

# Abstract of **ENGINEERING NOTEBOOK**

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**CITY  
SHAPER**



**HANDS ON  
TECHNOLOGY**

# 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. |
| <i>TIP – At tournaments you should expect, and design for, rare imperfections like changes in light, or bumps under the mat.</i> |  |

| 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. | <br>Medium<br><br>Large   |
|  | Sensors    | Unlimited                               |  <br>  |
| SOFTWARE   |            |   |  |
| You can use any software that allows the Robot to move autonomously – meaning it moves on its own. |            |   |  |
| <b>No</b> form of remote control is allowed.   |            |   |  |

# Set up your field

## Your challenge set contains:

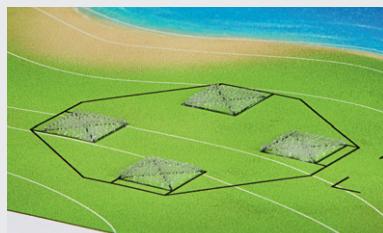
Field Mat, Mission Models, Dual Lock and White LEGO bricks that can be used to build your Innovation Project prototype

**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.

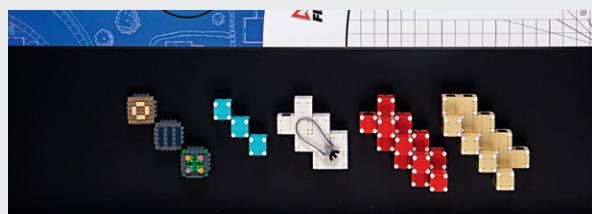
**Loose models** – Place as shown detailed here.



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.



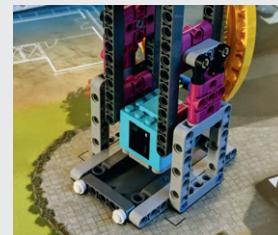
Swing



Tree



Traffic jam



Elevator

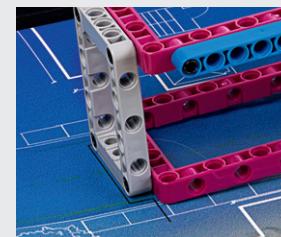
## Multi-step secured models

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

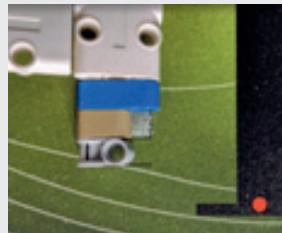
## Bridge:



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



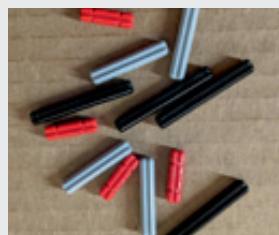
Step 4: Adjust dual lock to get corners on red dots



Step 5: Be sure flag moves freely and points down



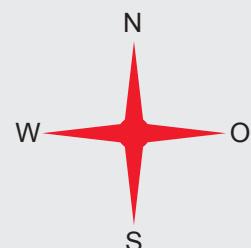
Step 6: Be sure the bridge top is centered over the north wall and substitute wall (if you have a wall).



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



Field mat overview



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

# 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.

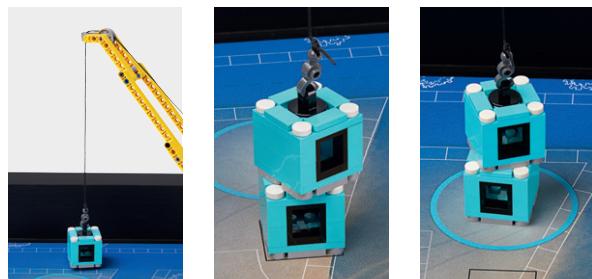
*When clearly only one Robot is holding a Flag raised, only that Robot scores for that Flag.*



## Mission 2 Crane (score all that apply)

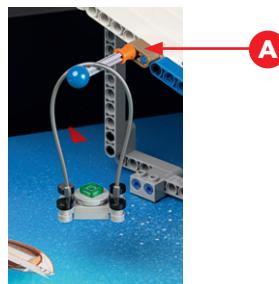
If the Hooked Blue Unit is

- 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**

**B****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**

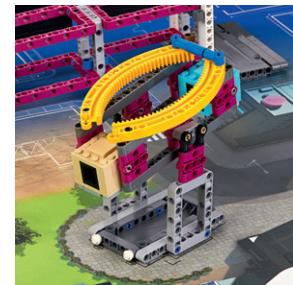


### **Mission 8 Elevator (Score one or the other)**

If the Elevator's moving parts are Independent, and Supported only by its hinges as shown, in the following position

→ Blue Car Down: **15**

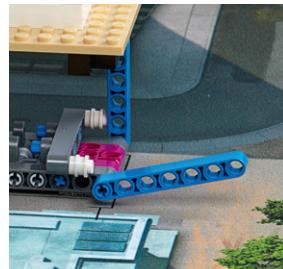
→ Balanced: **20**



### **Mission 9 Safety factor**

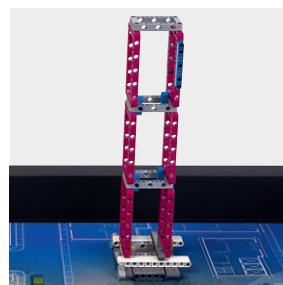
→ If the Test Building is Independent and Supported only by the blue beams, and some beams have been knocked out at least half way:

**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



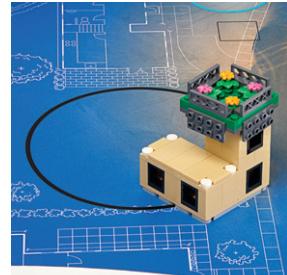
Color match = no  
Bridged stack = 4 levels  
20 points shown



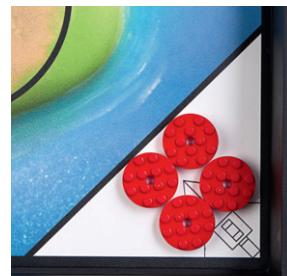
Color match = red  
Red stack = 2 levels  
Other stack = 4 levels  
40 points shown

**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.

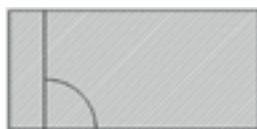
**03. MATCH** – When two teams play opposite each other on two Fields placed north to north. Your Robot Launches one or more times from the Launch Area and tries as many Missions as possible in 2-1/2 minutes.

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

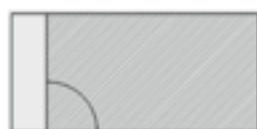
**05. MISSION MODEL** – Any LEGO object already at the Field when you get there.

**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 further. 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, Go!" or Beeeeeep!

**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?

- |                                  |                         |
|----------------------------------|-------------------------|
| → <b>Completely</b> in Home:     | No problem.             |
| → <b>Not Completely</b> in Home: | Lose a Precision Token. |

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

Where was the Cargo acquired?

- |   |          |
|---|----------|
| → <b>Completely</b> in the Launch Area:       | Keep it. |
| → <b>Not Completely</b> in the Launch Area... |          |

Where was the Cargo at Interruption?

- |                                  |                   |
|----------------------------------|-------------------|
| → <b>Completely</b> in Home:     | Keep it.          |
| → <b>Not Completely</b> 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?

- |                                  |              |
|----------------------------------|--------------|
| → <b>Completely</b> in Home:     | Keep it.     |
| → <b>Not Completely</b> 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.