the next match need to be ready and on the field within normal time limit. Furthermore, if the concerned team exceeds the time limit of 4 minutes, it could lose the right to use its second coupon, or be given a penalty as stipulated in Section 3.

It is also important to know that if Polytechnique were to play with Sherbrooke and were in the need of a coupon but had no more, Sherbrooke would be allowed to give their coupon to Polytechnique. Following that event, Polytechnique would be the only machine team benefiting from the 4 minutes timeout.

Furthermore, if a machine team were to play two match in a row, a 2 minutes timeout would automatically be given to that same machine team in order to give them time to change their alliance panels (if they must do so), and to make alterations, repairs and other necessary maneuvers. Finally, any machine team accessing the finals will get an additional timeout coupon.

5.4.4 CONSEQUENCES OF PENALTIES

During the matches, machine teams may receive penalty points. These points are subtracted from the individual match points total of the faulty machine team and, by extension, the cumulative match points total of the alliance in which the faulty machine team is part of. These penalty points are used to decide between two machine teams with the same score in the final classification; the machine team with the lowest number of penalties will have a higher overall ranking.

In the event that two machine teams have the same number of penalties, other rules will apply to settle the tie. See section 5.2.2.

5.4.5 RESPECT OF THE REFEREES

The referees of the machine design competition of the 2017 Engineering Games are impartial members of the organizing committee. They are there to enforce the rules of the competition as described in this document and to ensure that the game is fair to all the delegations. These referees obviously always have the last word on a decision, regardless of its nature.

It is important to respect the referees, as the result of a match does not result from a personal decision, but the application of the rules.

5.4.6 UNSPORTSMANLIKE BEHAVIOR

This competition being basically a team sport, unsportsmanlike conduct will not be tolerated. We define an unsportsmanlike gesture as any attempt to make the game unplayable for the opposing team or even play badly deliberately in order to lower the score of your teammate.

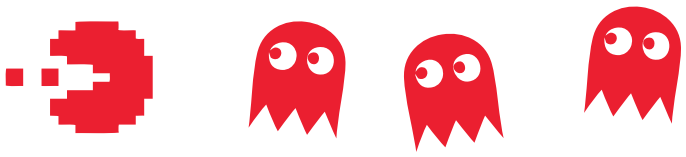
An example would be a team with a rank not allowing him to reach the final, playing with a team being ensured to reach the final. An unsportsmanlike behavior would be for the team with the lower ranking to sabotage the game in order to prevent his teammate to make the finals.

Any unsportsmanlike behavior from any school during the machine design competition of the Engineering Games will be sanctioned. The competition should be healthy and enjoyable for all in order to offer a good show to the rest of the delegations.

Referees will use their best judgment to decide whether an action brought by a delegation is unsportsmanlike.

5.4.7 INTERUNIVERSITY MATCHES

It is forbidden to play interuniversity matches before the engineering games, because it would put to a disadvantage the delegations who are are to far away from other universitiies to practice with them.



ORGANIZING COMMITTEE

The organizing committee of the 2017 Quebec Engineering Games wants to wholeheartedly thank you for the attention you have given to this document. We hope that we will count you in this 27th edition. To ask us questions, or give us comments, do no hesitate to contact our organization: it will be our pleasure to give you the answers you seek!

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ANNEX A : EVALUATION CRITERIA

Criterias	Description	Points
Tournament	The team that finishes first in the ranking will be awarded 65 points. The other teams will have their score weighted by their number of victory points with respect to the first team's number of victory points according to the following equation: (Team's ranking points / 1st team's ranking points) * 65	65 points
Originality and innovation	Points will be awarded for a mechanism's originality, an idea, a concept and/or an innovative strategy allowing a team to successfully perform during the matches. The concepts and mechanisms of each machine will be evaluated during the Engineering Games.	5 points
Reliability and durability	Points will be awarded in function of the reliability and durability of a machine during the matches. The teams that can constantly score points from one match to another, that has a resistant machine and doesn't break will have more points.	5 points
General look	Points will be awarded according to the general look of the machine, such as for conception details, mechanism's finish and polishing, the presence of a theme that reflects the delegation's, colour choices, decorative elements, etc.	5 points
Efficiency and precision	Points will be awarded in function of the team's efficiency and the machine's ability to interact with the game elements, such as bringing down the drawbridge, scoring points in the hoops, climbing the pole, etc. Teams that can perform those actions quickly, with precision and several times will receive those points.	5 points
Cooperation and professionalism	Teams that will cooperate with other teams, whether it is during the matches or outside of them, will be awarded points according to their behavior. The professionalism of each team member, the respect of the rules, courtesy, mutual assistance and the elaboration of cooperative strategies will also be considered when awarding those points.	5 points
Video	The details for the video's scoring can be found in Table 4 of section 1.4 of the Machine Specifications document.	5 points
Mid-term report	The details for the mid-term report's scoring can be found in Table 5 of section 1.5 of the Machine Specifications document.	5 points
Total		100 points

Note :
The assessment of the Originality & innovation, Reliability & durability, General look, Efficiency & precision and Cooperation & professionalism criterias will be made during each of the machine's work periods as well as during the competition. A team composed of the official referees, Gauthier Viau and Simon Barrette, VP Machine of the Engineering Games, as well as judges coming from external companies will come and talk with each delegation several times to talk about their machine, their development processus, their concept, how the 4 month conception prior to the Games went as well as other information that they'll judge pertinent. The information that those judges will gather will not be shared with the other teams. We strongly encourage the delegations to prepare themselves for such meetings by preparing a presentation, by bringing mechanisms that were used in early prototypes, etc. From those discussions, the teams will really be able to show their talents, their assets, their innovative ideas and thus acquire points as described above.

ANNEX B : COMPLETE TABLE OF CONTENT

ANNEX B : COMPLETE TABLE OF CONTENT