STAR net

Hands-on

Tested & Approved STEM Activities

Rover Designs

Coding with Art

Activity Guide

STAR net

Science-Technology Activities & Resources For Libraries

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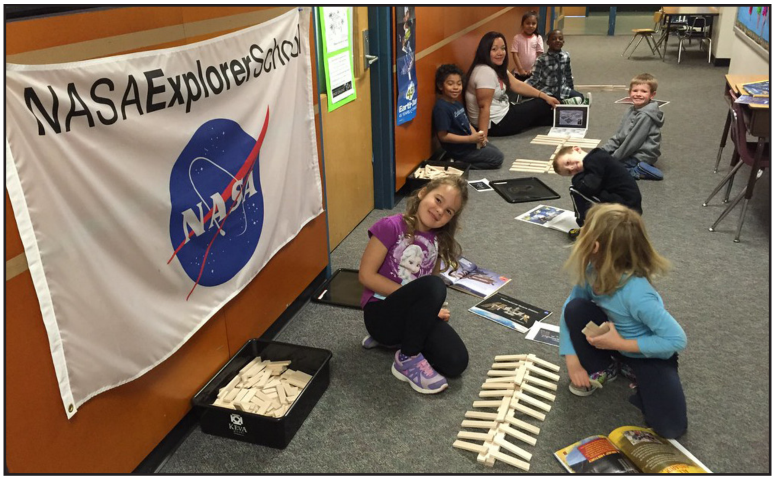
This material is based upon work supported by the National Science Foundation under Grant No. DRL-1421427. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

Rover Designs

STAR net Hands-on



Credit: Barrett NASA Explorer School

Overview

Participants explore programming by "coding" one another to build space designs using uniform blocks, such as Keva Planks.

Activity Time

40 minutes to 1 hour

Intended Audience

Families or other mixed-age groups, including children as young as 7 years old *with assistance from an older child, teen, or adult*
Tween
Teens

Type of Program

- ☑ **Facilitated hands-on experience for teens and/or children under close supervision**
- ☐ Station, presented in combination with related activities
- ☐ Passive program (if instructions are provided)
- ☐ Demonstration by facilitator

What's The Point?

- **Robots are machines that carry out a complex series of "instructions," or specific sets of things that they have been programmed to do (sometimes called an algorithm).**
- **NASA scientists use rovers and other robotic devices to collect data and learn about other planets.**
- **These rovers are controlled remotely. Sending signals (or rover instructions) all the way to Mars can take anywhere between 13 and 24 minutes, which means NASA has to send rovers a batch of step-by-step instructions at a time.**

Facilitator Note: While no computers are used in this activity, patrons will develop computational thinking skills by creating algorithms (series of instructions on how to accomplish a task), writing codes, and practicing debugging (finding and fixing incorrect code).

Materials

For each facilitated group:

- ☐ Symbol Key (1 per group) *

- ☐ Uniform blocks and suggested patterns; for example:
  - Keva Planks (8-20 per group)
  - Keva Plank Design Cards *
  - Challenge Cards *

- ☐ Blank paper or note cards (1 per person)

- ☐ Pencil (1 per person)

- ☐ White board (or something to write the example "program")

* See supplement materials at the end of this guide

Preparation

Before the activity:

- ☐ Print out one Symbol Key for each group

- ☐ Print and cut out the Keva Design Cards

- ☐ Print and cut out the Challenge Cards

- ☐ Set up two separate areas: one area where the groups write their code and another, separate, area for some members of the group to wait with the Keva Planks.

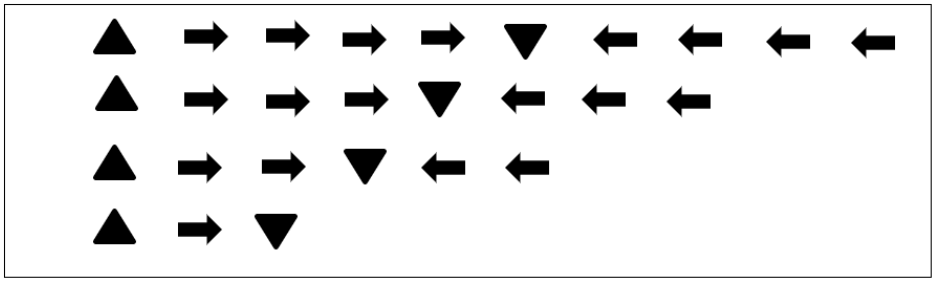
Activity

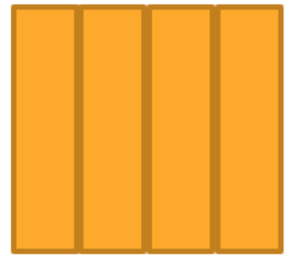
1. Introduction

- Introduce yourself. Help the participants learn each other's names (if they don't already).

- Try out a simple code, with yourself as the "rover" and the group providing your instructions (or "code").
  - Ask the group what they know about robotic space exploration, such as: What is a rover? What are ways astronomers use them for space exploration? How is communicating with a robot different from communicating with other humans?
  - Show the group a copy of the Symbol Key and emphasize that these will be the only six symbols that they will be using for this activity. For this task, Mission Control will instruct (or "code") their Rover to build a specific structure using only these arrows.

- It can be helpful to go over an example as a large group. Show the participants the "Rover Landing Pad" Design Card and ask them to imagine that you are a rover on Mars, and they must give you step-by-step instructions to build the landing pad. Walk them through the exercise:
  - Place a stack of four Keva Planks where everyone can see them. Ask the group to instruct you on the first thing to do. The correct answer is "pick up one Keva Plank." Once you have done that, ask for the next move, and the next, until you have placed the first plank in the correct spot. Continue until all four planks are lying in parallel and flat on the table.
  - Transition to the white board and challenge the group to help you write the symbols on the board. One possible solution looks like this:





Rover Landing Pad

Facilitator Note:
Patrons may be familiar with remote-controlled robots that can be maneuvered with a joystick. Ask them why it is beneficial to "code" the robot instead of "driving" it.

- Coding specific symbols will result in more precise instructions.
- There is a time lag of 13 to 24 minutes for the signals from Earth to reach Mars, so it is important to be precise (you don't want to accidentally damage your robot!).

2. Mission Steps

Rules:

- *Mission Control* should list all moves using only the eight arrows suggested.
- Keva Planks should remain with the *Rover*, not provided to *Mission Control* during coding.
- Once *Rovers* are back with their groups, everyone must remain silent.

1. Invite the participants to form a team of 2-3 family members or friends. One person will be the *Rover* and the rest of the people will be *Mission Control*.

2. Send the *Rover* with the Keva Planks to a separate area where they cannot see their partners.

3. Choose one Keva Design Card for each group.

4. *Mission Control* will create an "algorithm," or set of instructions, for how the rover should build the selected design.

5. *Mission Control* will then translate their algorithm into "code" by using the arrows from the Symbol Key.

Activity (continued)

6. When *Mission Control* has finished coding their design, they can invite the *Rover* to rejoin the group.

7. The *Rover* reads the code and must follow the commands exactly to build the design. Remember: once the *Rovers* are back, the only way to test the code is to follow the instructions in silence.

8. *Mission Control* should watch for incorrect movements, then work together to debug their program before asking the *Rover* to re-run it.

9. When the *Rover* successfully completes the mission, switch roles and distribute new Keva Design Cards.

3. Developing New Code!

- Regroup the patrons and discuss the following questions:
  - What was challenging about these missions?
  - What did your team do successfully?
  - How does the existing code (the eight different types and directions of arrows) limit what you can build?

- Show the Challenge Cards and explain that these structures would be impossible to build only using the existing code. What new symbols would we need to develop to communicate additional instructions to a Rover (i.e., "stand plank up" and "flip plank on its side")? Remember, each instruction needs to be assigned a new code (symbol).

4. Create Your Own Design!

- Allow groups to work as a team to add to the Symbol Key, and then build their own Keva Plank designs!

5. Conclude

- Invite each group to share their new Keva Plank design.

- Discuss the following questions:
  - Coding requires very explicit (specific) language. How is communicating with a robot, or computer, different from communicating with a human?
  - What else could we add to the symbol key to make it more efficient?

Add a Tech Twist!
Try pairing this activity with on online coding activity, such as Space Quest (https://www.tynker.com/hour-of-code/) from Hour of Code (https://code.org/learn).

Next Generation Science Standards

Science and Engineering Practices

- Analyzing and Interpreting Data
- Using Mathematics and Computational Thinking
- Obtaining, Evaluating, and Communicating Information
- Constructing Explanations and Designing Solutions

Disciplinary Core Ideas

- ETS1.A: Defining and Delimiting Engineering Problems
- ETS1.B: Developing Possible Solutions
- ETS1.C: Optimizing the Design Solution
- 3-5-ETS1-2: Engineering Design
- MS-ETS1-3: Engineering Design

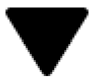
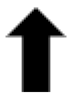
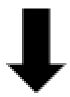
Crosscutting Concepts

- Patterns
- Structure and Function
- Interdependence of Science, Engineering, and Technology
- Influence of Science, Engineering, and Technology on Society and the Natural World

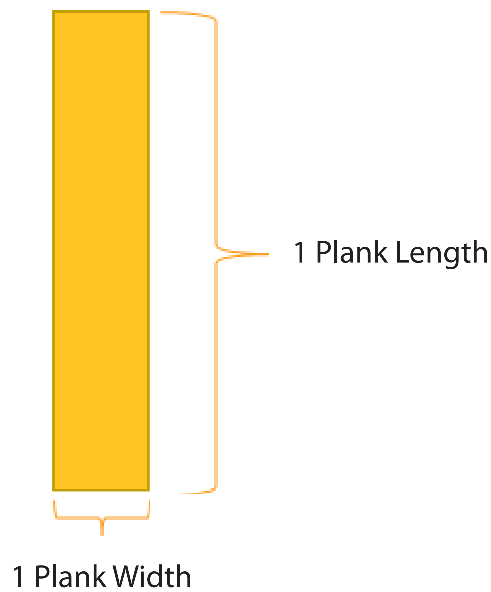
Computer Science Teachers Association Standards

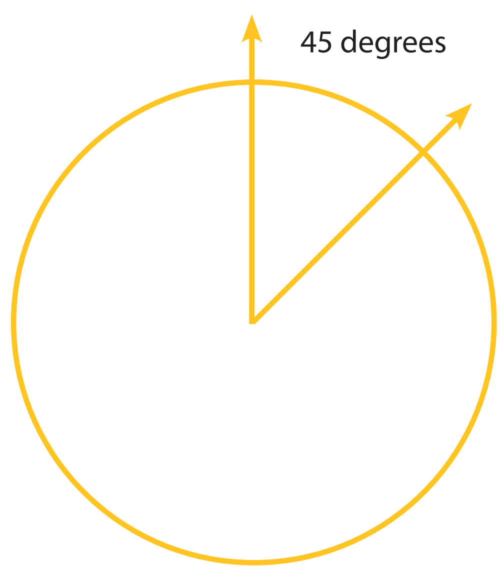
- 1B-AP-08: Compare and refine multiple algorithms for the same task and determine which is the most appropriate
- 1B-AP-10: Create programs that include sequences, events, loops, and conditionals
- 1B-AP-11: Decompose (break down) problems into smaller, manageable subproblems to facilitate the program development process
- 1B-AP-12: Modify, remix, or incorporate portions of an existing program into one's own work, to develop something new or add more advanced features
- 1B-AP-15: Test and debug (identify and fix errors) a program or algorithm to ensure it runs as intended
- 1B-AP-16: Take on varying roles, with teacher guidance, when collaborating with peers during the design, implementation, and review stages of program development
- 2-AP-19: Document programs in order to make them easier to follow, test, and debug
- 3B-AP-11: Evaluate algorithms in terms of their efficiency, correctness, and clarity

Symbol Key

Code	Algorithm
	Pick Up Plank
	Put Down Plank
	Move 1 Plank Length Up
	Move 1 Plank Length Down
	Move 1 Plank Length Right
	Move 1 Plank Length Left
	Move 1 Plank Width Right
	Move 1 Plank Width Left
	Move 1 Plank Width Up
	Move 1 Plank Width Down
	Turn Plank Right 45 Degrees (rotate from center of plank)
	Turn Plank Left 45 Degrees (rotate from center of plank)

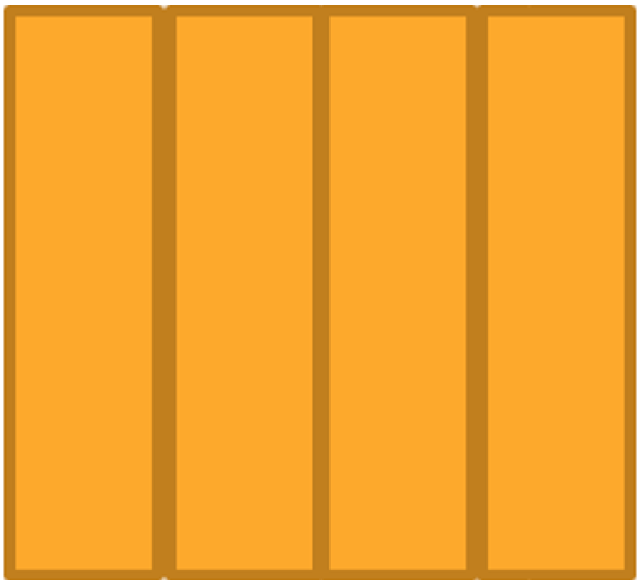
1 Plank Length = 5 Plank Widths



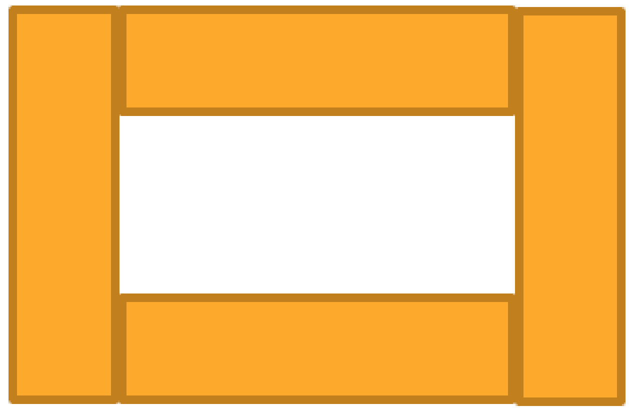


Keva Plank Design Cards

Rover Landing Pad
4 planks: above view



Docking Zone
4 planks: above view



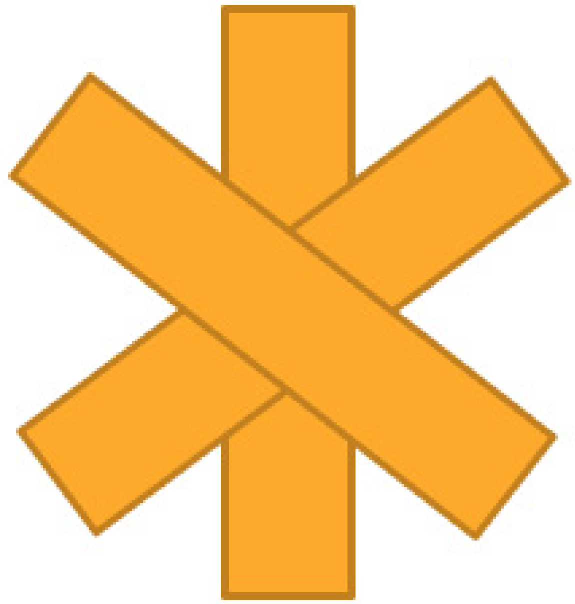
Rover Landing Pad

Docking Zone

Keva Plank Design Cards

Telescope
2 planks: above view

Imaging Device
3 planks: above view

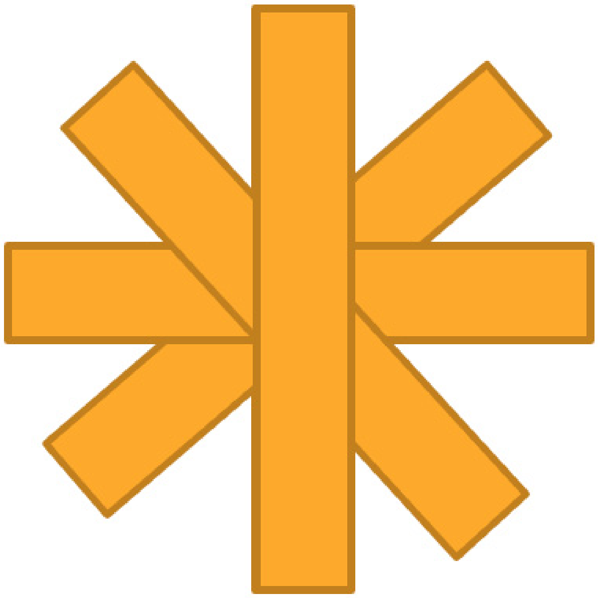


Telescope

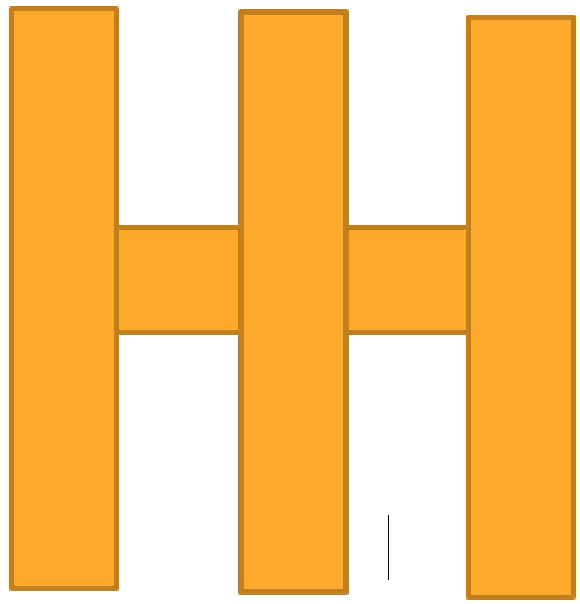
Imaging Device

Keva Plank Design Cards

Engine Fan
5 planks: above view



Solar Panel
4 planks: above view

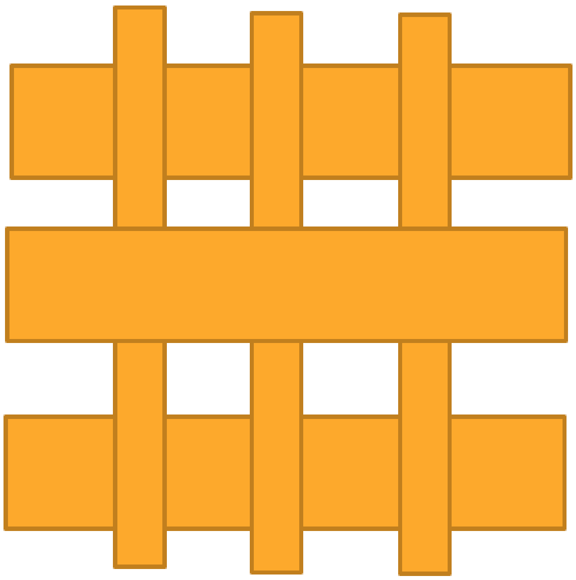


Engine Fan

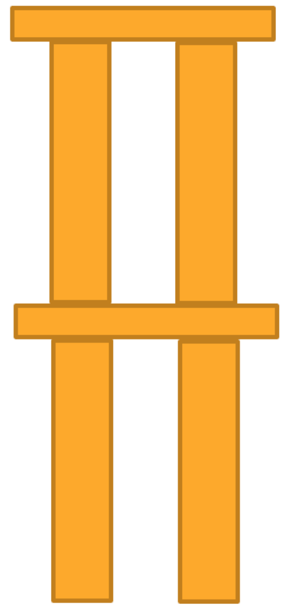
Solar Panel

Challenge Cards

Satellite
6 planks: above view



Radiation Detector
6 planks: above view



Satellite

Radiation Detector