

ARDUINO: INTERACTIVE LEGO POLICE CAR

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OVERVIEW

At the heart of a child's toy is the interaction that the child has with the toy. It is this engagement of activity where the child's imagination is lived out in their mind that true interactivity takes place. We strove to capture the imagination of a child and implement the interactivity that they might have with a particular toy. Our aim is to bring this imagination to life using Arduino technology, with two physical inputs and two outputs.

RESEARCH



TOY OBSERVATION

Before we began the process of design, we both observed toys in toy stores. We noted how toys reflect societal expectations on boys and girls. We photographed toys during this process, then shared the photographs and notes with each other. After the toy store observations, we decided to work on an existing Lego set.



RESEARCH



OBSERVATION

Kevin has two small daughters, ages six and three. He observed them playing with Legos, watching how they interacted with them, and what their process was of building with Legos.



Initially, the children dumped a tub of Legos on the floor. First, they searched for the pieces they wish to build with. They typically began with a large base to build onto, whether it was a large green Lego platform, or a smaller flat Lego piece. By this point they had determined what they wanted to build. When they finished their Lego creation, they either played with it for a short period of time, or they tore it apart and created something different. Lego creations that tended to be kept in tact were houses and cars. If an adult created something for the child, the Lego creation was typically kept in tact for several days.

RESEARCH



LITERACY

We also gathered a number of articles on Legos. One article in particular was about DigiBlox, research that combined Lego-like blocks and Arduino interactions. Their research suggested that when these blocks were constructed that interactions would be created. This article was also an inspiration in our approach.

INSIGHTS

CHILDREN NEED INTERACTIONS BETWEEN TOYS AND THEM, AS WELL AS THE OTHER PEOPLE AND THEMSELVES.

CHILDREN HAVE EXPECTATIONS OF THE TOYS THEY INTERACT WITH, LIKE A “SHOULD BE” REACTION, PLACE OR SOUND.

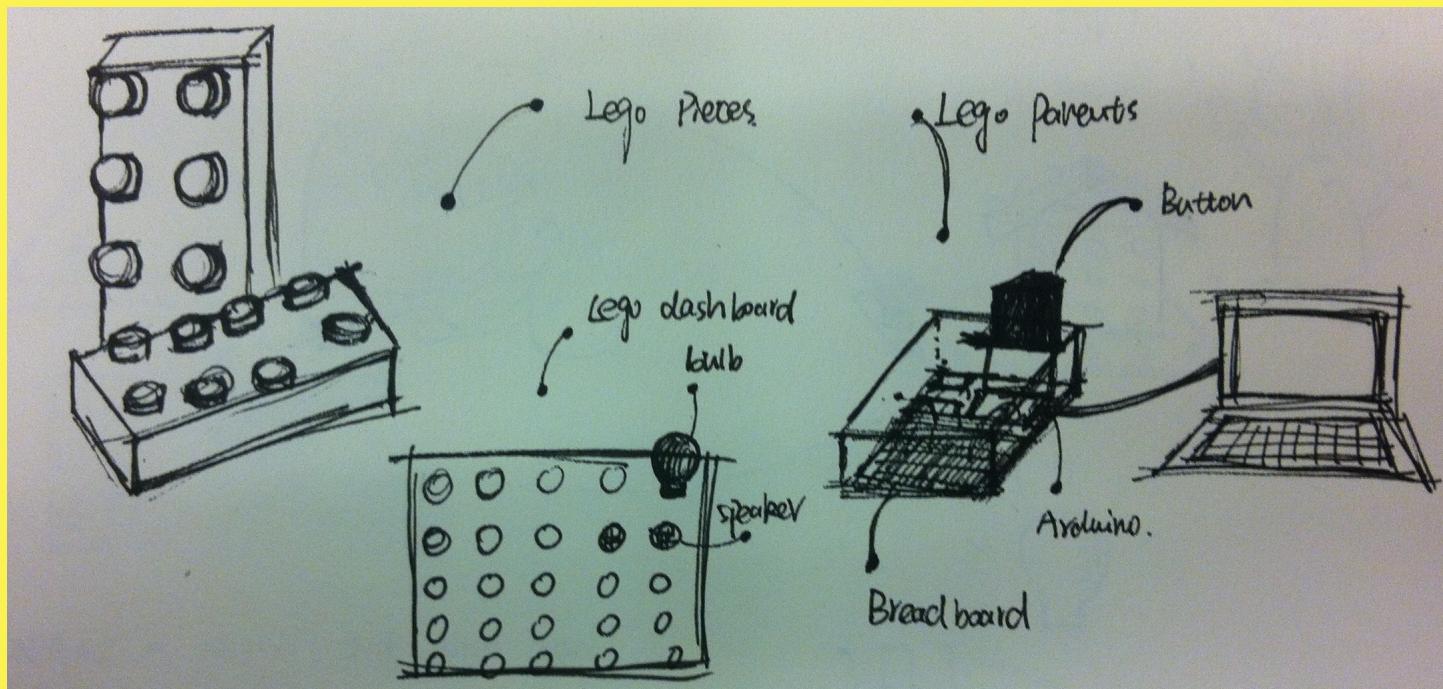
PARENTS NEED A CHANCE TO PARTICIPATE IN CHILDREN’S PLAYING WITH TOYS, AND THEY NEED EDUCATIONAL TOY SETS.

CONCEPTS



LEGO PARENT

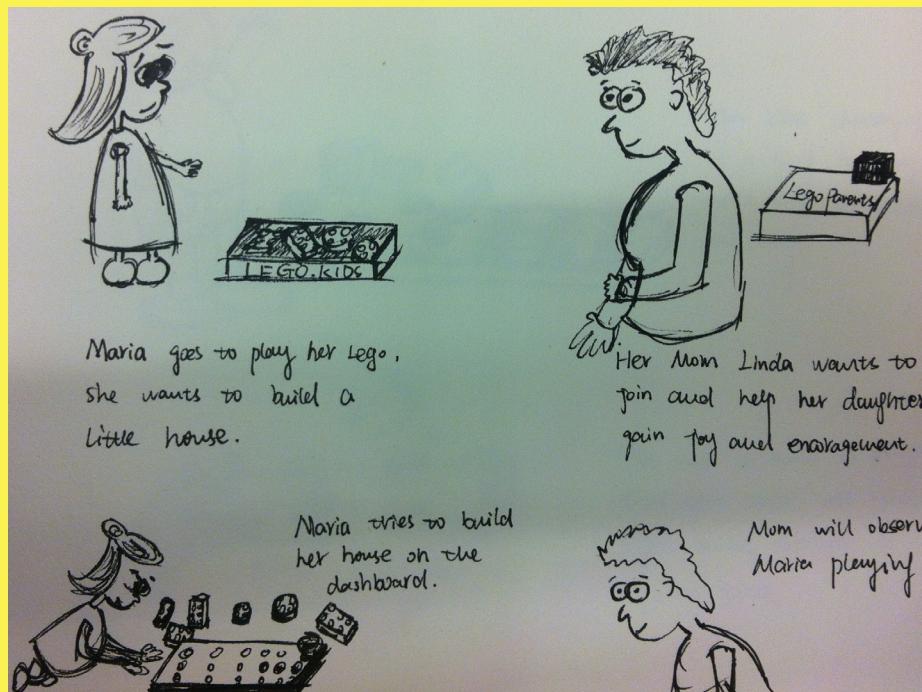
LEGO Parent is designed for enhancing the communication between children and parents. As shown below, there are three separate parts: regular LEGO pieces, LEGO plate with a LED and a speaker and interactive button for parents. This design concept allows parents to control the button, which enables the LED to blink and the speaker to sing a song, in which way to give children encouragement and praise when children finish a project.



CONCEPTS



LEGO PARENT



STORYBOARD

Maria goes to play her LEGO, she wants to build a little house. Her Mom, Linda, wants to join and help Maria gain joy.

Maria tries to build her house on the LEGO plate and Linda is observing Maria playing.

CONCEPTS



LEGO PARENT



STORYBOARD

When Maria finishes the project, Linda pushes the button to activate the LED and the speaker.

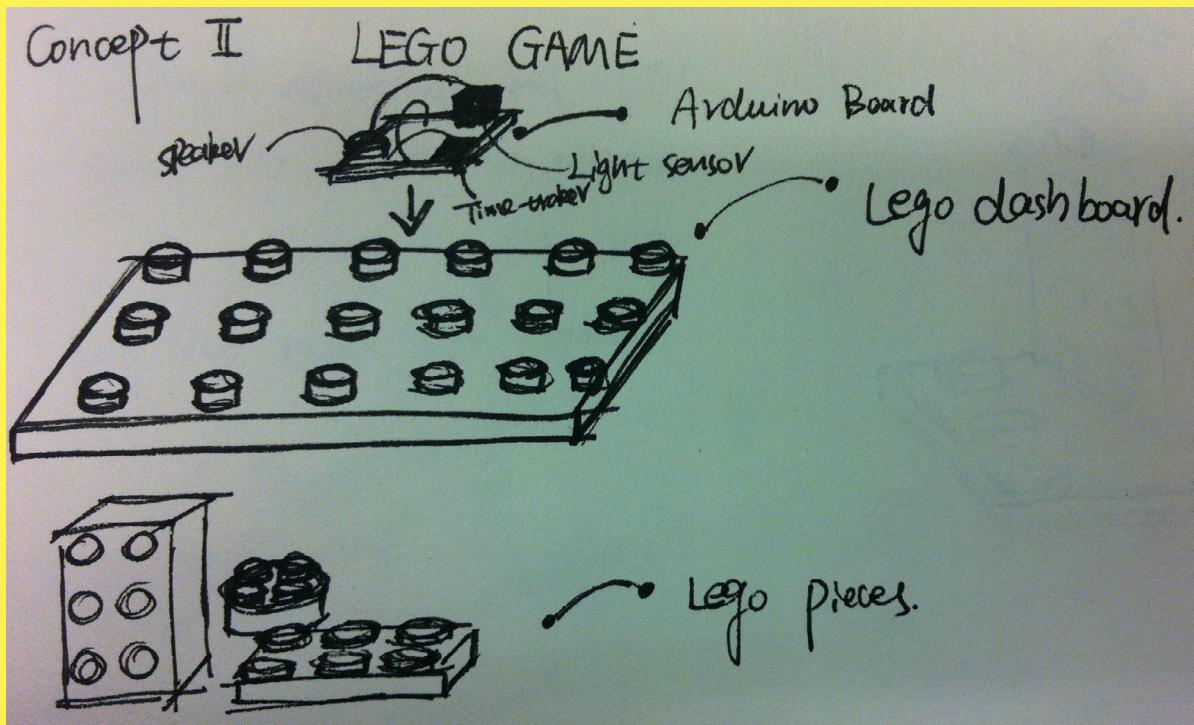
The song and the lit light give Maria a surprise and encouragement.

CONCEPTS



LEGO GAME

LEGO Game is designed for enhancing the interaction between LEGO and children. As shown below, there is an Arduino pad within the regular LEGO plate, on which there will be a speaker, a light sensor and a time tracker. If children can finish a project on the plate which can cover the light sensor within a required time, the speaker will sing a song.



CONCEPTS



LEGO GAME



STORYBOARD

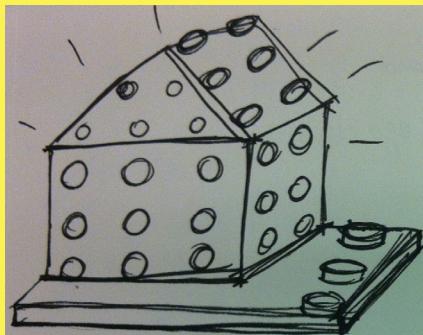
Jim likes a challenge. He is going to play with LEGO Game one day.

Jim has to build a project that can cover the light sensor within a required time.

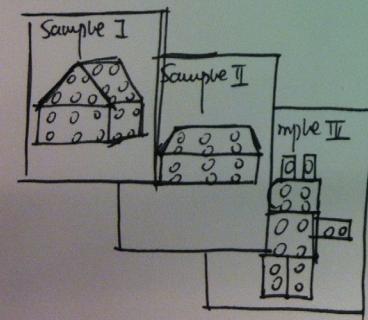
CONCEPTS



LEGO GAME



If Jim can finish a project within the time, the sensor can play a music; if cannot, the sensor will play an alarm sound.



There will be some sample chart, from which Jim can choose, or the children can design for their own project.

STORYBOARD

If Jim can finish the project within the required time, the speaker will sing a song, if Jim cannot, the speaker will play a siren.

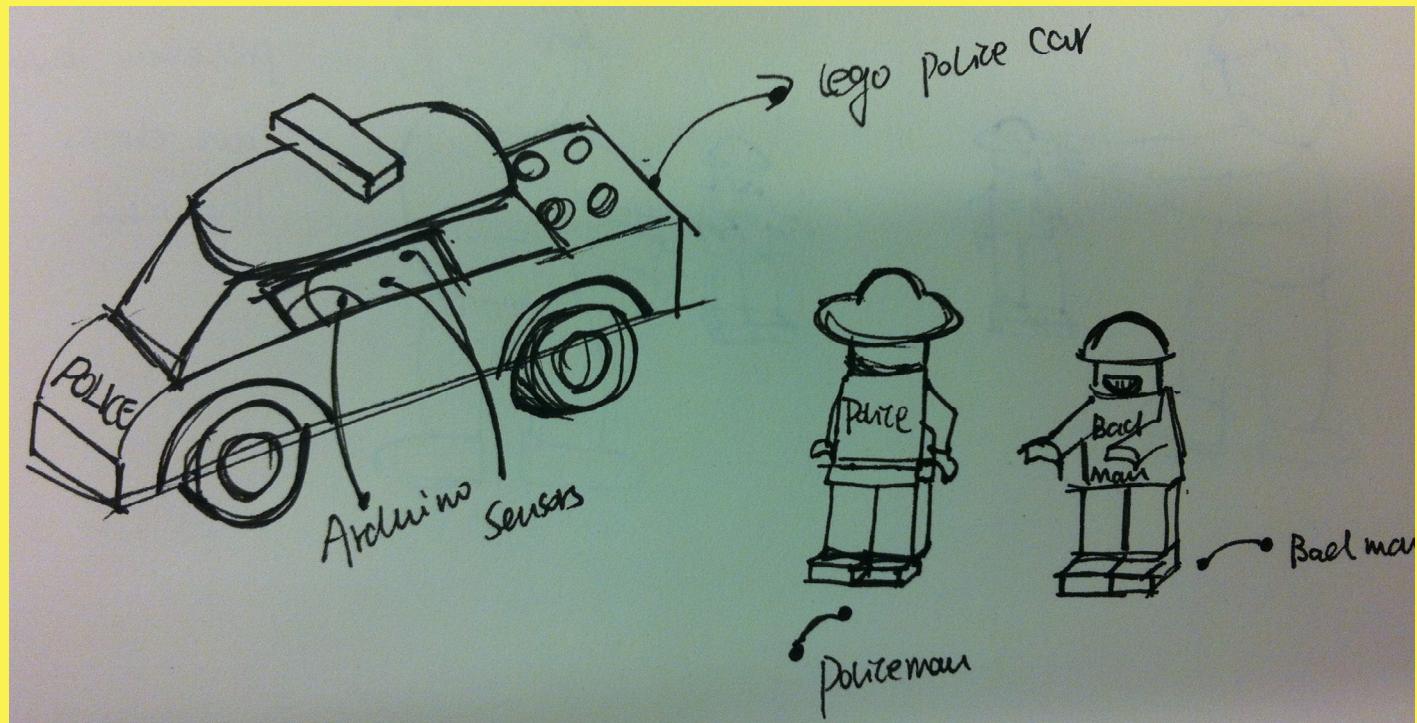
There will be some sample project charts, from which Jim can choose, or Jim can design his own project.

CONCEPTS



LEGO POLICE

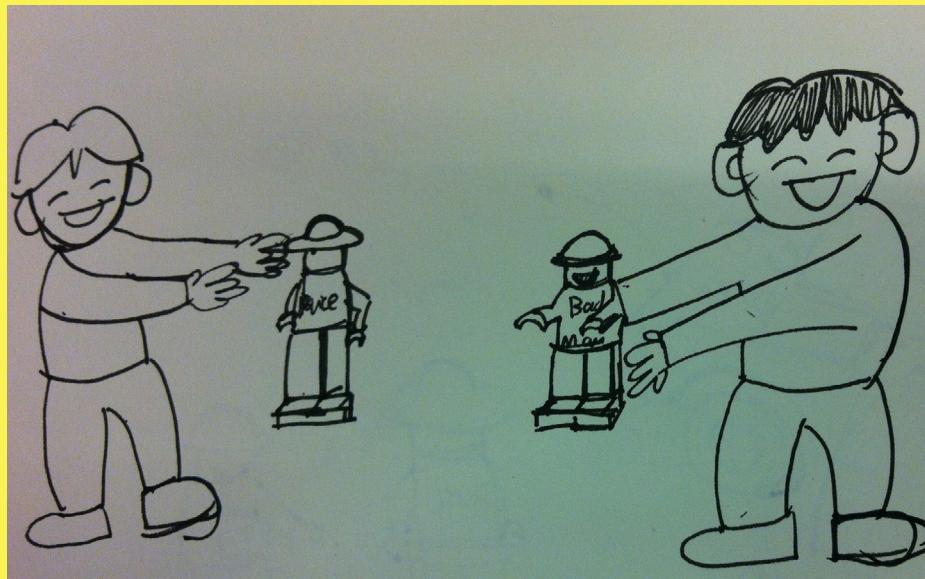
LEGO Police is designed for enhancing the interaction between LEGO and children and also the communication between children and children. As shown below, there is an Arduino pad within the LEGO car, on which there is a sensor and a speaker. On the LEGO policeman, there will be another sensor, which is different than the one on the LEGO bad man. When the police car has reached different people, the speaker will sing a song or make a siren sound.



CONCEPTS



LEGO POLICE



STORYBOARD

Jim and Tom are good friends, they like playing LEGO together. One day, they play with LEGO Police, Jim chooses the policeman and Tom chooses the bad man.

CONCEPTS



LEGO POLICE



STORYBOARD

They play with the two people in front of the police car, the car can sense different people in front of it. When it senses it's the policeman, it will sing a song and if it's the bad man, it will play a siren sound.

CONCEPTS

After we came up with three different concepts, we started to think about how to implement the design idea with available techniques. We were trying to make the interaction easy to access for children and meanwhile realizable with what we got: an Arduino UNO pad and an Arduino Lilypad. We narrowed down our ideas to the LEGO police car, and in order to modify our initial concept we conducted more research.

RESEARCH



OBSERVATION

The police car was ordered and constructed. The Lego set came with a police man, a thief, a police car and something that resembled a railroad crossing with gates.

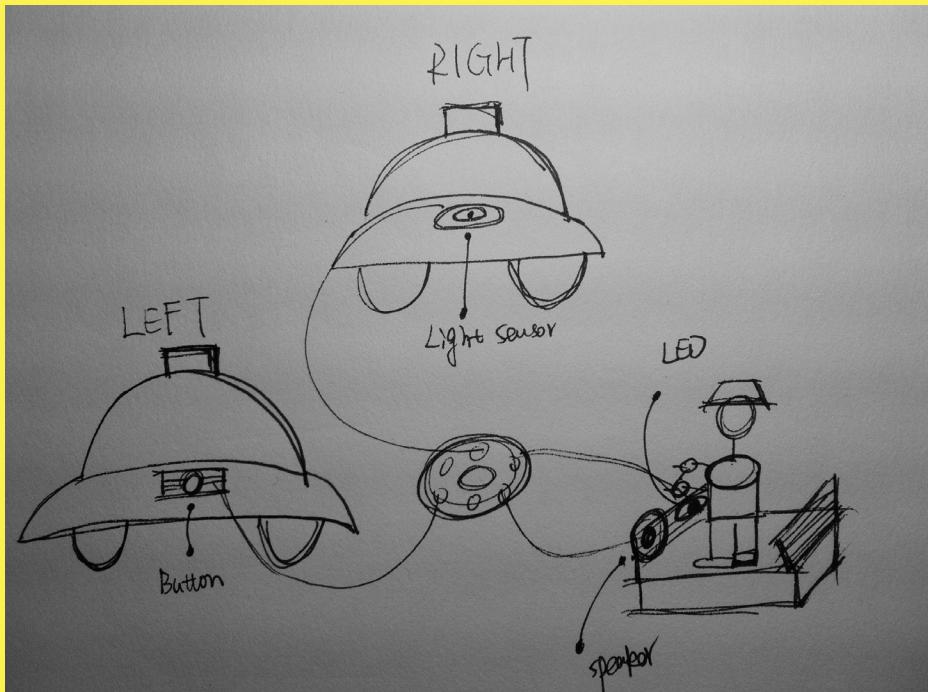


Kevin then allowed his girls to play with the car. He asked his oldest daughter what she imagined the car could do. She said that she imagined the car lighting up with a siren. She also thought the gate should hold the thief when the policeman catches him. This inspired our design and the interactions we brought to the police car set.

CONCEPTS



LEGO POLICE CAR



The modified LEGO Police Car is built with Arduino Lilypad. As shown on the left, it has two inputs: light sensor and button; and it has two outputs: siren speaker and a LED.

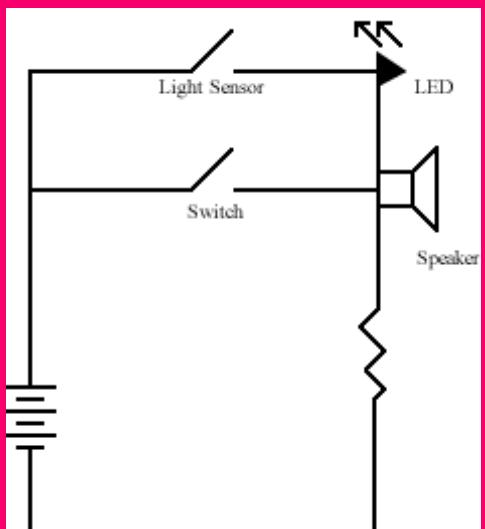
When children touch the light sensor, it will activate the LED, and when children push the button the speaker will play a siren sound.

Parents can use this toy to educate children about the relationship between the “bad guys” and policeman. The added interaction will also increase the enjoyment of playing with LEGO.

PROTOTYPE



CIRCUIT DIAGRAMS

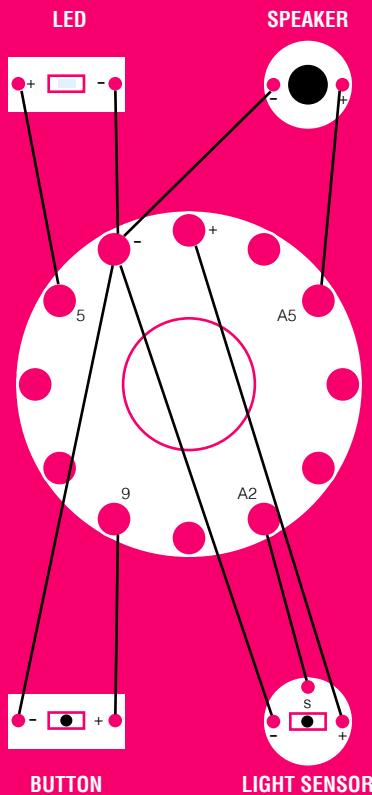


In order to develop our prototype, we designed the electric circuit diagrams, as shown on the left and the next page.

PROTOTYPE



CIRCUIT DIAGRAMS

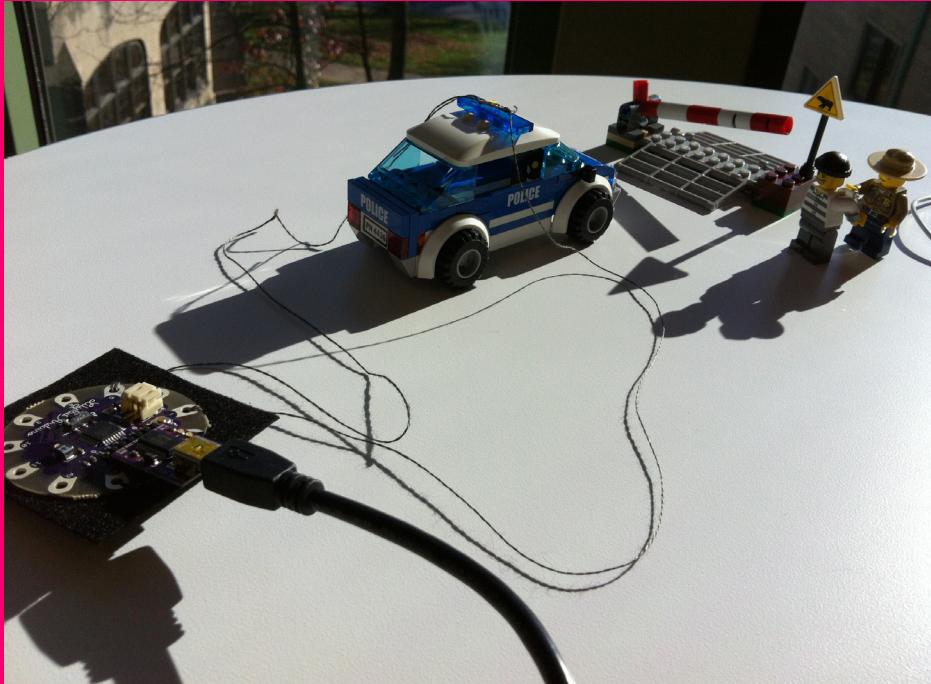


The biggest circle in the middle is the Lilypad; above it is the LED and the speaker and below it is the button and light sensor.

PROTOTYPE



TEST



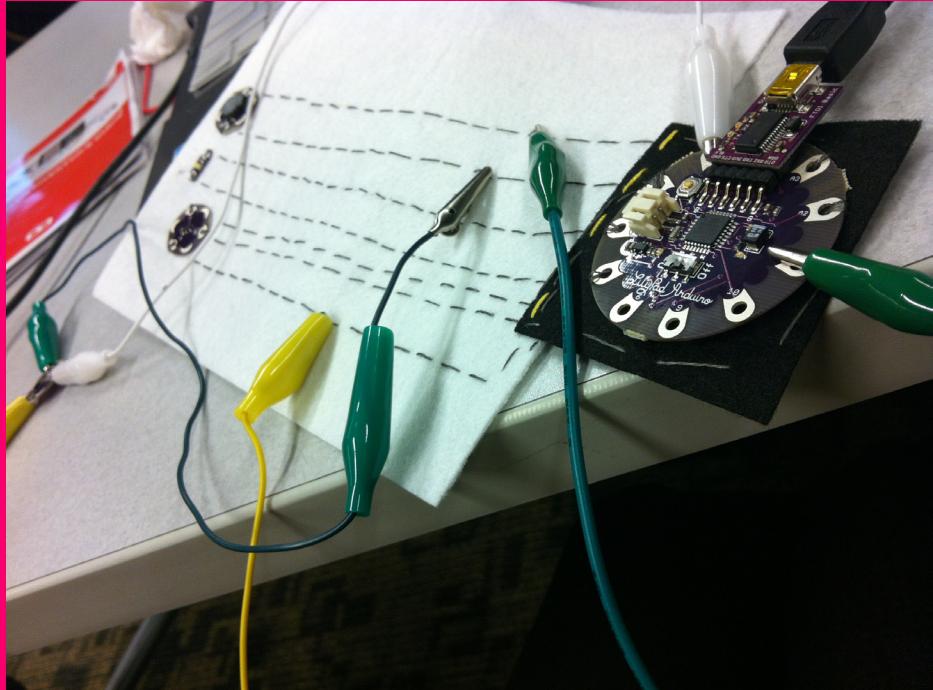
We built our prototype to test the circuit and code, but initially it didn't work.

One problem was in the code, so we started with a simple functionality: the LED, and then we found out it was because the wires were touching each other, which caused the problem.

PROTOTYPE



TEST



We sewed wires on a piece of cloth and used alligator clips to avoid wires from touching each other; this was effective and we could pay attention to the code.

PROTOTYPE



CODE

/* Interactive Toy: LEGO Police Car Kevin Flick, Mengyao Zhao */

```
#define aref_voltage 4.08 // This is a reference voltage for your power supply: as 4.08  
//but measure it with a multimeter when running and add in the correct voltage.
```

```
int buttonPin = 9; //put the button on pin 9  
int lightPin = A2; //put the light sensor on pin A2  
int lightReading;  
int lightPin1 = 5; //put the LED light on pin 5  
int speakerPin = A5; //put the speaker on pin A5
```

```
void setup(void)  
{  
  Serial.begin(9600); // To send debugging information via the Serial monitor  
  pinMode(buttonPin, INPUT); //set the pin as an input  
  digitalWrite(buttonPin, HIGH); //enable the pull-up resistor  
  pinMode(lightPin1, OUTPUT); //Setting LED (lightPin1) to be an output  
  pinMode(speakerPin, OUTPUT); //sets the speakerPin to be an output  
}
```

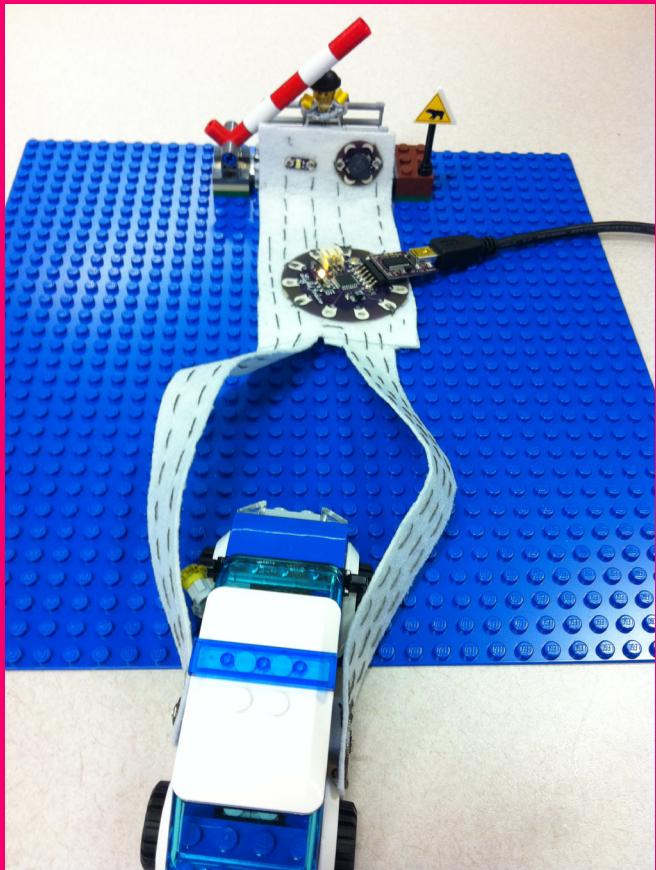
```
void beep (unsigned char speakerPin, int frequencyInHertz, long timeInMilliseconds) // the sound producing function  
{  
  int x;  
  long delayAmount = (long)(1000000/frequencyInHertz);  
  long loopTime = (long)((timeInMilliseconds*1000)/(delayAmount*2));  
  for (x=0;x<loopTime;x++)  
  {  
    digitalWrite(speakerPin,HIGH);  
    delayMicroseconds(delayAmount);  
    digitalWrite(speakerPin,LOW);  
    delayMicroseconds(delayAmount);  
  }
```

```
void loop(void)  
{  
  if (digitalRead(buttonPin)==0)  
  {  
    beep(speakerPin,2349,10); //D  
    beep(speakerPin,2637,10); //E  
    beep(speakerPin,2793,10); //F  
    beep(speakerPin,3136,10); //G  
    beep(speakerPin,3520,10); //A  
    beep(speakerPin,3951,10); //B  
    beep(speakerPin,4186,10); //C  
    beep(speakerPin,3951,10); //B  
    beep(speakerPin,3520,10); //A  
    beep(speakerPin,3136,10); //G  
    beep(speakerPin,2793,10); //F  
    beep(speakerPin,2637,10); //E  
    beep(speakerPin,2349,10); //D  
  
    beep(speakerPin,2349,10); //D  
    beep(speakerPin,2637,10); //E  
    beep(speakerPin,2793,10); //F  
    beep(speakerPin,3136,10); //G  
    beep(speakerPin,3520,10); //A  
    beep(speakerPin,3951,10); //B  
    beep(speakerPin,4186,10); //C  
    beep(speakerPin,3951,10); //B  
    beep(speakerPin,3520,10); //A  
    beep(speakerPin,3136,10); //G  
    beep(speakerPin,2793,10); //F  
    beep(speakerPin,2637,10); //E  
    beep(speakerPin,2349,10); //D  
  
    }  
  else  
  {  
    beep(speakerPin,0,0);  
  }  
  
  lightReading = analogRead(lightPin);  
  if (lightReading < 20)  
  {  
    digitalWrite(lightPin1, HIGH);  
    delay(100);  
    digitalWrite(lightPin1, LOW);  
    delay(100);  
  }  
  else  
  {  
    digitalWrite(lightPin1,LOW);  
  }  
}
```

PROTOTYPE



FINAL PROTOTYPE



After we fixed all the problems, we sewed wires onto a piece of cloth, and modified our code until all the expected functionalities worked well (as shown on the last page). The photo on the left is an overview of the toy set.

PROTOTYPE



FINAL PROTOTYPE



To the left is the light sensor and the button, and below shows the LED and the speaker.

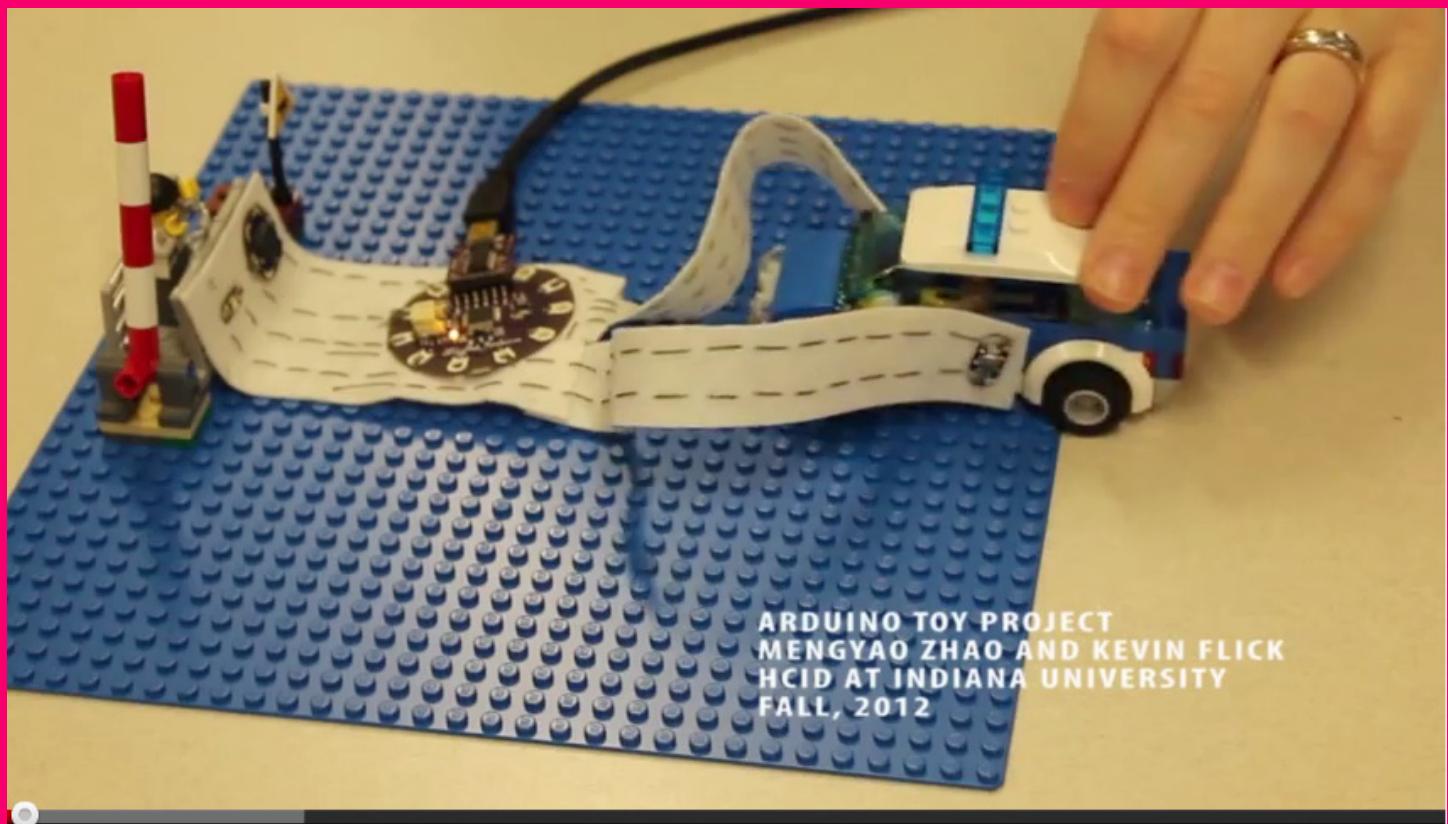


PROTOTYPE



FINAL PROTOTYPE

You can view our video about the final prototype here: <https://docs.google.com/file/d/0BzAbQhygAusBajRnck5zMDIIV2c/edit>



LESSONS

WHAT WOULD YOU DO DIFFERENTLY IF YOU WERE TO DO IT AGAIN?

WE FOUND IT DIFFICULT TO USE THE LILYPAD WITH THE LEGO CAR, MAINLY BECAUSE OF THE SMALL SIZE OF THE CAR. THE LEGO POLICE CAR WAS FROM A LEGO SET AND WASN'T WIDE ENOUGH TO CONTAIN THE LILYPAD.

ALSO, THE WIRES WERE DIFFICULT TO MANAGE. SINCE THERE WERE SO MANY WIRE THREADS, WE WERE NOT ABLE TO ATTACH THE LED FLASHING LIGHT AND THE SIREN TO THE CAR WITHOUT CROSSING THE WIRES.

WHAT WOULD YOU HAVE LIKED TO HAVE INCLUDED?

WE WOULD HAVE LIKED TO HAVE INCLUDED THE TEMPERATURE SENSOR INSTEAD OF THE BUTTON TO CONTROL THE SIREN. THE IDEA WAS THAT THE SENSOR WOULD DETECT WHEN A CHILD PICKS UP THE LEGO CAR AND WOULD SOUND THE SIREN. WE HAD DIFFICULTIES GETTING AN ACCURATE READING FROM THE SENSOR, WHICH FORCED US TO ABANDON THE SENSOR.

WHAT WOULD YOU LIKE TO BE ABLE TO DO WITH ARDUINO NEXT?

WE IMAGINE LEGO AND ARDUINO WORKING TOGETHER IN THE FUTURE TO ALLOW FOR THE CIRCUITRY TO BE INTEGRATED INTO THE LEGO PIECES. IDEALLY, THE LIGHTS ON THE POLICE CAR COULD HAVE ARDUINO LED LIGHTS BUILT INTO THEM. CHILDREN COULD CREATE INTERACTIVE LEGO DESIGNS SIMPLY BY COMBINING LEGO PIECES TOGETHER. THIS IDEA WAS INSPIRED BY RESEARCH CONDUCTED BY DIGIBLOX (<https://www.wpi.edu/Pubs/E-project/Available/E-project-011411-082210/unrestricted/DigiBlox.pdf>).

CITATIONS

LEGO	http://www.lego.com
INTERACTIVE-GAMING CUBES	http://venturebeat.com/2012/08/30/new-sifteo-cubes-make-the-little-blocks-of-gaming-joy-more-convenient/
INTERACTIVE LEGO APP	http://www.ohhaveyouseenthis.com/2011/09/interactive-lego-app.html
INTERACTIVE LEGO EXHIBIT	http://www.azcentral.com/community/phoenix/articles/2012/10/04/20121004arizona-science-center-hosts-interactive-lego-travel-exhibit.html
DigiBlox	https://www.wpi.edu/Pubs/E-project/Available/E-project-011411-082210/unrestricted/DigiBlox.pdf
LIVING WALL	http://hlt.media.mit.edu/?p=27
ELECTRONIC POPABLES	http://hlt.media.mit.edu/?p=5
Pu Gong Ying Tu	http://hlt.media.mit.edu/?p=2286
TWEET-A-POT	http://www.instructables.com/id/Tweet-a-Pot-Twitter-Enabled-Coffee-Pot/
SINGING PLANT	http://www.instructables.com/id/Singing-plant-Make-your-plant-sing-with-Arduino-/