STEM Through Kinetic Folk Art

Design Fundamentals

The Model #302 telephone
was the standard for forty years.

How long will this one last?

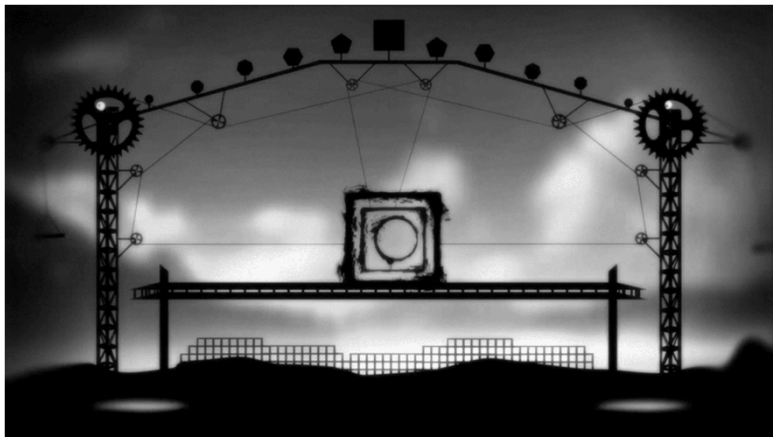
Foundation Concepts for Teaching Problem Solving

Engineering Design

- ✓**Design** is to technology and engineering as **inquiry** is to science and **reading and writing** are to English language arts

- ✓Design is the core problem solving process

- ✓Design problem solving extends learning beyond the classroom



The Design Loop/Process

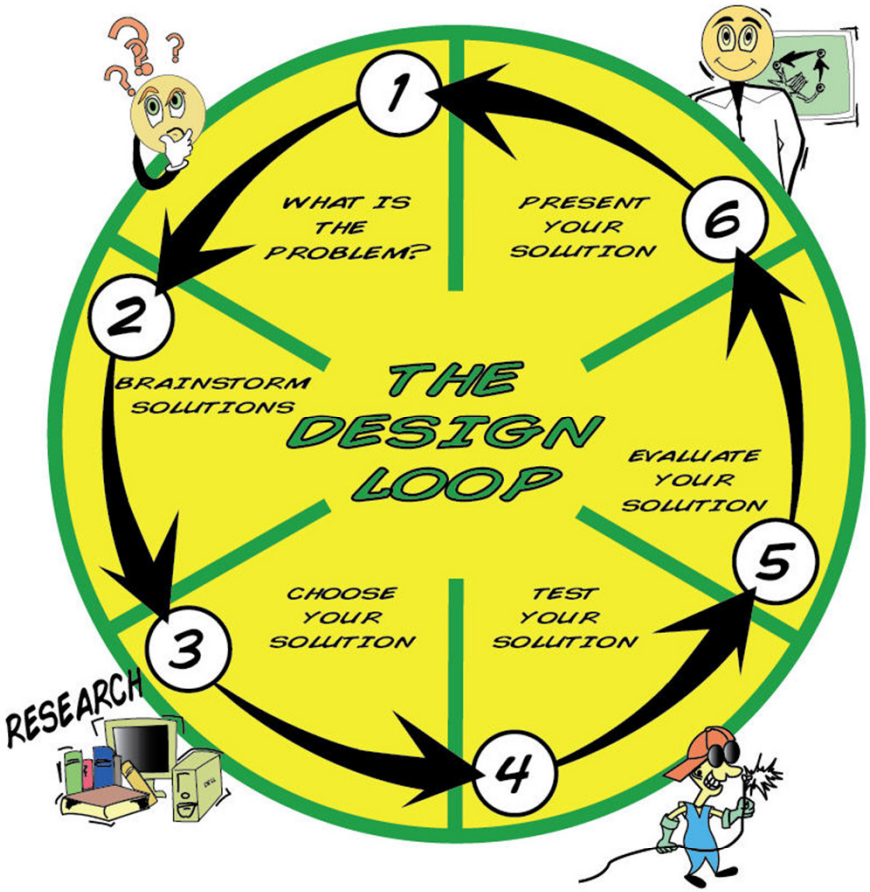
Different tasks to be completed

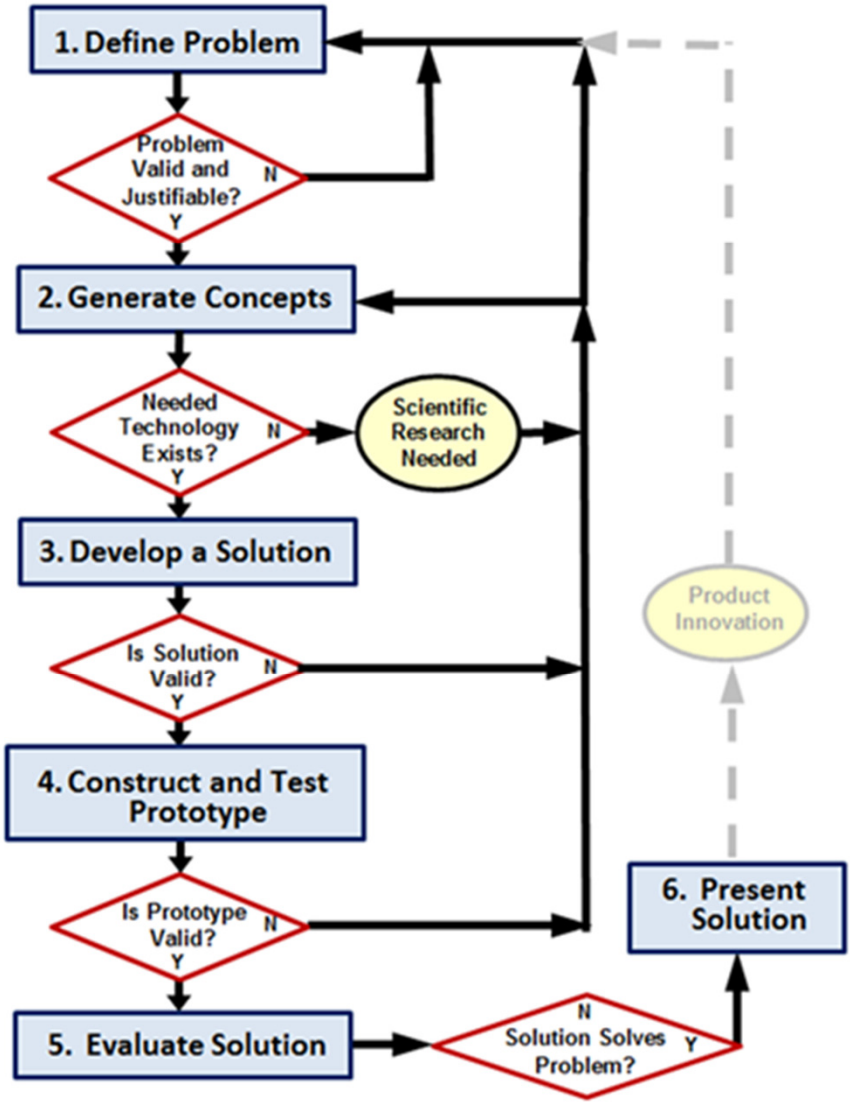
- **Suggested, rather than prescriptive**

1. **Identify the problem**
2. **Investigating**
3. **Developing ideas**
4. **Refining the idea**
5. **Modeling/prototyping**
6. **Evaluating/assessing**
7. **Communicating**

NEXT GENERATION SCIENCE STANDARDS

Practices in Mathematics, Science, and English Language Arts*		
Math	**Science**	**English Language Arts**
M1. Make sense of problems and persevere in solving them.	**S1.** Asking questions (for science) and defining problems (for engineering).	**E1.** They demonstrate independence.
M2. Reason abstractly and quantitatively.	**S2.** Developing and using models.	**E2.** They build strong content knowledge.
M3. Construct viable arguments and critique the reasoning of others.	**S3.** Planning and carrying out investigations.	**E3.** They respond to the varying demands of audience, task, purpose, and discipline.
M4. Model with mathematics.	**S4.** Analyzing and interpreting data.	**E4.** They comprehend as well as critique.
M5. Use appropriate tools strategically.	**S5.** Using mathematics, information and computer technology, and computational thinking.	**E5.** They value evidence.
M6. Attend to precision.	**S6.** Constructing explanations (for science) and designing solutions (for engineering).	**E6.** They use technology and digital media strategically and capably.
M7. Look for and make use of structure.	**S7.** Engaging in argument from evidence.	**E7.** They come to understanding other perspectives and cultures.
M8. Look for and express regularity in repeated reasoning.	**S8.** Obtaining, evaluating, and communicating information.	


THE DESIGN LOOP
1
WHAT IS THE PROBLEM?
2
BRAINSTORM SOLUTIONS
3
CHOOSE YOUR SOLUTION
4
TEST YOUR SOLUTION
5
EVALUATE YOUR SOLUTION
6
PRESENT YOUR SOLUTION
RESEARCH


1. Define Problem
Problem Valid and Justifiable?
N
Y
2. Generate Concepts
Needed Technology Exists?
N
Y
Scientific Research Needed
3. Develop a Solution
Is Solution Valid?
N
Y
4. Construct and Test Prototype
Is Prototype Valid?
N
Y
5. Evaluate Solution
N
Solution Solves Problem?
Y
6. Present Solution
Product Innovation

What do students learn by solving design problems?

- ✓Contributing to the team
- ✓Strategies for conducting research and solving problems
- ✓Techniques for making models and prototypes
- ✓Methods for assessing their own work
- ✓Techniques for communicating team process and results

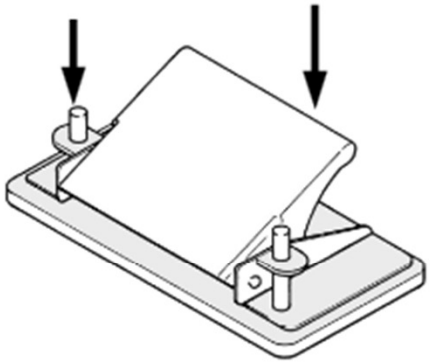
STEM and Kinetic Folk Art

Mechanisms

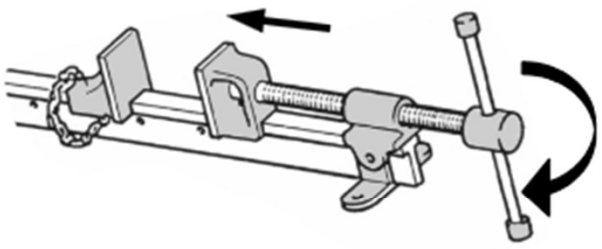
All mechanisms have 2 things in common

1. Input motion and force
2. Output motion and force

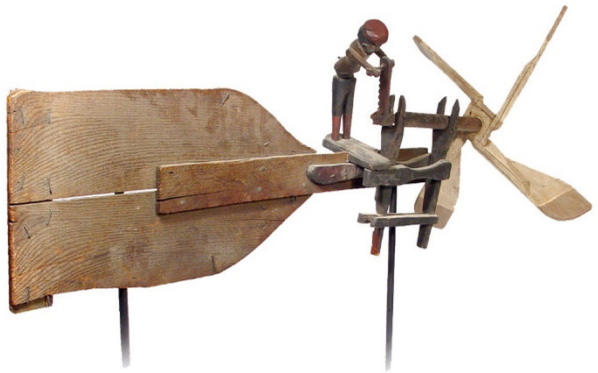
The input and output motions associated with particular mechanisms may or may not be the same. Consider the examples below:



The paper punch has both a linear input and a linear output motion



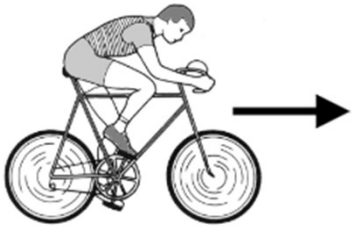
The T-Bar clamp has a rotary input motion and a linear output motion



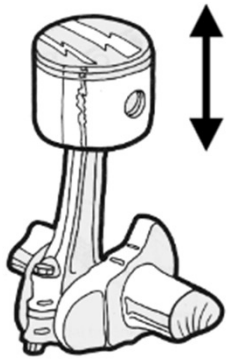
Mechanisms

Mechanisms use four types of motion

Linear Motion
This is motion in a straight line and can be represented by an arrow like this:



Reciprocating Motion
This is forward and backwards motion in a straight line. It can be represented by a double arrow like this:

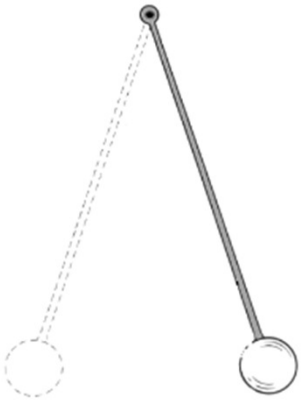


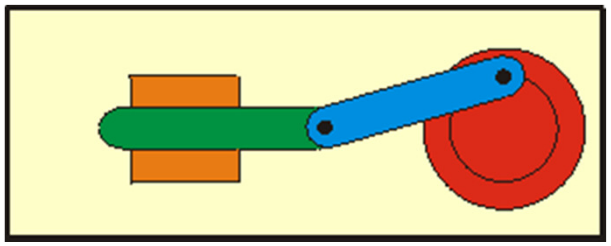
Engine crankshaft and piston

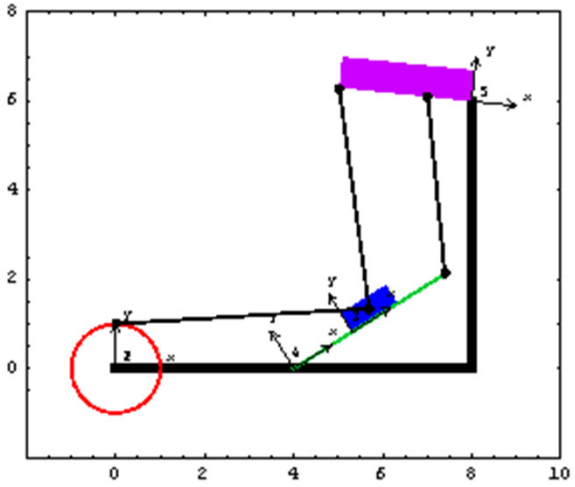
Rotary Motion
This is motion in a circular direction and may also be called circular motion. It is a very common form of motion and can be represented by a curve with an arrow head like this:

The chuck of a drill moves in a circular motion

Oscillating Motion
Oscillating motion is essentially reciprocating motion along an arc. It can be represented by an arc with an arrow head at both ends.






8
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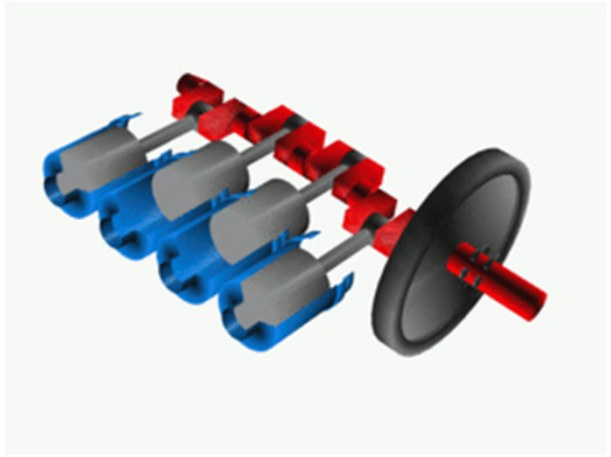
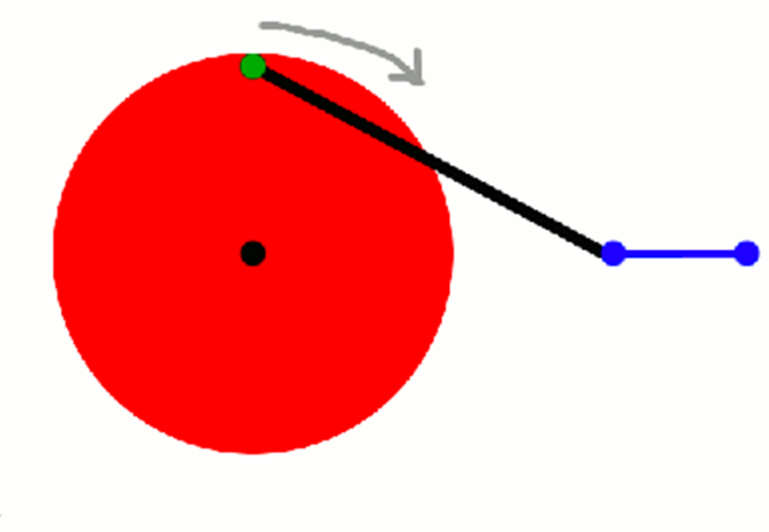


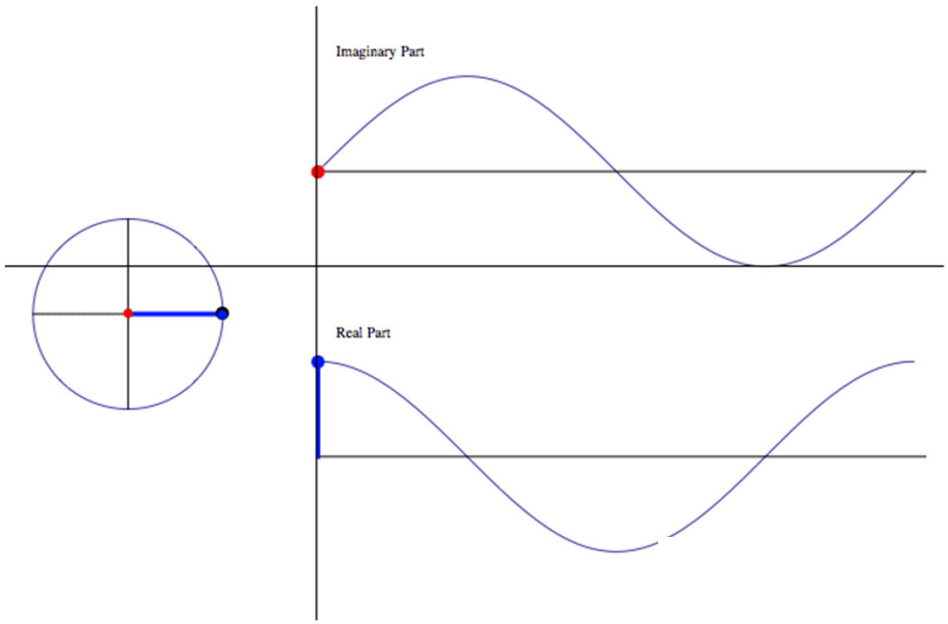


Circular and Sinusoidal Motion

Using trigonometric functions to model mechanical behavior

Circular motion in the complex plane is related to the sine and cosine functions used to describe motion.

As a point rotates counterclockwise around a circular path in the complex plane the real component (blue line) oscillates back and forth along the real axis as a cosine function. Meanwhile, the height of the imaginary component (red line) oscillates up and down as a sine function.



Whirligig Design Challenge

Big Ideas

- Understand the types of energy and energy conversion.
- Mathematics can be used to measure time, distance, intervals, speed, etc.
- Major STEM concepts can be used to create works of art
- Art can be kinetic
- Art is often an expression of surroundings

Essential Question

How can a kinetic machine be designed to convert rotary motion into reciprocal motion while representing an idea or a concept?

Challenge

Using a whirligig and simple recycled materials, your team will design a whirligig that turns rotary motion into reciprocating motions and powers a piece of kinetic art.