The Illusion of Life

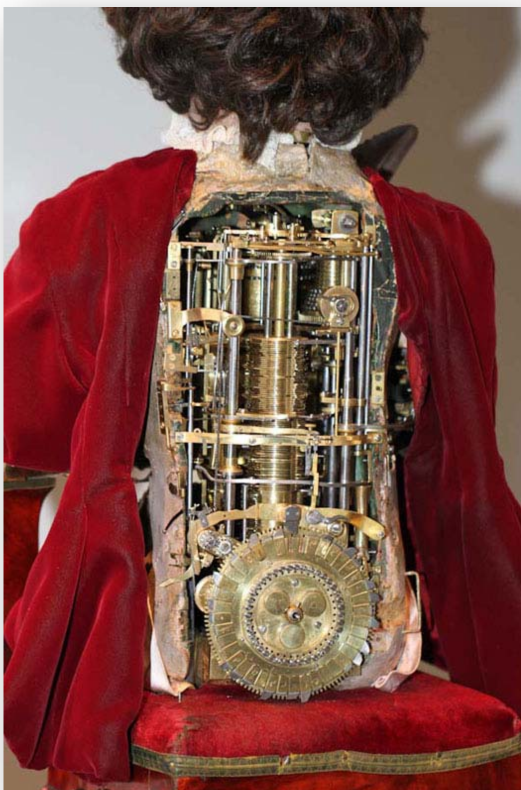
Keeps On Ticking

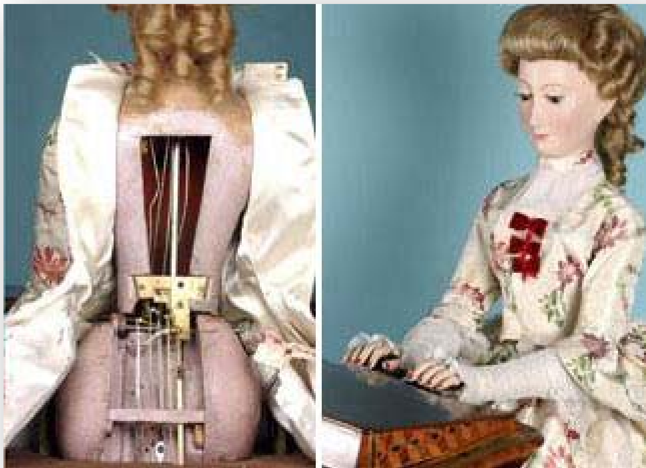
The oldest working automaton known today is the rooster atop the cathedral clock tower in Strasbourg, France. Built in 1352, the rooster flaps its wings, thrusts out its tongue and crows. Like the Strasbourg rooster, glockenspiels, German for "players of the bells", are run by the clockwork and move atop clock towers, chiming the hours. Glockenspiels can be quite elaborate and are often life-sized figures moving to the clock chimes in a choreographed dance.

Where'd they Wind Up?

At the 1876 World's Fair in Paris, some of the last of the great performing automatons were on display. J. N. Maskelyne created a popular attraction for the fair that featured three musicians who played various tunes on brass instruments, "Zoe," a young girl who drew pictures and Psyco," a card playing gypsy.

By 1770, inventor/artist and watchmaker Pierre Jaquet-Droz became the first to create automatons that had all of the mechanisms built in the figures themselves. Droz's "Scribe" or 'Writer' was an adorable life-like boy who could dip his pen in ink and write whatever short message the operator selected. The almost 240-year-old automaton, which looks simply like a doll holding a quill and sitting on a pedestal, still works perfectly to this day. This fact is as amazing as the automaton itself, due to the complexity of it. The Writer is made from around 6000 parts, which have been miniaturized and designed to fit into the body of the doll. The Writer is considered his masterpiece. The doll can write any word or sentence up to 40 characters in length. As well as writing, the doll is able to control the pressure of the quill on the paper while writing and the eyes follow the writing on the paper as if it is actually following what it is writing.





"Musician" was a figure who played on a piano with all ten of her fingers. These figures can still be seen operating in Neuchatel, Switzerland, more than 240 years after their construction.

Soon, inventors started putting automated machines to work to make their lives easier. A French silk cloth weaver built a loom in 1801 that automatically created patterns as it wove thread into cloth!

In 1822 English mathematician Charles Babbage used punch cards (a card with holes punched in it that gives directions to a machine or computer) in his Analytical Engine, one of the first mechanical calculators. His friend Lady Ada Lovelace designed a series of steps which would make Babbage's engine solve certain math problems. Her work is considered the world's first computer program. And in 1898 in New York, the electrical pioneer and inventor Nikola Tesla showed off the first remote-control device: a mechanical boat controlled by a radio transmitter.

Automata-mazing!

Automata, or kinetic sculpture, is quite simply art and science that moves. Even the most complicated seeming ones are actually made up of very straightforward bits and pieces.

To get, and give students a view behind the scenes of creating automata, have them watch: Making the Don Quixote Automaton with Keith Newstead -- Smart TV.

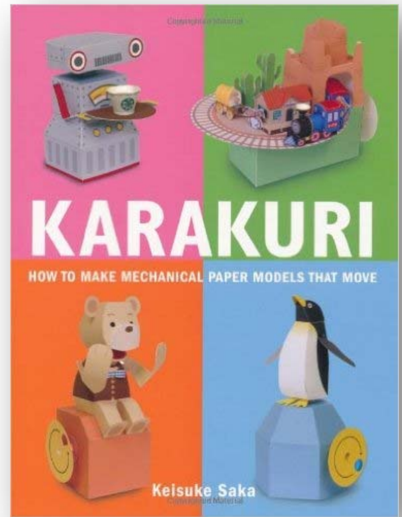
Cardboard Automata are a playful way to explore simple machine elements such as cams, levers, and linkages, while creating a mechanical sculpture.

Time to Make Your Own and Put Paper in Motion!

Working with simple materials, this activity is easy to get started, and may become as complex as your students' mechanical sculpture ideas. And as they tinker, they can learn (and actually see) just how many different solutions there are for the same problem as they build a physical representation of their line of thought and inquiry.

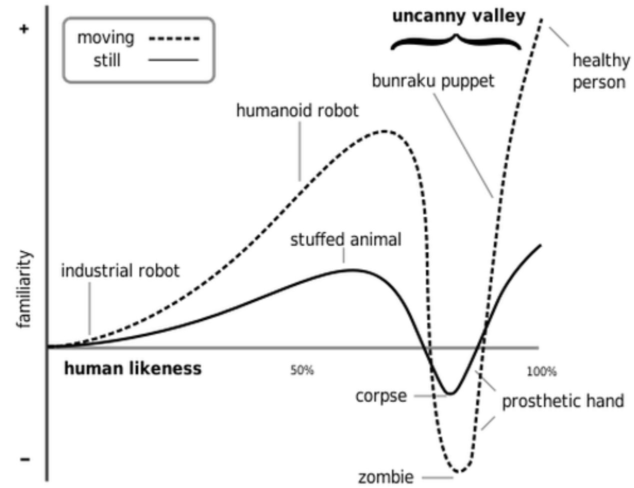
Resources and Materials:

- RobIves.com
- Printer Paper
- White Cardstock
- Books such as *Karakuri*
- Scissors
- Tape
- Craft/Tacky Glue



Robot Skin?

Robots come in every shape and size imaginable! They range from microscopic research bots to giant space rovers. And they can be made out of almost any kind of material, from stretchy fabric to the toughest metals or plastic. Many industrial, military, and exploration robots look like everyday tools or vehicles. Robot toys and social robots often look like animals, cute friendly monsters or imaginary creatures. Some look like blisteringly fast jet planes, whirling miniature helicopters, or tiny insects. A 'humanoid' robot is one that often has a face, two arms, and two legs. It can look like what everyone thinks of as a robot, an old-fashioned mechanical man. But if its covering is made soft and squishy, like skin, it can look so real it can scare people.



The uncanny valley as envisioned by the roboticist Masahiro Mori in 1970.
Credit: Creative Commons | SmurrayinchesterView full size image

Have you ever noticed that some of the most realistic robots are also the, well, creepiest?

A century ago, psychologists identified "the uncanny" as an experience that seems familiar yet foreign at the same time, causing some sort of brain confusion and, ultimately, a feeling of fear or repulsion. Originally no more than a scientific curiosity, this psychological effect has gradually emerged as a profound problem in the fields of robotics and computer animation.

According to scientists, there's a place right between believable and not-quite-believable that gives humans the willies. Scientists call it the 'Uncanny Valley.' The term comes from a graph created by Japanese roboticist Masahiro Mori that plots human empathy against the anthropomorphism of robots. On the graph, as robots become more realistic and we feel more and more empathy for them, the line trends upward. But as the robots' humanism approaches that of actual humans, our empathy for them — and the line on the graph — suddenly plummets. The resemblance between human and robot goes from remarkable to repulsive, and this precipitous drop became known as the "uncanny valley."

The Uncanny Valley is the idea that there's a curve related to an object's level of realism and how acceptable we perceive it to be. If something is somewhat realistic but stylized (like a stuffed animal), we're going to like it. The more realistic it is, the more we like it—to a certain point. A cute doll or human-like robot might bring us joy. However, once we cross a critical point in realism, our opinion of it plummets into the valley. Think about "realistic" video games or animated movies (Polar Express, perhaps) where the characters just feel… off. It's possible to get out of that valley, but only if the realism is cranked up enough to be truly indistinguishable from reality.

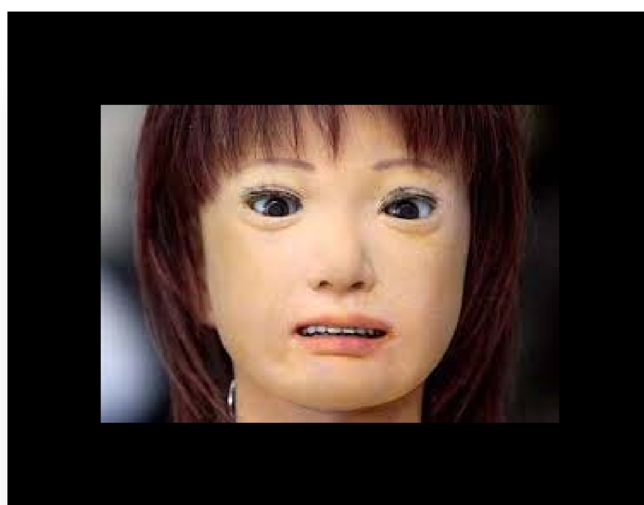
For example, which of the images below seems off, or “uncanny”? The animated and slightly cartoonish Anna from Frozen, the realistic girl from Polar Express, or the hyper-realistic painting (yes, painting!) of Morgan Freeman?

Researchers still don’t know why it happens.

The original hypothesis states that as the appearance of a robot is made more human, some observers' emotional response to the robot will become increasingly positive and emotional, until a point is reached beyond which the response quickly becomes that of strong revulsion. However, as the robot's appearance continues to become less distinguishable from that of a being, the emotional response becomes positive once again and approaches human-to-human empathy levels.

In experiments even monkeys that were show pictures of almost-real monkeys turned away in fright.

Whatever the psychological root of the problem, there's a lot to be gained from figuring out how to get around it. Many computer animation studios, including industry leader Pixar, shy away from characters that might get lost in the uncanny valley, preferring cartoon stylization instead. They've watched braver studios fail. For example, ImageMovers Digital, a computer animation firm headed by producer Robert Zemeckis, produced a series of critical and commercial flops because of negative audience reactions to their eerie characters— starting with "The Polar Express" in 2004 and including "A Christmas Carol" and "Mars Needs Moms." You can't make much money on a robot,



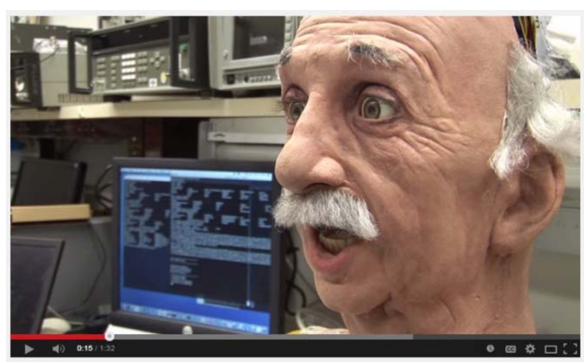
video game, or a film or whose uncanny protagonist doesn't garner empathy from consumers.

Rubbery Frubbery Robot Skin

Make new friends, but keep the old. One is silver, and the other gold!

Making a robot skin that's tough, soft, and sensitive is another challenge for scientists.

David Hanson of Hanson Robotics makes almost-real robot heads that can talk, smile, make jokes, interact with humans in a relatively natural, conversational way and recognize facial expressions around it and can respond accordingly. The key is a special artificial skin he invented called Frubber. It makes robot faces bend and crinkle in a lifelike way. (But videos of the Einstein head mounted on a shiny plastic robot body give many people the chills. The company will have to work hard to keep its fantastic machines from falling into the uncanny valley!)


Einstein Robot - UCSD Machine Perception Laboratory

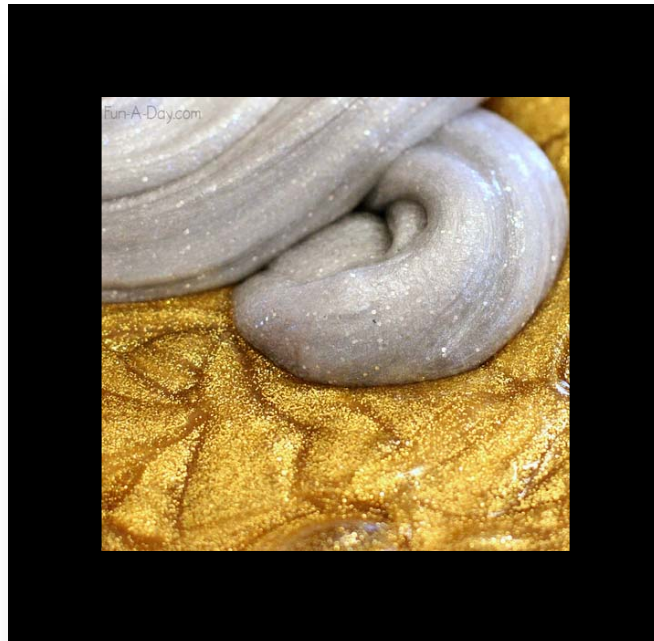
Einstein Robot - UCSD Machine Perception Laboratory

In 2011, at Stanford University in California chemist Zhenan Bao demonstrated a rubbery film that can 'feel'. The material contains microscopic springs that stretch when pressed, even if the pressure is very light. The springs send an electrical signal to the robot's brain, telling it how much pressure has been applied. Based on the amount of pressure the robot can detect something as light as a fly or as heavy as an elephant.

She, Zhenan Bao, is working on adapting the skin to absorb solar energy and to detect other things like chemicals or microscopic life in its surroundings. Some day, the robotic skin may be sued to help people feel through their artificial limbs or make touch screens even more sensitive.

Roboticists turn to chemistry when they want to create lifelike skin for humanoid robots. Here's how to make up some silver and gold skin for your new robot friends.

Have students experiment with the ingredients to change the thickness, stickiness, and stretchiness. They should make notes as they try different formulas so the group can determine which one they like best.



IMPORTANT: Be careful not to get their concoctions ground into furniture or clothes and don't pour it down the drain, or it will clog up the plumbing.

Silver Skin Slime

Tips: *Always shake your* liquid starch *container a bit to make sure that it is well-mixed.*

Materials (per batch):

- 5 oz. bottle Clear Elmer's glue (Colorations clear glue also works well)
- Silver metallic liquid watercolor, ex. Colorations brand or Sax, etc.
- Sta-Flo liquid starch
- Option: Silver glitter

Directions

1. Pour the bottle of clear glue into a bowl.
2. Add 2 tablespoons of silver liquid watercolor to the glue. Mix well.
3. (Optional) For extra sparkle, carefully add several tablespoons of silver glitter and mix well.
4. Add 4 tablespoons of liquid starch. Mix well.
5. Add another 2 tablespoons of liquid starch. Mix well.
6. Add 2 more tablespoons of liquid starch and knead (just like you would with bread dough). At this point, you should have added a total of 8 tablespoons of liquid starch to the mixture.[1]

Gold Skin Slime

Materials:

- 5 oz. bottle of Elmer's Clear School Glue
- 2 TB [ex. Colorations] Gold Liquid Watercolor
- 1/2 cup (4 oz. or 8 TB) of Sta-Flo Liquid Starch
- Option: Gold Glitter

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[1] Recipe, images, and instructions from http://fun-a-day.com/silver-gold-homemade-slime-new-year/ . All Rights Reserved.

Directions

1. Place all of the clear glue into a bowl or cup.

2. Add the gold watercolor to the glue. Be sure to stir it in completely before the next step.

3. **Shake the liquid starch bottle** to make sure nothing's settled to the bottom.

4. Pour HALF (about 1/4 cup) of the liquid starch into the glue, then stir very well.

5. Add half of the remaining liquid starch (about 1/8 cup) to the mixture and stir well.

6. Add the remaining liquid starch and keep on mixin'.

7. Knead the mixture using hands. It will feel like thick pudding at first. As kneading progresses, it will transform! After kneading for a minute, check the stickiness and stretchiness of the slime. Knead for another minute if necessary, but don't over-knead.

8. If need be, add another tablespoon of liquid starch to the slime and knead for another minute or two.

Be sure to add the liquid starch in small increments or it'll become a clumpy mess! If you run into any problems with the process, check out Fun at Home with Kids' how to fix slime post [http://www.funathomewithkids.com/2014/06/how-to-fix-slime-that-didnt-work-out.html]. She has a different glittery, gold slime recipe you might want to check out while you're there.

Troubleshooting:

Let's look at the two ways this slime can go wrong.

First way: Not enough liquid starch. How do you know if this is your issue? Your slime will be stringy - it will stick to your fingers a ton. As you stir, you'll see little strings of glue grabbing your spoon. If you grab a section of your slime, it won't lift out in a glob - just a small stringy portion will stretch up.

Remedy? Add more liquid starch, approximately one Tablespoon at a time. Stir well to mix in between each addition of liquid starch. You'll know you've added enough when you no longer see those strings of glue grabbing your spoon as you stir, and you'll be able to lift all or most of the slime out if you grab a section of it. After a few minutes of kneading it will be beeeautiful and not sticky.

Second way things can go wrong: Too much liquid starch. A slime that's had too much liquid starch added will be stringy, but NOT sticky. It won't stick to your fingers - it will slide right off. It won't stick to a spoon or even to itself. It's just gross looking clumps of goo.

You can see strands of floating slime, and there will be standing liquid starch. How do you fix it? First, pour off any standing liquid starch. Then add clear glue, approximately 1/4 cup at a time, and stir. Once the slime starts holding together, you will need to knead it by hand. After adding glue and kneading for 2-3 minutes, it will be just like new! It will gel even more if left overnight in a sealed bag.

So what does perfect slime look like? It holds together and doesn't have any strings of glue or standing liquid starch. If you grab it, it moves as one cohesive unit. Kneading it for a minute or two will make it gel into a smoother and more uniform slime.

Store it in an airtight container or Ziploc bag when you aren't using it. It will keep for several weeks.

And don't worry if it bubbles. That's normal.

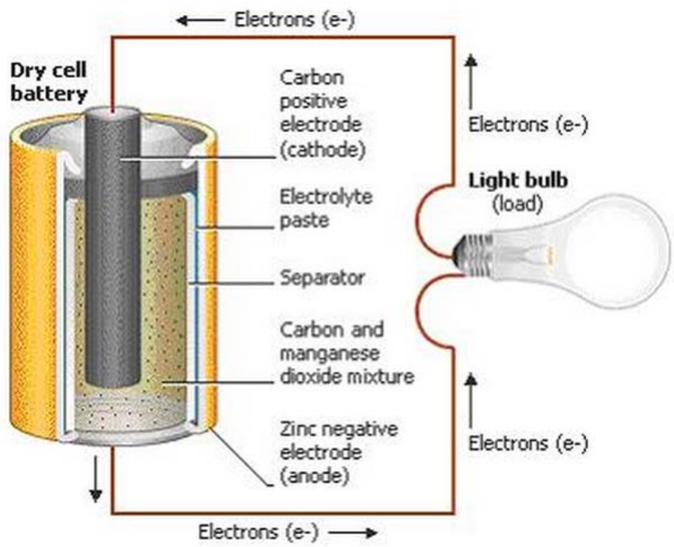
Final tip: Vinegar will dissolve this slime - just in case you get any on your carpet or clothing!

We Like to Move it Move it!

Just like humans and other living things, robots need energy to nove and "think." Even the earliest nata that moved by themselves powered by humans. People ed the weights, turned the cranks, and wound up the springs that made them move. Humans were their power source. But the power source for most modern robots is a battery. The kinds of batteries used in robots range in tiny disks like watch batteries to big heavy batteries like you'd see in a car, often bigger than a cinder block. Batteries are portable power plants that use a **chemical** reaction (chemical energy) to produce electricity.

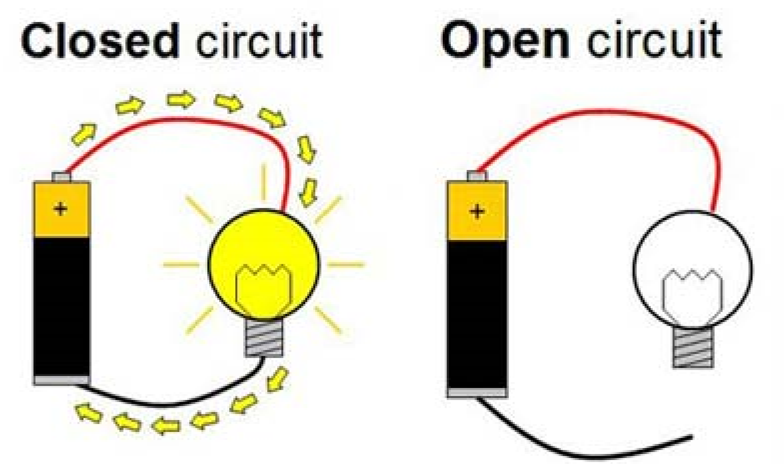
How does a battery produce electricity

Energy cannot be created or destroyed, but it can be saved in various forms. One way to store it is in the form of chemical energy in a battery. When connected in a circuit, a battery can produce electricity. A battery is a portable power plant that uses a chemical reaction to make electricity. In a battery two metals made of different kinds of atoms are placed near each other



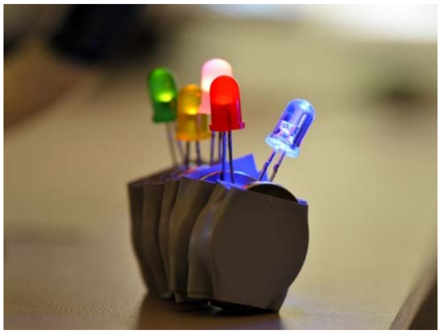
in a container that's filled with a special acidic solution. All atoms contain electrons, which have a negative charge. Negative charges repel or push away other negative charges. Opposites attract though. So negative electrons don't like to be near other negative particles, but are attracted to positive charges, and vice versa.

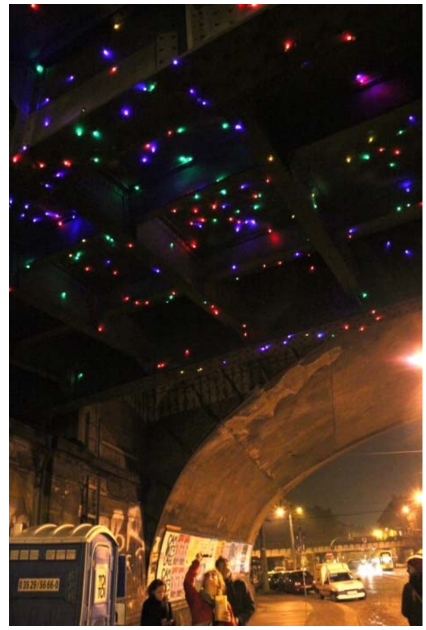
In the battery, one metal has a slight positive charge, while the other metal has a slight positive charge. So the electrons from the negatively charged metal are attracted to the positively charged metal. The electrons travel through the chemical inside the container from one metal to the other. This movement creates a flowing negative charge, which we call electricity.



If a circuit (a path that lets electricity flow when it's closed in a loop), is hooked up to the battery, the negative charge will flow out of the positive end, or terminal (the point where electricity flows in or out), of the battery, through the wires and components, and back into the battery through the negative terminal. The circuit has a switch that opens and closes like a drawbridge. When the switch is opened, no electricity can travel over the circuit. But when it is closed, the circuit is complete and the power? It starts humming!

LED Throwies





The more you make, the cooler they look!

The LED throwie was first invented around 2005 or 2006 as a kind of non-destructive electric graffiti. Guerilla graffiti artists incorporated LEDs to produce temporary pieces in public places.

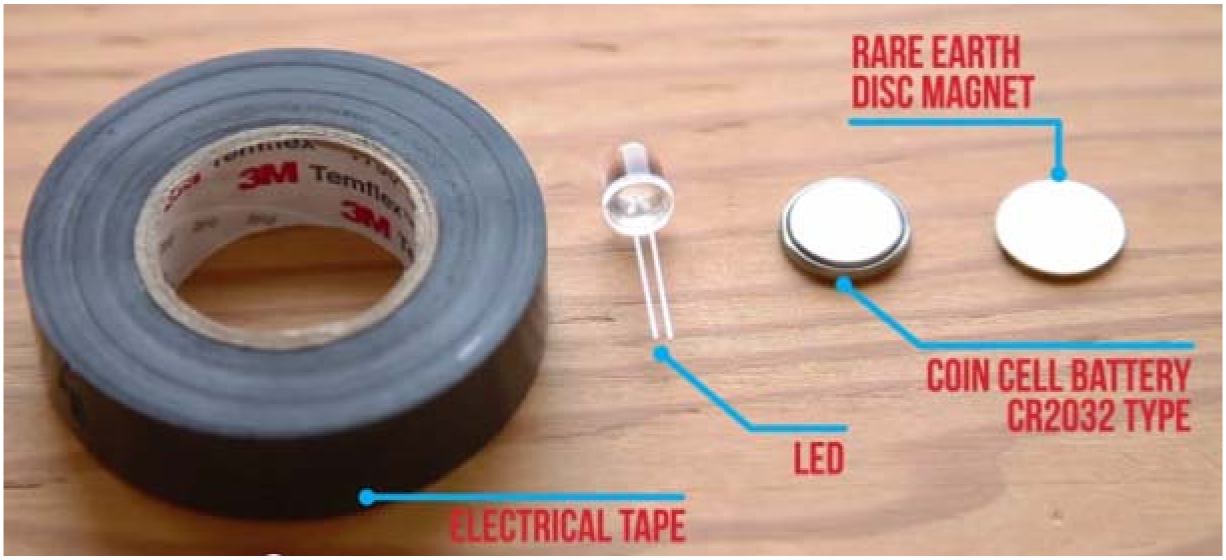
Artists use them by throwing individual LEDs onto metallic objects, like public sculpture or road infrastructure. By throwing LEDs onto an object, the object itself acts as a canvas.

Note: LED throwies were invented in 2006 by the artists Evan Roth and James Powderly the founder of Graffiti Research Lab at Eyebeam Atelier open lab NYC. After Graffiti Research Lab posted the instructions how to make a throwie on Instructables LED throwies went viral on the Internet and could be found in advertising, were for sale as DIY kits or further developed by other artists and hackers worldwide. You'll also find them in those little keychain flashlights– open one up and there's just a battery and an LED.

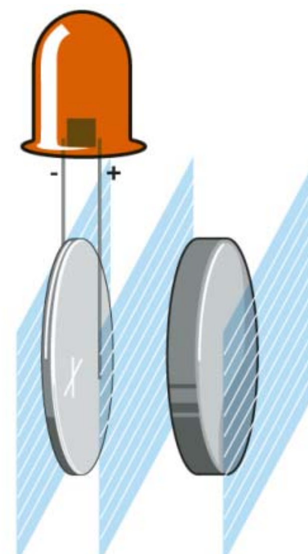
LED throwies are cheery glow-dots (a.k.a. magnetic, closed circuits that stay lit for weeks!) students can make in seconds from simple components and they stick to any ferro-magnetic surface. But that's just the beginning. First we'll make a basic LED throwie, and chain them up into big throwie "bugs." Then we'll learn to hack the throwie circuit with an On-Off tab (made of paper) so we can switch it on, or off, whenever we want (the beauty of circuits!) *Also we can make up games, ex. throwie darts, while kids learn about the properties of currents, circuits, and electricity.* **Warning:** DON'T use a whiteboard that someone cares deeply about, ex. another teacher's, to play throwie dart review. The board will get a bit pockmarked by the end, so a cheap and portable one (especially one that can be permanently dedicated to the game) is perfect.

There's a very helpful and informative video that takes you step by step through the throwie construction process here: http://makezine.com/projects/extreme-led-throwies/

Materials:



- First you'll need **LEDs**. You can buy them from any electronics supplier.
- Some electrical tape
- Coin Cell batteries and
- You'll also need small **magnets**. Ex. 12mm×2mm neodymium-boron magnets
- Paper
- And maybe some scissors for the tape



Tips: A throwie will shine for 1-2 weeks, depending on the weather and the LED color. To get one off a ferro-magnetic surface, don't pull it, or it might come apart. Instead, slide the magnet sideways while lifting it with a fingernail or tool.

Let's get started:

1. Pinch the LED's leads to the sides of the battery, with the longer lead (the anode, or positive leg) touching the battery's positive (+) terminal, and the shorter lead (cathode,



negative leg) touching negative (–).

It should light up. If not, you probably just have the battery the upside down, so flip it over.

2. Cut a 7" length of strapping tape or electrical tape, and wrap the leads tightly to the battery so the LED does not flicker. Wrap once around both sides of the battery.


3. Place the magnet on the positive side of the battery and continue wrapping tightly.


4. The battery's positive contact surface extends around the edges of the battery, so don't let the short lead (cathode) touch it or you'll short the circuit.
5. That's it! You’ve got an LED throwie (and a complete circuit) You're ready to throw it and watch it stick to any ferro-magnetic surface.


Throwie Bugs

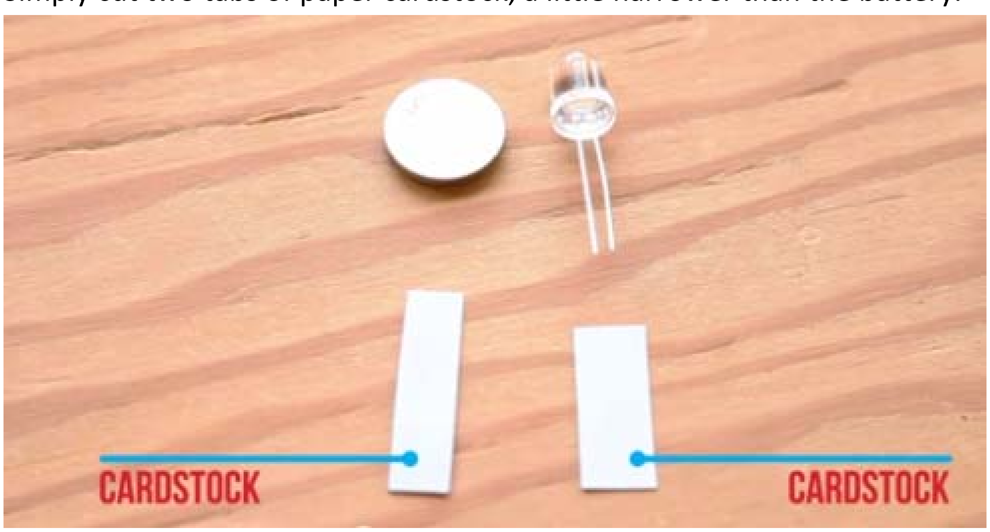
Throwies will naturally stick together because of the magnets, so they can be chained together in giant 'throwie bugs' to really light things up.

On Off Switch

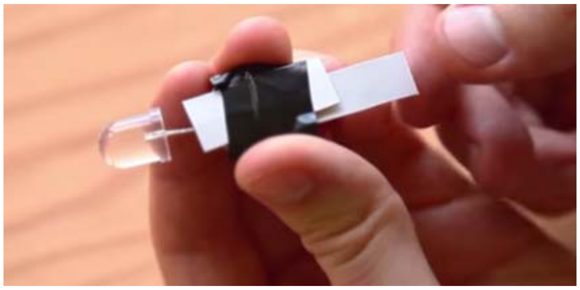
Once we make a basic throwie it stays lit, until it uses up the whole battery. To modify it so that we can turn it on and off whenever we want, we need a circuit breaker.

Materials:

Simply cut two tabs of paper cardstock, a little narrower than the battery.



Then sandwich the LED's longer lead between these two pieces of cardstock before you tape up the throwie. One tab will stick to the tape, the other will slip in and out making and breaking contact, so we can switch throwies on and off whenever we want.[2]



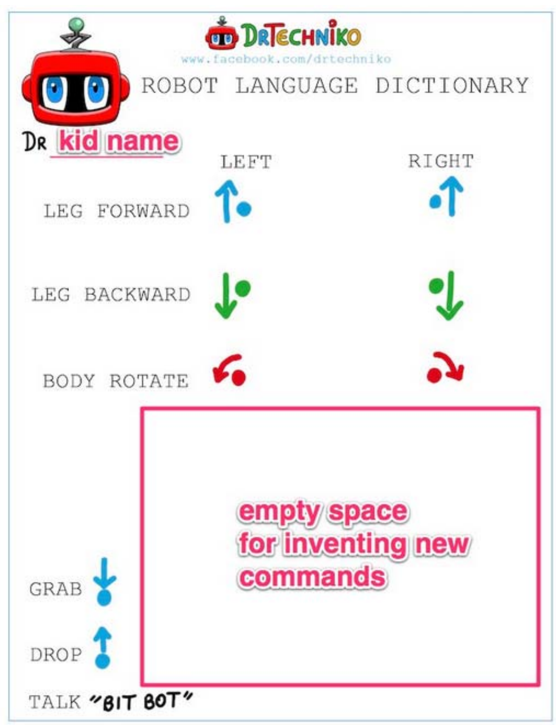
[2] Retrieved from: http://makezine.com/projects/extreme-led-throwies/

How to train your robot

[3]Learning how to program is going to be one of the most useful new skills we can teach our kids today. More than ever our lives depend on how smart we are when we instruct computers. They hold our personal data and they make decisions for us. They communicate for us and they are gradually becoming an extension of our brains. The time to begin to learn programming is now.

The goal of this game is for the ‘robots’ to go through an obstacle course, pick up a ball and bring it back. The kids have to write a program that will tell the robot how to do all that. Every time they write a program, they hand it to their robot and the robot executes it. To do that, give each kid a pen and paper where they copy symbols from the dictionary to write their programs and off their robots go!

The fun part begins when each robot retrieves the ball. After the initial run [aka test program] let kids invent their own moves and symbols that they add to their dictionary and then teach their robots. There is no limit to what the kids come up with.



This game teaches some very basic principles of computer science and programming:

- Programming languages are just another way to communicate to an entity (via programs).
- Programs are recipes for automating stuff

Important programming elements students also often quickly figure out:

- Program Parametrization: Instead of putting a forward step ten times, put a 10 in front of the “step” symbol.

[3] *Image via Favius @ deviantart.com ©2014-2015 favius*

- Composition: Grouping of a set of moves (“move left leg forward, then move right leg forward and do this combo 10 times”)
- Abstraction: “Run in a circle, then say “I’m dizzy!” , then call this the “Run Dizzy” program and do it 100 times. (For some reason, kids love making their partners repeat stuff 100 times over.)
- Unit testing: Write a test program to get the partner moving a few steps, have their partner run it, then fix it and run it again, and then add a few more steps until they reach the goal.

Materials:

- Printouts of the Robot Dictionary
- Pens/pencils
- Materials for an obstacle course
- Ball for each partnership

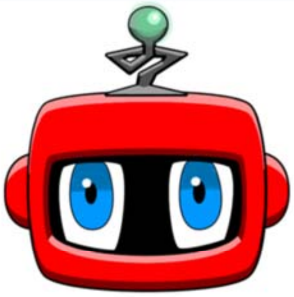
Procedure:

1. Set up an obstacle course
2. Divide students into pairs
3. Introduce the game:

So now that we’ve learned a bit how robots work, you will get to train your own robot! But, wait. Do you guys see any robots around here? Well, I do. Your partner! Let's turn your partner into your own personal robot. Imagine you are on the planet Mars and you cannot go out of your station. There is a very precious element called B-Rainium that you want to retrieve.

Your mission is to write a program that will send your robot around these obstacles retrieve the ball of B-Rainium and bring it back to the station.

But your robot doesn't understand a human language. It only understands the Robot Language. Here is the Robot Language Dictionary. Let's all practice the moves and then you can use these moves to tell your robot what to do!



Dr

DrTechniko

ROBOT LANGUAGE DICTIONARY

	LEFT	RIGHT
LEG FORWARD		
LEG BACKWARD		
BODY ROTATE		

GRAB 

DROP 

TALK **"BIT BOT"**

The Illusion of Life Supply List

Automata-mazing!

- RobIves.com
- Several packs of Printer Paper
- Several packs of White Cardstock for printing automata patterns
- Books such as *Karakuri*
- 15 Scissors (one for every student)
- 3-5 rolls of Tape
- 5 large bottles of Craft/Tacky Glues

Silver Skin Slime (per batch of slime)

- 5 oz. bottle Clear Elmer's glue (Colorations clear glue also works well)
- Silver metallic liquid watercolor, ex. Colorations brand or Sax, etc.
- Sta-Flo liquid starch
- Option: Silver glitter

Gold Skin Slime (per batch of slime)

- 5 oz. bottle of Elmer's Clear School Glue
- 2 TB [ex. Colorations] Gold Liquid Watercolor
- 1/2 cup (4 oz. or 8 TB) of Sta-Flo Liquid Starch
- Option: Gold Glitter

LED Throwies

- 30+ Small **LEDs**. You can buy them from any electronics supplier.
- 2 rolls of electrical tape
- 30 Coin Cell batteries
- 30 small **magnets**. Ex. 12mm×2mm neodymium-boron magnets
- Several sheets of paper
- And maybe some scissors for the tape

How to Train Your Robot

- Printouts of the Robot Dictionary (one per student)
- Pens/pencils (one per student)
- Materials for an obstacle course
- Ball for each partnership

Samples of Academic Standards that can be reinforced during 'The Illusion of Life' activities

K

7.T/E.1 Recognize that both natural materials and human-made tools have specific characteristics that determine their use.

7.2.1 Recognize that some things are living and some are not.

These standards will be met and reinforced as we discuss the relationships and similarities and differences between humans and robots, and their uses and purposes as well as limitations.

7.9.1 Describe an object by its observable properties.

7.9.2 Identify objects and materials as solids or liquids.

These standards will be met and reinforced as students make and describe batches of 'robot skin' slime and relate them to the robot skin created by scientists.

RF.K.3. Know and apply word analysis skills in decoding words.

L.K.3. Apply knowledge of language to understand how language functions in different contexts, to make effective choices for meaning or style, and to comprehend concepts and texts more fully.

7.11.1 Explore different ways that objects move.

7.11.1 Use a variety of objects to demonstrate different types of movement. (e.g., straight line/zigzag, backwards/forward, side to side, in circles, fast/slow).

These standards will be met and reinforced as students participate in creating the codes and while playing the computer coding and code reading/computer code execution game using the robot language.

7.1.3 Take apart an object and describe how the parts work together.

7.1.2 Use building materials to create a whole from the parts.

These standards will be met and reinforced as students participate in constructing and deconstructing 'throwies.' We'll discuss what each part does and how they work together as a whole.

1

7.T/E.1a Explain how tools (ex. like robots), technology, and inventions are used to extend the senses, make life easier, and/or solve everyday problems.

7.T/E.1b Recognize that both natural materials and human-made tools have specific characteristics that determine their use.

These standards will be met and reinforced as we discuss the relationships and similarities and differences between humans and robots, and their uses and purposes as well as limitations.

7.9.3 b Predict the changes that may occur when different materials are mixed.

7.9.3c Investigate and describe the results of mixing different substances.

These standards will be met and reinforced as students predict what will happen when we mix the ingredients, then make and describe batches of 'robot skin' slime and relate them to the robot skin created by scientists.

RF.1.3. Know and apply word analysis skills in decoding words.

L.1.3. Apply knowledge of language to understand how language functions in different contexts, to make effective choices for meaning or style, and to comprehend concepts and texts more fully.

7.11.1 Use familiar objects to explore how the movement can be changed.

These standards will be met and reinforced as students participate in creating the codes and while playing the computer coding and code reading/computer code execution game using the robot language.

7.12.1 Identify and classify objects in the classroom as magnetic or non-magnetic.

7.12.2 Make predictions about how various objects will be affected by a magnet.

These standards will be met and reinforced as students participate in constructing and deconstructing 'throwies.' We'll determine what the magnet does for the throwie and what they think it will stick to and how the magnet helps hold the throwie in place.

2

7.T/E.1a Explain how tools (ex. like robots), technology, and inventions are used to extend the senses, make life easier, and/or solve everyday problems.

7.T/E.1b Recognize that both natural materials and human-made tools have specific characteristics that determine their use.

These standards will be met and reinforced as we discuss the relationships and similarities and differences between humans and robots, and their uses and purposes as well as limitations.

7.9.1 Use tools to observe the physical properties of objects and materials.

7.9.2 Describe what happens when a material changes, ex. from a solid to a liquid.

These standards will be met and reinforced as students predict what will happen when we mix the ingredients, then make and describe batches of 'robot skin' slime and relate them to the robot skin created by scientists.

RF.2.3. Know and apply grade-level word analysis skills in decoding words.

L.2.3. Apply knowledge of language to understand how language functions in different contexts, to make effective choices for meaning or style, and to comprehend concepts and texts more fully.

7.12.1 Determine that objects can move without being touched.

These standards will be met and reinforced as students participate in creating the codes and while playing the computer coding and code reading/computer code execution game using the robot language.

7.12.2 Realize that things fall toward the ground unless something holds them up.

7.12.1 Explain how two magnets interact.

These standards will be met and reinforced as students participate in constructing and deconstructing 'throwies.' We'll determine what the magnet does for the throwie and what they think it will stick to and how the magnet helps hold the throwie in place. We'll predict what will happen when we join two of them together and then test our theories.

3

7.T/E.2 Recognize that new tools, technology, and inventions are always being developed.

7.T/E.1 Explain how different inventions and technologies impact people and other living organisms.

These standards will be met and reinforced as we discuss the relationships and similarities and differences between humans and robots, and their uses and purposes as well as limitations.

7.9.1 Describe a substance in terms of its physical properties.

7.9.4 Classify combinations of materials according to whether they have retained or lost their individual properties.

These standards will be met and reinforced as students predict what will happen when we mix the ingredients, then make and describe batches of 'robot skin' slime (determining whether the ingredients have stayed the same, like when you mix sand and water or salt and pepper, (they are still recognizably themselves), or if they have changed. We relate our batches of slime o the robot skin created by scientists.

RF.3.3. Know and apply grade-level word analysis skills in decoding words.

L.3.3. Apply knowledge of language to understand how language functions in different contexts, to make effective choices for meaning or style, and to comprehend concepts and texts more fully.

These standards will be met and reinforced as students participate in creating the codes and while playing the computer coding and code reading/computer code execution game using the robot language.

7.10.1 Use an illustration or model to identify various sources of energy, ex. heat, light, and chemical

7.12.2 Determine that only certain types of objects are attracted to magnets.

These standards will be met and reinforced as students participate in constructing and deconstructing 'throwies.' We'll determine what the magnet does for the throwie and what they think it will stick to and how the magnet helps hold the throwie in place.

We'll determine what the energy source is for the throwie and discuss how the chemical energy in the battery gets changed into the light and heat energy in the bulb.

4

7.T/E.2 Recognize that new tools, technology, and inventions are always being developed.

7.T/E.1 Explain how different inventions and technologies impact people and other living organisms.

These standards will be met and reinforced as we discuss the relationships and similarities and differences between humans and robots, and their uses and purposes as well as limitations.

7.9.1 Use appropriate tools to measure and compare the physical properties of various solids and liquids.

7.9.2 Compare the causes and effects of various physical changes in matter, mixtures, and materials.

These standards will be met and reinforced as students participate in discussions about robot skins, their characteristics, and why scientists create them. Students will predict what will happen when we mix the ingredients, measure out the amounts for test batches, then make, adjust, and describe batches of 'robot skin' slime. As we troubleshoot our batches of slime students will hypothesize what caused the problem and a solution, ex. if the slime is too sticky…what was the cause and what effect will adding more starch or glue have?

RF.4.3. Know and apply grade-level word analysis skills in decoding words.

L.4.3. Apply knowledge of language to understand how language functions in different contexts, to make effective choices for meaning or style, and to comprehend concepts and texts more fully.

7.11.2 Identify factors that affect the speed and distance traveled by an object in motion.

These standards will be met and reinforced as students participate in creating the codes and while playing the computer coding and code reading/computer code execution game using the robot language.

7.12.3 Describe how electricity passes through a simple circuit that includes a battery, wire, switch, and bulb.

7.12.3c Determine the path of an electrical current in a simple circuit.

These standards will be met and reinforced as students participate in constructing and deconstructing 'throwies' and discuss and discover how they work. We'll find out what happens when the circuit is complete (light) and when it's broken (light shuts off) or the energy source is drained (light shuts off), what the battery does, and how the switch works to interrupt the flow of electricity.

5

7.T/E.2 Recognize that new tools, technology, and inventions are always being developed.

7.T/E.1 Explain how different inventions and technologies impact people and other living organisms.

These standards will be met and reinforced as we discuss the relationships and similarities and differences between humans and robots, and their uses and purposes as well as limitations.

7.T/E.1 Explain how different inventions and technologies impact people and other living (and non-living) organisms.

7.T/E.1c Study a tool, technology, or invention that was used to solve a human problem.

These standards will be met and reinforced as students participate in discussions about robots, robot skins, their characteristics, and why scientists create them and what problems they were designed to solve and what problems they have inadvertently caused. Ex. the uncanny valley. We'll discuss how students feel about the various 'solutions' scientists have come up with and what they think are the most effective ones.

RF.5.3. Know and apply grade-level word analysis skills in decoding words.

L.5.3. Apply knowledge of language to understand how language functions in different contexts, to make effective choices for meaning or style, and to comprehend concepts and texts more fully.

These standards will be met and reinforced as students participate in creating the codes and while playing the computer coding and code reading/computer code execution game using the robot language.

7.10.5 Demonstrate different ways that energy can be transferred from one object to another.

7.10.2 Conduct experiments on the transfer of energy.

These standards will be met and reinforced as students participate in constructing and deconstructing 'throwies' and discuss and discover how they work. We'll find out what happens when the circuit is complete (light) and when it's broken (light shuts off) or the energy source is drained (light shuts off), what the battery does, and how the switch works to interrupt the flow of electricity.

6

7.T/E.1 Explore how technology responds to social and economic needs.

7.T/E.3 Explore how the unintended consequences of new technologies can impact society.

These standards will be met and reinforced as we discuss the relationships and similarities and differences between humans and robots, and their uses and purposes as well as limitations.

7.T/E.3 Distinguish between the intended benefits and the unintended consequences of a new technology.

7.T/E.3 Explore how the unintended consequences of new technologies can impact society.

These standards will be met and reinforced as students participate in discussions about robots, robot skins, their characteristics, and why scientists create them and what problems they were designed to solve and what problems they have inadvertently caused. Ex. the uncanny valley. We'll discuss how students feel about the various 'solutions' scientists have come up with and what they think are the most effective ones.

RL.6.4. Determine the meaning of words and phrases as they are used, ex. in a text.

L.6.3. Apply knowledge of language to understand how language functions in different contexts, to make effective choices for meaning or style, and to comprehend concepts and texts more fully.

These standards will be met and reinforced as students participate in creating the codes and while playing the computer coding and code reading/computer code execution game using the robot language.

7.12.1.b Identify how simple circuits are associated with the transfer of electrical energy when heat, light, motion, sound, and/or chemical changes are produced.

7.12.1 Describe how simple circuits are associated with the transfer of electrical energy.

These standards will be met and reinforced as students participate in constructing and deconstructing 'throwies' and discuss and discover how they work. We'll find out what happens when the circuit is complete (light) and when it's broken (light shuts off) or the energy source is drained (light shuts off), what the battery does, and how the switch works to interrupt the flow of electricity.

7

7.T/E.1 Explore how technology responds to social, political, and economic needs.

7.T/E.3 Explore how the unintended consequences of new technologies can impact society.

These standards will be met and reinforced as we discuss the relationships and similarities and differences between humans and robots, and their uses and purposes as well as limitations.

7.T/E.3 Distinguish between the intended benefits and the unintended consequences of a new technology.

7.T/E.3 Explore how the unintended consequences of new technologies can impact society.

These standards will be met and reinforced as students participate in discussions about robots, robot skins, their characteristics, and why scientists create them and what problems they were *designed to solve and what problems they have inadvertently caused. Ex. the uncanny valley. We'll discuss how students feel about the various 'solutions' scientists have come up with and what they think are the most effective ones.*

RL.7.4. Determine the meaning of words and phrases as they are used, ex. in a text.

L.7.3. Apply knowledge of language to understand how language functions in different contexts, to make effective choices for meaning or style, and to comprehend concepts and texts more fully.

7.Inq.5 Communicate scientific understanding using descriptions, explanations, and models.

These standards will be met and reinforced as students participate in creating the codes and while playing the computer coding and code reading/computer code execution game using the robot language.

7.T/E.5 Develop an adaptive design and test its effectiveness.

7.Inq.5 Communicate scientific understanding using descriptions, explanations, and models.

These standards will be met and reinforced as students participate in constructing and deconstructing 'throwies' and come up with their own designs, modifying ones that have been created by previous inventors. Students will demonstrate their understanding of simple circuitry by building simple circuits and testing them and explaining why their design works or why it does not.

8

7.T/E.1 Explore how technology responds to social, political, and economic needs.

7.T/E.3 Explore how the unintended consequences of new technologies can impact society.

These standards will be met and reinforced as we discuss the relationships and similarities and differences between humans and robots, and their uses and purposes as well as limitations.

7.9.7 Describe how the characteristics of a mixture are different than the characteristics of their component parts.

7.T/E.3 Distinguish between the intended benefits and the unintended consequences of a new technology.

7.T/E.3 Explore how the unintended consequences of new technologies can impact society.

These standards will be met and reinforced as students predict what will happen when we mix the ingredients, then make and describe batches of 'robot skin' slime (determining whether the ingredients have stayed the same, like when you mix sand and water or salt and pepper, (they are still recognizably themselves), or if they have changed. We relate our batches of slime o the robot skin created by scientists.

Students will also participate in discussions about robots, robot skins, their characteristics, and why scientists create them and what problems they were designed to solve and what problems they have inadvertently caused. Ex. the uncanny valley. We'll discuss how students feel about the various 'solutions' scientists have come up with and what they think are the most effective ones.

RL.8.4. Determine the meaning of words and phrases as they are used, ex. in a text.

L.8.3 Apply knowledge of language to understand how language functions in different contexts, to make effective choices for meaning or style, and to comprehend concepts and texts more fully.

These standards will be met and reinforced as students participate in creating the codes and while playing the computer coding and code reading/computer code execution game using the robot language.

1.5.6 Build circuits to demonstrate how they function.

7.12.1 Investigate the relationship between magnetism and electricity.

These standards will be met and reinforced as students participate in constructing and deconstructing 'throwies.' We'll determine what the magnet does for the throwie and how electrical and magnetic forces are similar, different, and/or work together. And as they participate in constructing and deconstructing 'throwies' and come up with their own designs, modifying ones that have been created by previous inventors, students will demonstrate their understanding of simple circuitry by building simple circuits and testing them and explaining why their design works or why it does not.