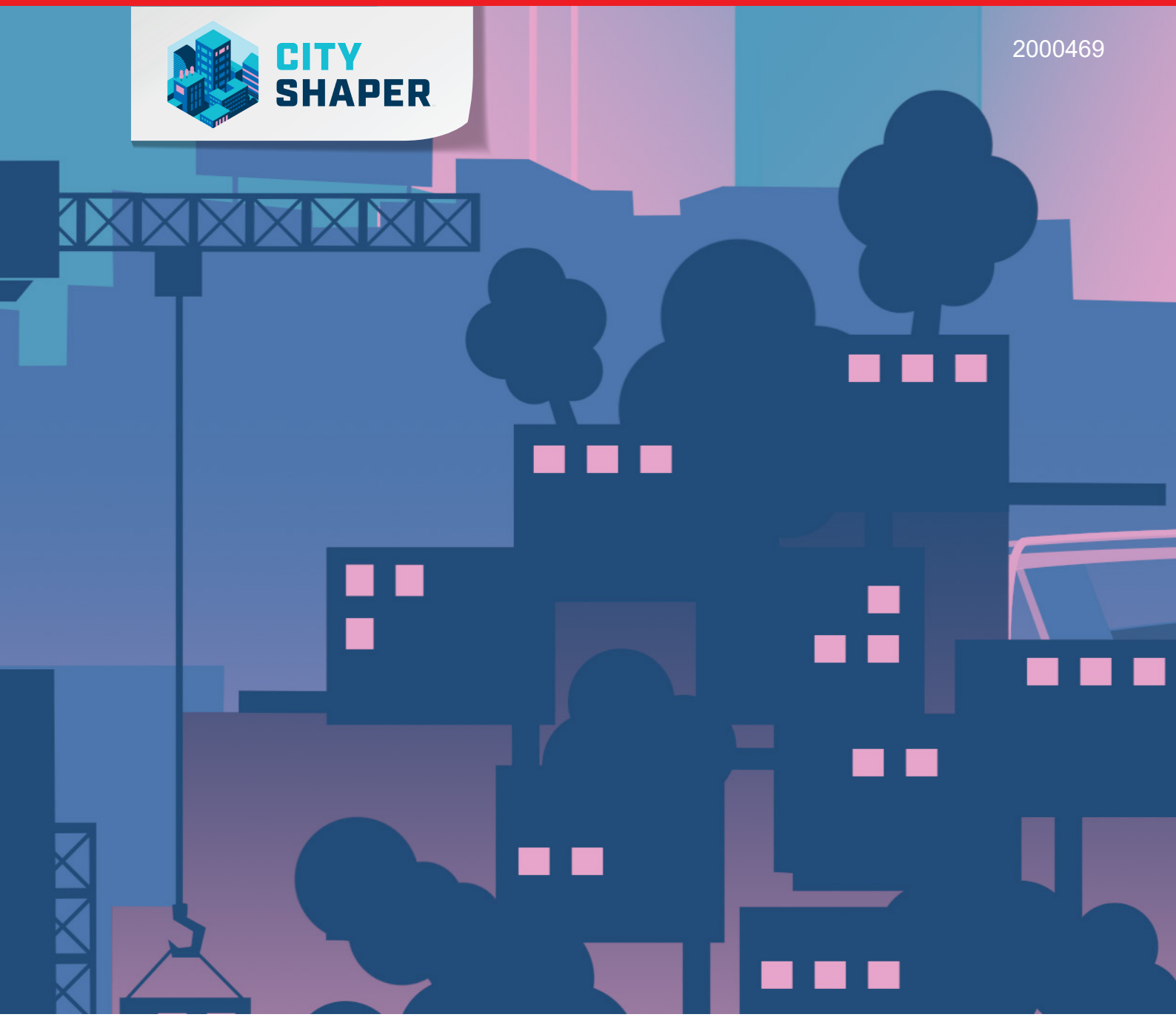
FIRST LEGO LEAGUE

ENGINEERING NOTEBOOK



FIRST

LEGO education

My Team

Team Name: _____ Team No. _____

Team Members:

Group 1

_____

_____

_____

_____

_____

Group 2

_____

_____

_____

_____

_____

Table of Contents and Session Summaries

Architects design and construct **buildings.** They combine science and art to make buildings and **structures** for their **clients.** Sometimes they make new buildings and sometimes they redesign old ones.

They work as part of a larger team, just like yours. **Structural, civil and environmental engineers** make sure a project suits its **site.** Construction workers like electricians, plumbers and carpenters, and **project managers** make sure the job stays on time and within budget. Every role is important to get the job done.

Our cities and towns face big issues, like transportation, **accessibility** and even natural disasters. How can we shape a better future for everyone? It will take teamwork and imagination. Are you ready to build a better tomorrow together?

In the Robot Game, your team will:

- **Identify** Missions to solve.
- **Design,** build and program a LEGO Robot to complete the Missions.
- **Test** and refine your program and design.

Your Robot will have to navigate, capture, transport, activate, or deliver objects. You and your Robot will only have **2½ minutes** to complete as many Missions as possible. So, be creative!

In the Innovation Project, your team will:

- **Identify** a problem with a building or public space in your community.
- **Design** a solution.
- **Share** your solution with others and then refine it.

At official events, your team will present your Project, including the problem, your solution, and how you shared it, in a 5-minute presentation.

ROBOT GAME | PROJECT

CORE VALUES

Throughout your season, you'll be guided by the... *FIRST*® Core Values

We express the *FIRST*® philosophies of *Gracious Professionalism*® and *Coopertition*® through our Core Values:

Design, program and build your Robot

Construction

Use any LEGO-made building parts in their original factory condition

YOU MAY	YOU MAY NOT
Cut LEGO string and tubing.	Use factory-made wind-up/pull-back “motors.”
Mark parts for identification on hidden areas.	Create or use additional/duplicate mission models.
TIP – At tournaments you should expect, and design for, rare imperfections like changes in light, or bumps under the mat.	

HARDWARE			
Required	**Equipment**	**Number allowed**	**EV3 (also NXT and RCX equivalents)**
X	Controller	1 per Match	
X	Motors	Any combination, maximum of 4 in total.	 Medium  Large
	Sensors	Unlimited	   
SOFTWARE			
You can use any software that allows the Robot to move autonomously – meaning it moves on its own.			
No form of remote control is allowed.			

Set up your field

Your challenge set contains:

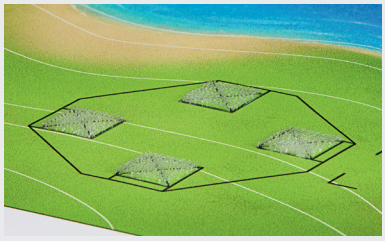
Field Mat, Mission Models, Dual Lock and White LEGO bricks that can be used to build your Innovation Project prototype

1. BUILD THE MISSION MODELS – Use the LEGO elements from your Challenge Set, and building instructions. Estimated time for 1 person = 6 hours. **Accurate Mission Model construction is essential. Double-check your builds, especially that all pieces are connected securely.**

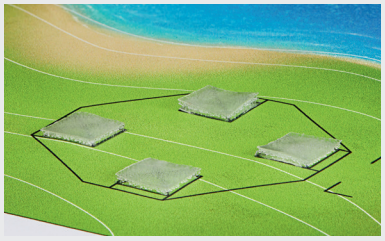
2.DUAL LOCK AND SECURE MISSION MODELS – Follow the instructions on the following pages.

Dual lock – Find the brown sheets of this material from 3M in your Challenge Set. It sticks Models to the Mat, but allows removal too.

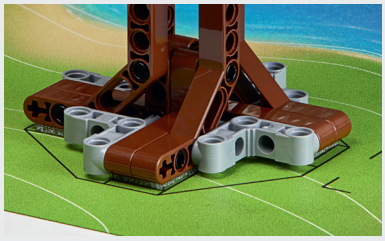
SECURING MODELS – "X" Squares show where to Dual Lock Models to the Mat. Use it as in this example, and **be very exact.**



STEP 1: Sticky side down



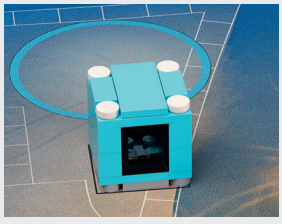
STEP 2: Sticky side up



STEP 3: Align model, press down

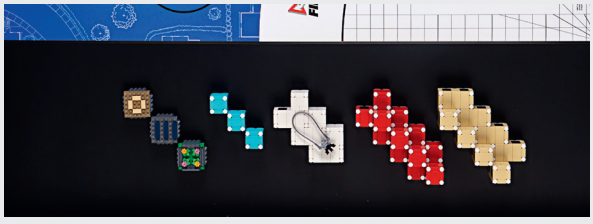
MODEL STRESS – When pressing a Model down, press on its lowest solid base structure instead of crushing the whole Model. Lift at that same structure if you need to separate the Model from the Mat.

Loose models – Place as shown detailed here.



One blue unit w/flat roof

One white unit



In home, arranged any way you like:
Bat, sustainability upgrades (solar panels, roof garden, insulation), 14 units, your structure for mission 11

Inspection drone

Six precision tokens

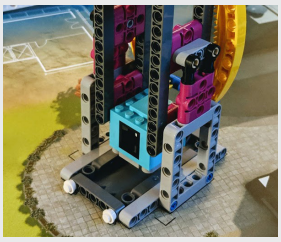
Simple secured models

Secure and prepare as shown and detailed here.

Swing

Tree

Traffic jam

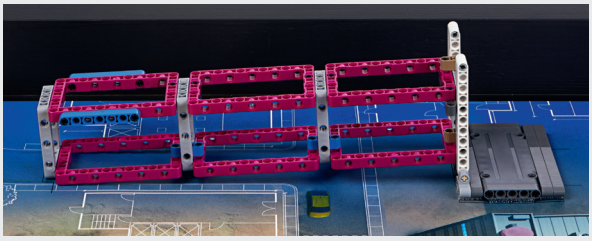


Elevator

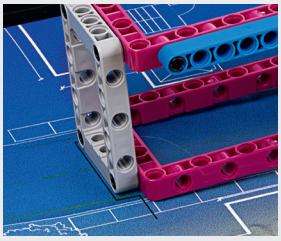
Multi-step secured models

Secure and prepare as shown and detailed here.

Steel construction:

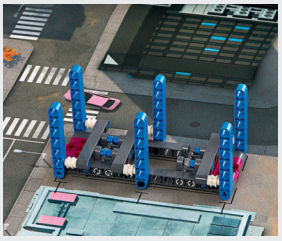


Step 1

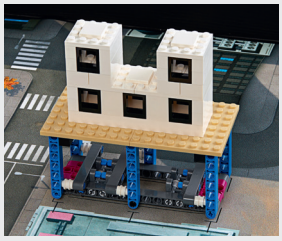


Step 2: Push East

Test building:



Step 1



Step 2

Crane:

Step 1: Tie square knot near end of string

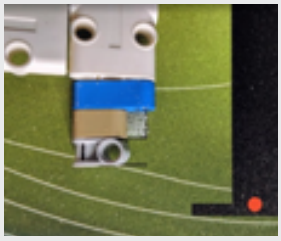
Step 2: Hook this blue unit and wind all the way up. Rotate arm all the way clockwise

Multi-step secured models (continued)

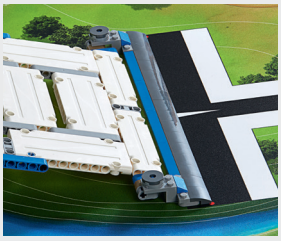
Bridge:

Step 1: Carefully remove the bridge's entrance

Step 1: bottom view



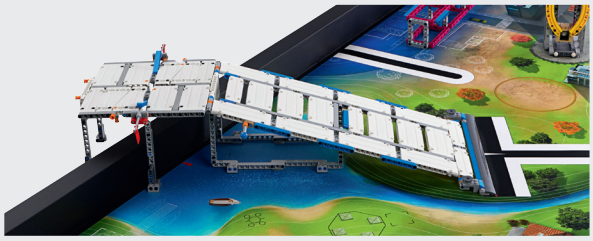
Step 2: Double-check all dual lock locations



Step 3: Reinstall the entrance

Step 4: Adjust dual lock to get corners on red dots

Step 5: Be sure flag moves freely and points down



Step 6: Be sure the bridge top is centered over the north wall and substitute wall (if you have a wall).

Step 7: Use the support axles under the bridge top so it can hold a heavy robot. Experiment to see which length makes the top most level

TIP - Use books for Bridge support if your Field has no walls.

Using this Engineering Notebook

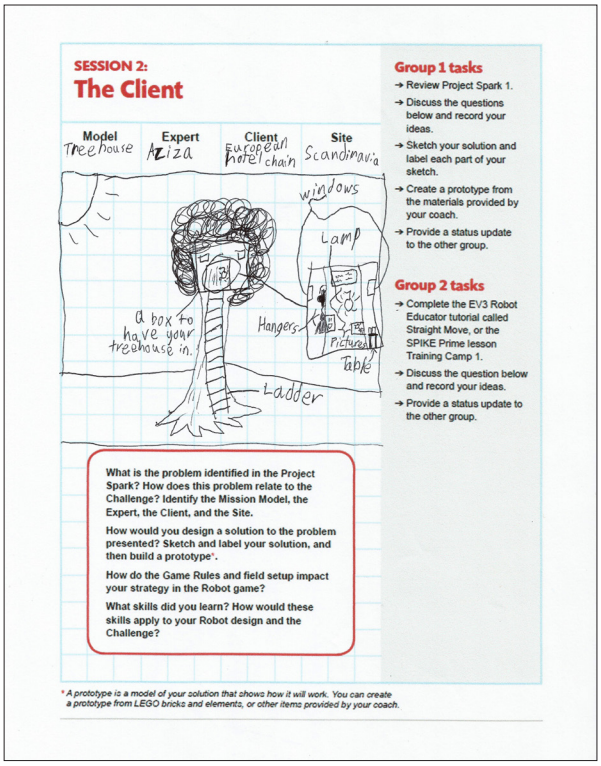
The Engineering Notebook guides you through each session. Use it to document your thoughts, sketches, and ideas. It serves as a proof of learning and is a great resource to use when presenting your Robot and Innovation Project solution. Also document Core Values concepts you see demonstrated by your team.

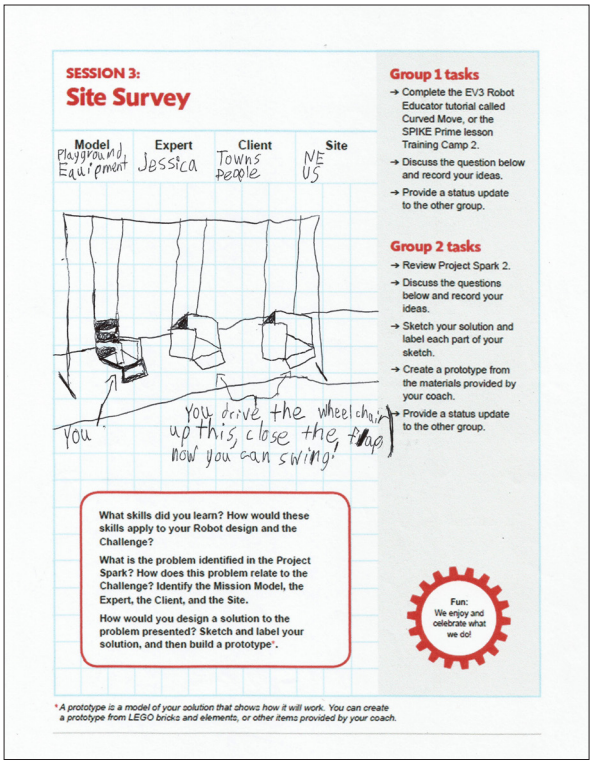
Each session has a series of tasks listed in by Group 1 and Group 2. Mark off each task as you complete them.

Here are some ideas of what could be captured in the Engineering Notebook.

- Sketches
- Designs
- Notes
- Calculations
- Pictures and drawings
- Processes
- Thoughts
- Code explanations
- Software development
- Discussions

On the next few pages, you will find out what you need to design, program and build your Robot for the Robot game. There is also an explanation of the missions for this year and the rules for playing the game. These are both really important to read carefully and understand.





Missions

The object of the game is to shape your growing city with more stable, beautiful, useful, accessible and sustainable buildings and structures. Solve the real-world problems represented in the Missions to score points. You can also score by moving new units on the field. New unit point values depend on their height and location.

Remember: Each official match lasts 2-1/2 minutes. You may not have time to complete all the Missions, so be strategic about which ones you choose.

NOTE: If your Robot and all its equipment fit in the 'Small Inspection Area', the advantage for this game is 5 points added to each Mission where you score ANY points. Exceptions: Mission 14 doesn't apply, and for Mission 2, you get 10 added instead of 5.

Mission 1 Elevated places (Score all that apply)

➔ If the Robot is Supported by the Bridge: **20**

➔ If one or more Flags are clearly raised any distance, only by the Robot: **15 Each Flag**

You can only get Flag points if you get Bridge points.
Rule 31 allowance: *It is okay and expected for Robots to collide while trying to earn Flag points.*

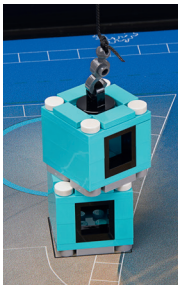
When clearly only one Robot is holding a Flag raised, only that Robot scores for that Flag.

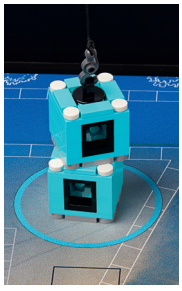
Mission 2 Crane (score all that apply)

If the Hooked Blue Unit is

➔ clearly lowered any distance from the Guide Hole: **20**

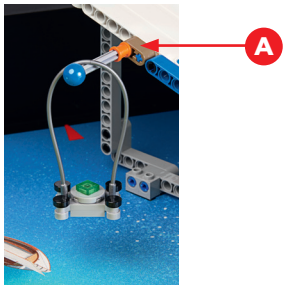
➔ Independent and Supported by another Blue Unit: **15**
and Level 1 is Completely in the Blue Circle: **15**





Mission 3 Inspection drone

➔ If the Inspection Drone is Supported by axle (A) on the Bridge: **10**



Mission 4 **Design for wildlife**

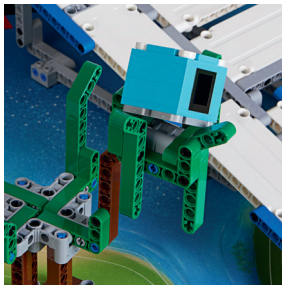
➔ If the Bat is Supported by branch (B) on the Tree: **10**

Mission 5 **Treehouse (Score all that apply)**

If a Unit is Independent and Supported by the Tree's

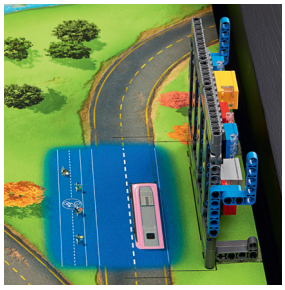
➔ Large Branches: **10 Each Unit**

➔ Small Branches: **15 Each Unit**



Mission 6 **Traffic jam**

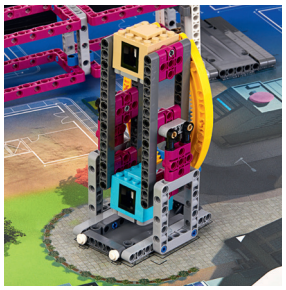
➔ If the Traffic Jam is lifted, its moving part is Independent, and it is Supported only by its hinges as shown: **10**



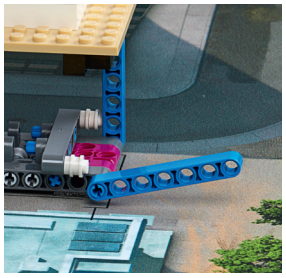
Mission 7 **Swing**

➔ If the Swing is released: **20**

Mission 8 Elevator (Score one or the other)
If the Elevator's moving parts are Independent, and Supported only by its hinges as shown, in the following position
➔ Blue Car Down: **15**
➔ Balanced: **20**



Mission 9 Safety factor
➔ If the Test Building is Independent and Supported only by the blue beams, and some beams have been knocked out at least half way:
10 Each Beam

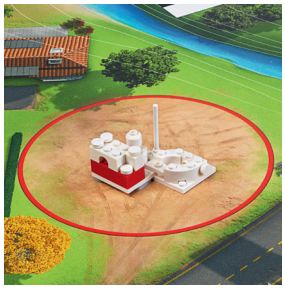


Mission 10 Steel construction
➔ If the Steel Structure is standing, and is Independent, and Supported only by its hinges as shown: **20**

Mission 11 Innovative architecture (score one or the other)
If there is a team-designed Structure clearly bigger than a Blue Building Unit, built only from your white LEGO bricks
➔ Completely In any Circle: **15**
➔ partly in any Circle: **10**

Random structure shown. Design and build your Structure before you compete, then bring that to each Match. You don't build it during the Match.

Your Mission 11 Structure needs to be built from Bag 10 elements only. It can include the red and gray elements. Not all of the Bag 10 elements need to be used.



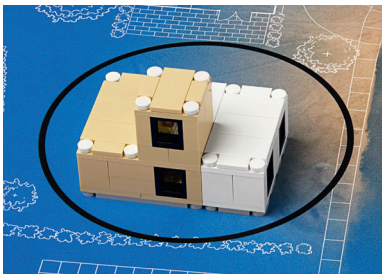
Mission 12 Design & build (Please take the needed time to understand the scoring examples)

➔ LOCATION - If there are any Circles with at least one color-matching Unit Completely In, and Flat Down on the Mat: **10 Each Circle**

(Note: The Blue Circle is not Part of Mission 12).

➔ HEIGHT - If there are Independent Stacks at least partly in any Circles, add all of their heights together: **5 Each Level**

(Note: A Stack is one or more Building Units with Level 1 touching Flat Down on the Mat, and any higher levels touching Flat Down on the level below).



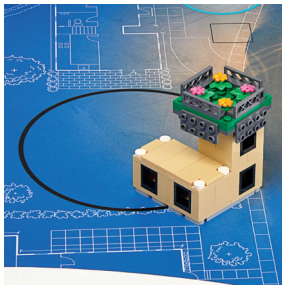
Color match = no
Tan stack = 2 levels
White stack = 1 level
15 points shown

Color match = no
Bridged stack = 4 levels
20 points shown

Color match = red
Red stack = 2 levels
Other stack = 4 levels
40 points shown

Mission 13 Sustainability upgrades (only one counts per stack)

➔ If an Upgrade (solar panels, roof garden, insulation) is Independent, and Supported only by a Stack which is at least partly in any Circle: **10 Each Upgrade**



Mission 14 Precision (only one score counts)

➔ If the number of Precision Tokens left on the Field is 6: **60** / 5: **45** / 4: **30** / 3: **20** / 2: **10** / 1: **5**

Robot game rules

Definitions

– Here's what to know and expect, and how to get ready for a Match.

01. ROBOT – This is your LEGO MINDSTORMS **controller** and **all the Equipment you combine with it by hand**, which is **not intended to separate from it, except by hand.**

02. EQUIPMENT – This is anything **you bring** to a Match for Mission-related activity, including the Robot.

03. MATCH – When two teams play opposite each other on two Fields placed north to north. Your Robot Launches one or more times from the Launch Area and tries as many Missions as possible in 2-1/2 minutes.

04. FIELD – Includes Home, the Field Mat, the Mission Models, and everything else extending to include the inner sides of the Border Walls.

05. MISSION MODEL – Any LEGO object already at the Field when you get there.

06. LAUNCH AREA – This is the Mat's inner quarter-circle area and the black lines that form it. It extends to include the face of the south Border Wall, but no father. It does not include the white band of sponsor logos.

07. HOME – Table surface west of the Field Mat that includes the faces of its Border Walls.

Field

Mat

Home

Large inspection area

Small inspection area

Launch area

08. – LAUNCH – Whenever you're done handling the Robot and then you make it GO.

09. INTERRUPTION – The next time you interact with the Robot after Launch.

10. PRECISION TOKEN – These are six red discs on the Field, already worth points when the Match starts. Interrupting the Robot before it gets Completely Into Home causes the Referee to take them away.

11. TRANSPORT & CARGO – When something is purposefully/strategically being
➔ taken from its place, and/or
➔ moved to a new place, and/or
➔ being released in a new place,
it is being 'Transported' and is called 'Cargo'. When the object is clearly no longer touching whatever was Transporting it, Transport is ended, and the object isn't Cargo any more.

Tournament rules

Remember you have at least three Official Rounds, so don't panic if something goes wrong. Your best score is the one that will count.

Bring to the match	Leave behind at the pits
Your full competitive team (up to 10), including two designated technicians.	All other electronic items
Your Robot (only one if you have more than one) and all its Equipment, including:	Spare Robots
ONE controller's power pack or SIX AA batteries	Extra controllers
LEGO wires and converter cables, as needed	

12. Teams, Coaches, Referees and all others are expected to model the *FIRST*® Core Values at all times.
13. Remote control and/or data exchange with Robots (including Bluetooth) in the competition area is illegal.
14. You can only safely touch the Robot while preparing to Launch, or when it's completely in Home.
15. The thin line around any scoring area counts as part of the area.
16. BENEFIT OF THE DOUBT – If the Referee is faced with a very tough call, and no one can point to strong text to settle it, you get the Benefit of the Doubt, but don't rely on this as a strategy.
17. Official Robot Game Updates override the Missions and Field Setup. Missions and Field Setup override the Rules. Your local Head Referee will make final decisions after a Match, when needed.

Before the match timer starts

18. You have at least 1 minute to prepare. This is your chance to ask the Referee to check that Mission Model setup is correct, and/or calibrate light/color sensors anywhere you like.
19. Show the Referee that ALL your Equipment fits in either the Large or Small Inspection Area (your choice), under an imaginary ceiling 12 in. (30.5 cm) high. If it fits in the **Small** Inspection area, you get an advantage. The "Small Area" advantage for the City Shaper game is 5 points added to each Mission where you score ANY points. Exceptions: Mission 14 doesn't apply, and for Mission 2, you get 10 added instead of 5.
After passing Inspection, arrange your Equipment anywhere in Home for storage and adjustments, and/or the Launch Area for Launch.
Before the Match starts, you are allowed to calibrate sensors anywhere you like, and/or ask the Referee to check the correctness of Mission Models and setups.

20. Decide on two technicians to begin play. Only two Technicians are allowed at the competition Field at once, but technicians can switch out at any time. The rest of the team must stand back as directed by tournament officials unless needed for emergency repairs during the Match.

During the match

21. Launch sequence

READY SITUATION: Your Robot and everything it's about to move or use is arranged as you like. It must fit **completely in the Launch Area** and measure no taller than 12 in. (30.5 cm).

➔ When the Referee can see that nothing on the Field is moving or being handled, she/he will begin the countdown of the first launch.

➔ The precise timing of the first Launch of the Match is at the beginning of the last word or sound in the countdown, such as "Ready, set, **G**o!" or **B**eeeep!

22. Don't interact with any part of the Field that's not **completely** in Home, except to Launch.
– Except: If Equipment breaks off the Robot **unintentionally**, you may pick it up immediately from anywhere.

23. Don't cause anything except the Robot to move or extend out of Home, even partly, except to Launch.
– Except: If something accidentally crosses out of Home, you can take it back.

24. Anything the Robot affects or puts completely outside the Launch Area **stays as is** unless the Robot changes it.

25. Don't take Mission Models apart unless the Mission asks you to.

26. Do store all your Equipment and anything the Robot brings to Home in Home.

27. INTERRUPTION PROCEDURE – If you **Interrupt** the Robot, stop it instantly, then calmly pick it up for the next Launch.

Where was the Robot Interrupted?

➔ **Completely** in Home:	No problem.
➔ **Not Completely** in Home:	Lose a Precision Token.

28. INTERRUPTION WITH CARGO – If the Robot has Cargo when Interrupted,

Where was the Cargo acquired?

➔ **Completely** in the Launch Area:	Keep it.
➔ **Not Completely** in the Launch Area...	

Where was the Cargo at Interruption?

➔ **Completely** in Home:	Keep it.
➔ **Not Completely** in Home:	Referee takes it.

29. STRANDED CARGO – If the Uninterrupted Robot loses Cargo, let the Cargo come to rest.

Where did the Cargo come to rest?

➔ **Completely** in Home:	Keep it.
➔ **Not Completely** in Home:	Leave as is.

30. INTERFERENCE – Do not negatively affect the other team at the table except as allowed in a Mission description. If you, your team or your Robot prevents another team from completing a Mission, the Referee will award them the points for that Mission.

31. FIELD DAMAGE – If the Robot separates Dual Lock or breaks a Mission Model **and** clearly benefits from the damage, Missions benefitting will not score.

End of the match

32. As the Match ends, everything must be preserved exactly as-is.
➔ If your Robot is moving, stop it ASAP and leave it in place. (Changes after the end don't count.)
➔ After that, hands off everything until after the Referee has given the ok to reset the Field.

Keep these two special definitions in mind as you read Mission scoring requirements:
33. INDEPENDENT – Not touching any equipment.
34. SUPPORTED – 100% of its weight is held up **and** kept from falling.

Scoring

35. Only the final (end-of-Match) condition of your Field is evaluated for scoring.
36. The Referee discusses what happened and inspects the Field with you, Mission by Mission.
➔ If the team and Referee agree, a team member signs the scoresheet, and it is final.
➔ If the team and Referee disagree, the Head Referee makes the final decision.
37. Only a team's **best** score from regular Match play counts toward awards/advancement. Any playoffs held are just for fun.
38. Ties are broken using 2nd, then 3rd best scores. If still not settled, tournament officials decide what to do.

Meet the Experts!

AZIZA

Civil engineer, Architect
Expertise: Making buildings fit surroundings
Creating sustainable buildings and public places
Goals: Help people enjoy beauty of nature

JESSICA

Architect
Expertise: Designing and constructing hospitals
Goals: Make buildings and public spaces that are accessible and functional for everyone by looking at the world through the eyes of people with different abilities

WEI

Civil Engineer, Environmental Engineer
Expertise: Designing building envelopes that allow the correct flow of air, heat and humidity
Goals: Create energy efficient buildings that keep people comfortable

LELLI

Structural Engineer, Professor
Expertise: Designing buildings and structures to resist earthquakes
Goals: Ensure that people and the things survive earthquakes by testing structural designs and inspecting how seismic damage occurs

Project Spark 1

Site: Sapmi Region in Scandinavia

Location: 50 km (30 mi) south of the Arctic Circle

Conditions: Gentle hills, thick forest. Extreme weather from - 16° C (3° F) til 3° C (37° F), snowfall up to 225 days a year.

Client: European hotel chain

Needs: New hotel

Goals: Guests feel like part of the forest with comforts of home. Keep views and don't disturb settings.

The game

The "Treehouse" mission demonstrates how architects solved the problem of the forest hotel. Their solution was a series of treehouses that seem to float in midair.

Project Spark 2

Site: Northeast United States

Conditions: Flat ground with a few rolling hills. Easy access for people, material and equipment

Client: Townspeople

Needs: Redesign and update an old playground

Goals: Playground equipment that can be used by everyone

The game

The "Swing" Mission shows you exactly how architects and engineers solved this problem: a swing built just for a wheelchair!

Project Spark 3

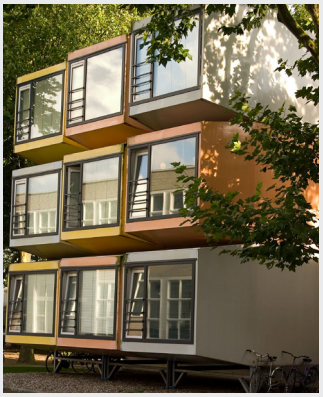
Site: Valparaíso Region on the coast of Chile.

Conditions: Steep, beachfront property with difficult access for builders. Prone to earthquakes.

Client: Homebuyers in Coastal Chile

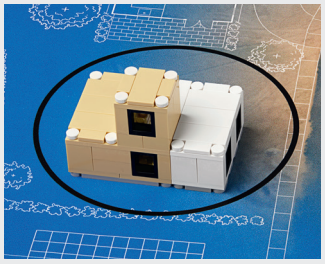
Needs: Affordable housing that can be constructed quickly.

Goals: Energy efficient homes that meet local building codes for earthquake safety.



The game

The “Building Units” Mission shows a great way to build homes swiftly. Modular construction is a way to create sections of a building in a factory that can be assembled quickly at the building site.



Project Spark 4

Site: Midwest United States

Conditions: Mainly flat prairie land with numerous lakes, rivers and streams.

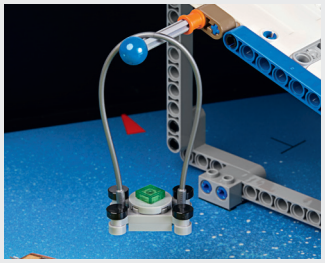
Client: State Department of Transportation

Needs: Inspection of about 20,000 road bridges.

Goals: Conduct inspections quickly and safely for as little cost as possible.

The game

The “Inspection Camera Drone” Mission reveals an inexpensive way to check out bridges and other tall structures. Drones can fly for hours and send back detailed pictures and even 3D scans.



SESSION 1:

The Architect

What did you find most interesting about the Challenge?

What are some obstacles you may encounter on the field?

What do you already know about the Challenge topic?

What is your favorite Mission Model? Why? What real world problems can be demonstrated with this model?

Group 1 tasks

- ➔ Review the Challenge.
- ➔ Record your assigned Mission Model Name(s) and Number(s).
- ➔ Build your assigned model(s) following the build instructions.
- ➔ Place the completed models on the field mat.
- ➔ Provide a status update to the other group.

Group 2 tasks

- ➔ Review the Challenge.
- ➔ Record your assigned Mission Model Name(s) and Number(s).
- ➔ Build your assigned model(s) following the build instructions.
- ➔ Place the completed models on the field mat.
- ➔ Provide a status update to the other group.

SESSION 2:
The Client

Model	Expert	Client	Site

What is the problem identified in the Project Spark? How does this problem relate to the Challenge? Identify the Mission Model, the Expert, the Client, and the Site.

How would you design a solution to the problem presented? Sketch and label your solution, and then build a prototype*.

How do the Game Rules and field setup impact your strategy in the Robot game?

What skills did you learn? How would these skills apply to your Robot design and the Challenge?

Group 1 tasks

➔ Review Project Spark 1.

➔ Discuss the questions below and record your ideas.

➔ Sketch your solution and label each part of your sketch.

➔ Create a prototype from the materials provided by your coach.

➔ Provide a status update to the other group.

Group 2 tasks

➔ Complete the EV3 Robot Lesson 1 to learn the basics and build your first robot driving base. Follow these tasks in EV3 Lab.

➔ Task 1: Start Here > Try.

➔ Task 2: Start Here > Use (page 3).

➔ Challenge: Start Here > Use (page 4).

➔ Discuss the question below and record your ideas.

➔ Provide a status update to the other group.

* *A prototype is a model of your solution that shows how it will work. You can create a prototype from LEGO bricks and elements, or other items provided by your coach.*

SESSION 3:

Site Survey

Model	Expert	Client	Site

What skills did you learn? How would these skills apply to your Robot design and the Challenge?

What is the problem identified in the Project Spark? How does this problem relate to the Challenge? Identify the Mission Model, the Expert, the Client, and the Site.

How would you design a solution to the problem presented? Sketch and label your solution, and then build a prototype*.

Group 1 tasks

➔ Complete the EV3 Robot Lesson 2 to program your robot to move in different ways. Follow the first two tasks in EV3 Lab.

➔ Task 1: Start Here > Use (page 3).

➔ Task 2: Start Here > Use (pages 4-8).

➔ Challenge: Use what you've learned to drive your robot across the Robot Game Field. Use the cube as a stopping point.

➔ Discuss the question below and record your ideas.

➔ Provide a status update to the other group.

Group 2 tasks

➔ Review Project Spark 2.

➔ Discuss the questions below and record your ideas.

➔ Sketch your solution and label each part of your sketch.

➔ Create a prototype from the materials provided by your coach.

➔ Provide a status update to the other group.

Fun:
We enjoy and celebrate what we do!

* *A prototype is a model of your solution that shows how it will work. You can create a prototype from LEGO bricks and elements, or other items provided by your coach.*

SESSION 4:
Foundations

Model	Expert	Client	Site

What is the problem identified in the Project Spark? How does this problem relate to the Challenge? Identify the Mission Model, the Expert, the Client, and the Site.

How would you design a solution to the problem presented? Sketch and label your solution, and then build a prototype*.

Which Mission do you think this Robot lesson will help you solve? How?

Group 1 tasks

➔ Review Project Spark 3.

➔ Discuss the questions below and record your ideas.

➔ Sketch your solution and label each part of your sketch.

➔ Create a prototype from the materials provided by your coach.

➔ Provide a status update to the other group.

Group 2 tasks

➔ Complete the EV3 Robot Lesson 3 to program your robot to move and stop in different ways. Follow these tasks in EV3 Lab.

➔ Task 1: Tutorials > Basics > Straight Move.

➔ Task 2: Tutorials > Basics > Stop at Object.

➔ Challenge: Tutorials > Basics > Tank Move.

➔ Discuss the question below and record your ideas.

➔ Provide a status update to the other group.

* *A prototype is a model of your solution that shows how it will work. You can create a prototype from LEGO bricks and elements, or other items provided by your coach.*

SESSION 5:

Vitruvius

Model	Expert	Client	Site

Which Mission do you think this Robot lesson will help you solve? How?

What is the problem identified in the Project Spark? How does this problem relate to the Challenge? Identify the Mission Model, the Expert, the Client, and the Site.

How would you design a solution to the problem presented? Sketch and label your solution, and then build a prototype*.

Group 1 tasks

➔ Complete the EV3 Robot Lesson 4 to program your robot to interact with game objects. Follow the first two tasks in EV3 Lab.

➔ Task 1: Tutorials > Basics > Curved Move.

➔ Task 2: Tutorials > Basics > Move Object.

➔ Challenge: Modify the program and attachment to deliver the different Building Units (Mission 12) to the Game Field.

➔ Discuss the question below and record your ideas.

➔ Provide a status update to the other group.

Group 2 tasks

➔ Review Project Spark 4.

➔ Discuss the questions below and record your ideas.

➔ Sketch your solution and label each part of your sketch.

➔ Create a prototype from the materials provided by your coach.

➔ Provide a status update to the other group.

Impact:
We apply what we learn to improve our world.

* *A prototype is a model of your solution that shows how it will work. You can create a prototype from LEGO bricks and elements, or other items provided by your coach.*

SESSION 6:
Blueprints

Problems	Constraints	Solutions

List your problem, solution and constraints* here in your Engineering Notebook. Determine the client for this job, the experts needed, and the site.

How would you design a solution to the problem you chose? Sketch and label your solution.

What attachment could you create to solve a Mission? How would you use the lines to get there?

Group 1 tasks

- ➔ Identify problems with a building or public space in your community.
- ➔ Research and brainstorm solutions and determine the constraints for each solution.
- ➔ Choose the solution that you think will work best. Sketch your solution and label each part of your sketch.
- ➔ Provide a status update to the other group.

Group 2 tasks

- ➔ Complete the EV3 Robot Lesson 5 to learn to use sensors in more advanced ways. Follow these tasks in EV3 Lab.
- ➔ Task 1: Tutorials > Beyond Basics > Multiple Switch.
- ➔ Task 2: Tutorials > Beyond Basics > Sensor Blocks.
- ➔ Challenge: Tutorials > Beyond Basics > Sensor Blocks (page 5).

- ➔ Discuss the question below and record your ideas.
- ➔ Provide a status update to the other group.

* *Constraints are things that help you focus so you create the best solution for your client and site. Constraints can be things like how much money you can spend, the building materials you have, and the location and features of your building site.*

SESSION 7:
Building Code

Problems	Constraints	Solutions

How can you program your Robot to be fast AND reliable on the Challenge field?

List your problem, solution and constraints* here in your Engineering Notebook. Determine the client for this job, the experts needed, and the site.

How would you design a solution to the problem you chose? Sketch and label your solution.

Group 1 tasks

➔ Complete the EV3 Robot Lesson 6 to learn to stop at and follow lines. Follow these tasks in EV3 Lab.

➔ Task 1: Tutorials > Basics > Stop at Line.

➔ Task 2: Tutorials > Beyond Basics > Switch.

➔ Challenge: Tutorials > Beyond Basics > Color Sensor - Calibrate.

➔ Discuss the question below and record your ideas.

➔ Provide a status update to the other group.

Group 2 tasks

➔ Identify problems with a building or public space in your community.

➔ Research and brainstorm solutions and determine the constraints for each solution.

➔ Choose the solution that you think will work best. Sketch your solution and label each part of your sketch.

➔ Provide a status update to the other group.

Inclusion: We respect each other and embrace our differences.

* *Constraints are things that help you focus so you create the best solution for your client and site. Constraints can be things like how much money you can spend, the building materials you have, and the location and features of your building site.*

SESSION 8:

Construction

Problems	Constraints	Solutions

List the constraints* for your Innovation Project solution. Record any changes you made to your solution after your research and brainstorming.

Sketch and label your solution, and then build a prototype. Be sure to include the white bricks in your prototype.

Sketch your Robot solution. What does its base look like? Does it have sensors and attachments?

What changes did you make during the creation of your Robot? What does the final design look like?

Group 1 tasks

➔ Decide on a final Innovation Project and solution for your team.

➔ Research or brainstorm all the constraints.

➔ Decide how you could test your solution to make sure it will work.

➔ Create a final prototype. Be sure to use the Innovation Elements (white bricks) in some way!

➔ Document any changes made from your initial design.

➔ Provide a status update to the other group.

Group 2 tasks

➔ Decide on a final Innovation Project and solution for your team.

➔ Complete the EV3 Robot Lesson 7 tasks on the Robot Lessons poster.

➔ Task 1: Build the attachments for the driving base.

➔ Task 2: Use the basic program to learn how to activate the Crane.

➔ Challenge: Design a way to activate both levers on the Crane.

➔ Discuss the questions below and record your ideas.

➔ Provide a status update to the other group.

* *Constraints are things that help you focus so you create the best solution for your client and site. Constraints can be things like how much money you can spend, the building materials you have, and the location and features of your building site.*

SESSION 9:

Inspection

Were you successful in this Mission? What changes did you make to the design and program?

Which Missions are located near each other on the field? Which Missions have similar elements?

List the supplies you will need to complete your presentation.

What still needs to be done to finish your presentation?

Project presentation

- Problem
- Research
- Solution
- Design process
- Innovation
- Core values
- Prototype

Group 1 tasks

➔ Determine your game strategy.

➔ Create and test your solution to the Crane Mission.

➔ Choose another Mission to create a solution for and test if time allows.

➔ Discuss the questions below and record your ideas.

➔ Provide a status update to the other group.

Group 2 tasks

➔ Decide how your team will present your final Innovation Project. You can create a slideshow, a poster or use some other approach. (Ask your coach for help.)

➔ Obtain any supplies you will need and begin work on your presentation.

➔ Be sure to include your problem, your solution and the constraints in your Project presentation.

➔ Provide a status update to the other group. Be sure to let them knows what needs to be done to finish the presentation.

Teamwork:
We are stronger when we work together.

SESSION 10:

Renovations

List the supplies you will need to complete your presentation.

What still needs to be done to finish your presentation?

Which Missions could be grouped together for maximum points?

What is your game strategy? How many Missions will you attempt in the event?

Robot presentation

- Problem
- Research
- Solution
- Design process
- Innovation
- Core values
- Prototype

Group 1 tasks

➔ Determine what needs to be done to complete your final Innovation Project presentation. Be sure to check in with the other group before you start.

➔ Obtain any supplies you will need and begin work on your presentation.

➔ Provide a status update to the other group so together you can put any finishing touches on the presentation.

Group 2 tasks

➔ Continue to create a solution for each Mission as time allows.

➔ Document your game strategy.

➔ Draw the path your Robot with travel.

➔ Discuss the questions below and record your ideas.

➔ Record which Mission(s) you will test in the competition.

➔ Work as a team to prepare for final presentations.

SESSION 11+12:

Grand Opening

What did you learn about working as a team?

What are your key takeaways from this experience?

Team

- ➔ Gather materials needed to do Innovation Project and Robot Design presentations.
- ➔ Practice your presentation.
- ➔ Give your presentations.
- ➔ Watch other teams present.
- ➔ Ask questions and provide feedback to other teams.
- ➔ Follow clean up instructions provided by coach.

Appendix

Judging Sample Questions

INNOVATION PROJECT EXAMPLES

Discovery

- What problem did your team choose to solve?
- What sources did you use?
- Did you adapt an existing solution or create your own solution?
- Did you consult with an expert to solve the problem?

Innovation

- What is original and innovative about your solution?
- Did you improve on someone's solution?
- How did you develop and test your idea?
- How did you evaluate your solution and improve upon it?

Communication

- How would your solution help others?
- Who have you shared your solution with?
- How would your solution help the world?
- How did your team work together to create your presentation?

ROBOT DESIGN EXAMPLES

Discovery

- How did you test your Robot design?
- Describe your programs. Did they work consistently?
- How did you evaluate your Robot design?
- What advanced programming concepts did you use?

Innovation

- Is your Robot design original or did you model it from something existing?
- Are your programs unique or did you modify them from something existing?
- What is your strategy for solving game missions?
- What is innovative about your Robot design?

Communication

- How did your team collaborate on the Robot design?
- How did your team work together to test the Robot?
- How were the programs created by the team?
- How did you act as a team to determine the game strategy?

CORE VALUES EXAMPLES

Discovery

- How did each person participate in each part of the Challenge?
- How did you explore and apply core values?
- How will your team expand Core Values and participation beyond this season?

Innovation

- How did you use Core Values to overcome challenges?
- How independent was your team?
- How much did you use your coach for help?
- What is your team identity?

Communication

- How did you demonstrate respect and inclusion within your team and beyond it?
- How did you learn and display *Coopertition,* fairness, and integrity within your team and beyond it?

Appendix

School Event Judging Rubric

This is the judging rubric to be used at school organized events.

Team Number _____ Team Name _____

		Developing	Achieved	Exemplary (Achieved + the following)
PROJECT	Discovery	Limited development of problem and solution. No sources or experts identified.	**Adapted existing solution and clear problem.** **Identified sources for innovation project ideas.**	Well defined problem and unique solution. Used a variety of sources including an expert.
	Innovation	Solution identified already exists. Limited testing and development of idea.	**Created an original and innovative solution.** **Developed, tested and improved their idea.**	Well defined testing and evaluation of solution. Results were used to improve their idea.
	Communication	Presentation doesn't always flow well. Not clear how the solution would help others.	**Creative and engaging presentation by team.** **Showed how the solution would help others.**	Shared presentation with experts. Showed how the solution would help the world.
ROBOT DESIGN	Discovery	Limited testing of Robot design. Basic programs that worked inconsistently.	**Clear testing of Robot design.** **Effective use of basic programs.**	Well defined testing and evaluation of Robot design. Effective use of advanced programs.
	Innovation	Design, programs, and strategy are unoriginal, and have not been improved or modified.	**Modified or improved Robot design or programs.** **Clear strategy for solving game missions.**	Innovative Robot design and programs. Well-defined strategy for solving game missions.
	Communication	Limited understanding of Robot design. Unclear or limited game strategy.	**Clear understanding of Robot design.** **Clear strategy for 1-2 game missions.**	Clear understanding of Robot Design and testing process. Clear strategy for most/ all game missions.
CORE VALUES	Discovery	Some team members participated. Team only beginning to explore Core Values.	**Full participation of team in entire Challenge.** **Clear exploration of Core Values.**	Participation extends beyond team and season. Application of Core Values during season and beyond.
	Innovation	1 or no Core Values used to overcome a challenge. Limited team autonomy with a lot of coach help.	**Used some Core Values to overcome challenges.** **Self-directed team with minimal coach guidance.**	Applied all Core Values to overcome challenges. Developed own team identity and autonomy.
	Communication	Respect and inclusion being developed. Developing fairness, integrity, and *Coopertition*.	**Demonstrated respect and inclusion of team.** **Understanding of fairness, integrity and *Coopertition*.**	Displayed inclusion and respect beyond team. Displayed *Coopertition*, fairness, and integrity.

APPENDIX

- ➔ **Architecture** – the art and science of planning, designing, and constructing buildings, structures and spaces
- ➔ **Engineering** – the use of mathematics, science and technology to create products and systems to improve the world
- ➔ **Vitruvius** – one of the first architects to develop a systematic approach to design – advised that building designs should strive for strength, usefulness, and beauty
- ➔ **Building** – a human-made assembly with a roof and walls intended as a place for people to live, work or play
- ➔ **Structure** – a system of connected parts used to support a weight or a load that is not designed for continuous human use
- ➔ **Public space** – an area or place that is open and accessible to all people
  Examples: plazas, squares and parks, and connecting spaces like sidewalks and streets
- ➔ **Site survey** – the process of selecting and developing the best available location for a building or structure
  Example factors: topography, landforms, drainage, community and environmental impact
- ➔ **Infrastructure** – the fundamental services that supply a place with modern the facilities necessary for its society to function
  Examples: roads, bridges, tunnels, waterways, water and sewer; electrical grids, and telecommunications (including Internet)
- ➔ **Modular building** – a design and build process that involves creating sections of a building away from the construction site, and then delivering the sections to the site for permanent construction
- ➔ **Inspection drone** – a small remotely-operated unmanned aerial vehicle (UAV) that can be employed to inspect bridges and infrastructure using high-definition cameras and other sensors; can serve as a cheaper and safer way to conduct some inspections
- ➔ **Tree house** – a structure or building constructed adjacent to or among a tree or trees; can be designed for play or leisure, or give people a more authentic experience when visiting forest areas for “eco-tourism”
- ➔ **Accessibility (in architecture)** – ensuring that building design and construction addresses the needs of potential users, with special emphasis placed on meeting the requirements for people of all levels of physical, cognitive, emotional and health abilities
- ➔ **Architect** - a professional skilled in the art and science of the design and construction of buildings and structures; architects decide how buildings will look
  Example factors: client needs, energy and cost efficient, strong and durable
- ➔ **Client** – the customer or user for whom a building or structure is designed and built
- ➔ **Civil engineer** – a professional who designs and constructs public and private infrastructure projects
  Examples: roads, buildings, airports, tunnels, dams, bridges, and systems for water supply and sewage treatment
- ➔ **Structural engineer** – a professional who use math, science and engineering principles to make sure that forces won’t damage or destroy a building or structure
- ➔ **Environmental engineer** – a professional who protects people from negative environmental effects
  Examples: reduce air and water pollution, and improve recycling, waste disposal, and overall public health

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