

Loops and Rotation

One-sheets: Making a Snowflake

DESCRIPTION

Students will continue working with loops, adding to their skills the ability to use loops with rotation to create radially symmetrical objects.

VIDEOS

- **Rotation Away from the Origin (part 2)** <https://www.youtube.com/watch?v=ywinUeZeG5Y>
- **Using Loops Part 2** https://www.youtube.com/watch?v=LSPY_KG8hSQ
- **(ADVANCED) Parametric Design using Loops** <https://www.youtube.com/watch?v=N2-OfLhIfk>

LEARNING OBJECTIVES

- Students will combine Loops with Translation transformations, using appropriate arithmetic operations to execute their designs.
- Students will combine iterative loops with rotational transformations, creating rotationally symmetrical designs.
- Students will use loops to drastically reduce the amount of repetitive coding they need to use in a model.
- Students will utilize programmatic loops to create code which executes repeatedly with small variations
- Students will use loops to make flexible models, which can be drastically altered by changing values in only a few locations.

REVIEW / PRIOR KNOWLEDGE

Before beginning with loops, students should already be comfortable with using the various Transforms and Set Operations in BlocksCAD. Students should also be comfortable using variables in their designs, and know how to use variables to alter a variety of parameters (such as size, translation, and scaling and other transforms). Students must also be comfortable creating models with rotational symmetry, as practiced in the Translate then Rotate one-sheets.

One-sheets

- **Snowflake**

Skills and Knowledge

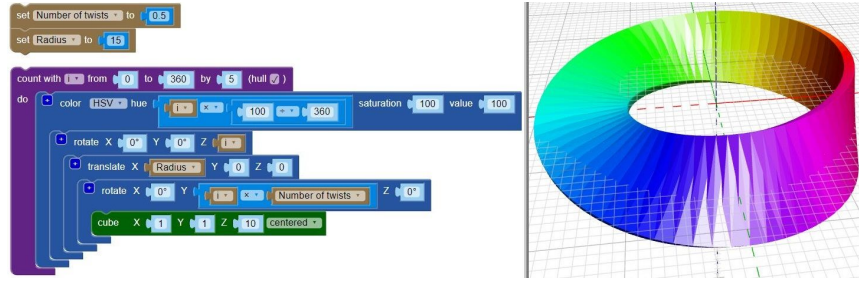
- Knowledge of arithmetic expressions and symbols (+, -, x, ÷)
- Knowledge of Order of Operations (i.e. PEMDAS)
- Knowledge of some generalized geometric formulas (e.g. volume of cube = $L \times W \times H$, area of triangle = $\frac{1}{2} B \times H$)
- Knowledge about rotation, angles, and that a full rotation is 360 degrees.
- Ability to generalize about geometric shapes in terms of indefinite values such as width(W), length (L), and height (H)
- Experience using the Rotate transform (block) to rotate shapes around the X, Y, and Z axes.
- Experience using variables to define parameters for 3D models in BlocksCAD

TEACHER NOTES

Mini Lesson (I Do)

This lesson is a variation on the Loops practice students completed in the previous section. The same skills students have used before to make rotationally symmetrical models (see Translation then Rotation) can be applied to loops. Using variables and arithmetic blocks, students will be able to create parametric designs where the angle of rotation is automatically calculated, without the need to calculate and type individual values.

Show students examples of models made using Loops to make circular objects. Simple examples could include a ring of cubes, while a more advanced option could include the Rainbow Mobius Strip (next page).



Guided Practice (We Do)

Begin with simple models where only one value is set to “i” in the loop. For loops with rotation, it’s generally a good idea to show examples using a cube or rectangular prism rather than a cylinder or sphere, because these shapes are already rotationally symmetrical and it can be unclear when they have been rotated around their central axis.

Loops with Rotation

- There are a few approaches students could take to making a loop with rotation. The most straightforward is to have the loop count “from” 0 “to” 360, and to count “by” whatever angle you would like to apply to each rotation. For example, if you wanted a loop create four cubes, each rotated by 90 degrees compared to last, then set up the loop like this:



- Changing the “by” value will change the angle of rotation, as well as the number of cubes generated. If it is changed to 45, then each cube will be rotated 45 degrees around the axis, and there will be 8 cubes.
- Have students experiment by changing the values in the loop. What happens if the loop is set from 0 to 180? Or from 180 to 360? Do negative numbers work?
- Students may begin to use variables to define values within the loop, so they can create parametric models which can be changed on the fly.
- The cube in this example could be replaced by a more complex model, which is how students can begin designing snowflakes or other rotationally symmetrical objects.

Other Notes and Misconceptions

- When using Translation then Rotation with cubes, use a “centered” cube (as opposed to “not centered”) for a cleaner end result.
- Technically, the values entered into the loop block only need to go from 0 to 359 (or 1 to 360). 0 and 360 are the same angle, and so running a loop from 0 to 360 in the example above will result in the first and last block generated by the loop being placed in the same location (on the positive X axis).

Independent Practice (You Do)

Give students one of the onesheets for Loops with Rotation (Snowflake), and allow them to complete their own version of the project. This activity may be challenging for many students, because they are used to thinking in terms of definite values and numbers, and knowing when to use a variable will be unfamiliar. Encourage students to experiment, and that the simplest place to start is with the Ring of Cubes or an example shown during Guided Practice, and testing variations on that model to see the results. If a student is truly stuck, they should make a prototype of their (repetitive) model without using loops, and then identify the key value that is being changed each time to make their model - this will be the value they should connect with “i”, because it is the value they are expecting to change between each execution. Act as a mobile facilitator, answering students’ questions and asking them questions about their step-by-step thinking.

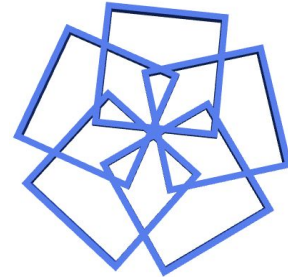
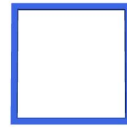
Begin your project at <https://www.blockscad3d.com/>

Can you make a snowflake generator?

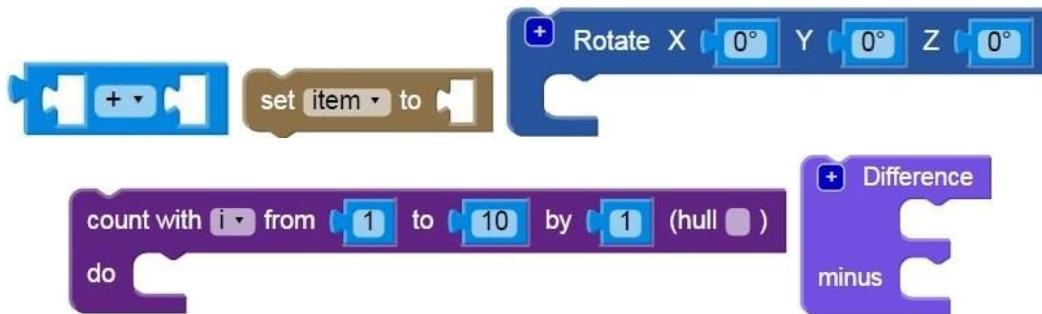
Getting Started:

1. Create a variable called **number of shapes**
2. Create a variable called **angle**
3. Set the **angle** variable to $360 \div \text{number of shapes}$
4. Create a square frame shape that you'll rotate with your loop (see picture)
5. Create a ring using a loop
6. **Hint:** Set your loop to **count with i from 0 to 360 by angle** (the angle variable you created!).

square frame:



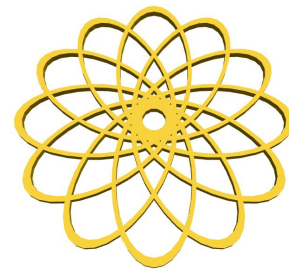
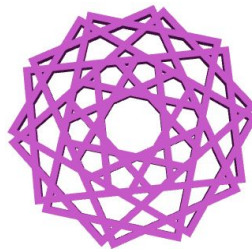
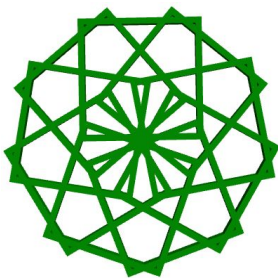
Use These Blocks!

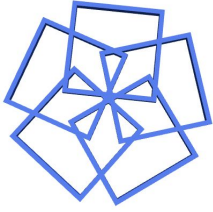


Think About It

- How does the snowflake change if you change your rotation angle?
- What happens when you change how far you translate your square frame?
- What would it look like if you rotated a different shape?
- What happens if you rotate around more than one axis?

Now Try This!





change this number to
change how many times
the shape is drawn

```
set number of shapes to 5  
set angle to (360 / number of shapes)
```

```
count with i from 0 to 360 by angle (hull )  
do  
  rotate X 0° Y 0° Z i  
  translate X 10 Y 0 Z 0°  
  difference  
    base shape cube X 20 Y 20 Z 2 centered  
  minus  
    cube X 18 Y 18 Z 2 centered
```