New Orleans JAZZED about Engineering Education

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MAKER: Star Car 2015

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Emily Marasco is a Ph.D. student at the University of Calgary. Her research focuses on creativity and cross-disciplinary curriculum development for engineering students as well as for K-12 and community outreach programs.

Ms. Stephanie Hladik, University of Calgary

Stephanie Hladik is a M.Sc student in Electrical and Computer Engineering at the University of Calgary. Through her research she is exploring topics related to the integration of engineering into K-12 curricula. In particular, she is interested in bringing electrical engineering, programming, and the engineering design process into K-12 education. Aside from her research, Stephanie also participates regularly in outreach programs to promote STEM topics in classrooms and beyond.

Robyn Paul, University of Calgary

Robyn is a Master's student researching engineering leadership education at the University of Calgary. She graduated from Manufacturing Engineering in 2011 and worked in industry for a few years before returning to school.

Mr. Riley S. Booth, University of Calgary

I'm a biomedical engineering MSc student at the university of Calgary. My research interests include haptics, rehabilitation, mobile and wearable technology, engineering education and educational software. I'm currently developing a wearable device for blind and/or deaf users to interface with a computer.

MAKER: Star Car 2015

Star Car 2015 is an interdisciplinary graduate student initiative resulting in an interactive art car displayed and demonstrated at educational engineering events. Originally developed in 2014 for a local engineering and art festival, Star Car has been improved and updated with new hands-on interactive stations. The 2015 theme of "Global Connectivity" demonstrated and educated the public about the impact of engineering through three types of connectivity: electrical connectivity through conduction, mechanical connectivity through switches, and cultural connectivity through cultural performances with integrated wearable technology costume components. The technical and artistic elements were designed around an educational space exploration theme, with the addition of global unity and cooperation.

Multiple interactive stations were attached on and around the car, allowing audience members to explore various elements of electrical and computer engineering through hands-on activities. The primary interactions were four conductive handholds, each featuring one basic element-wind, water, earth, and fire. Participants were encouraged to complete the circuits using the conductivity of human skin either alone, or by working alongside other participants. Each element played a different music sound through incorporated speakers when the corresponding circuit was completed. The 2015 design was significantly modified from the initial 2014 version, based on the feedback and experience of the 2014 design team.

Primary recommendations from 2014 implementation:

- Space theme was successfully and very popular
- Most successful with young audiences (K-6)
- Stations need to better withstand long-term use
- Participants were most interested in the conductive circuit
- Stations need to be better weather-proofed in case of unpredictable weather
- More lights and louder music for evening events
- Car needs to remain drivable and street legal

Primary changes incorporated in 2015 design:

- Modular station system for easy assembly and repair
- Car stations changed to four different conductive circuits, moving the alien to a decorative "mascot" piece and eliminating the light sensor station
- Expanded the simple conductive circuit to a parallel network with computer program control and multiple outputs at one time
- Incorporated global and community theme to attract varied audience
- Lights, music, and dance performances integrated for evening events

The 2015 modifications and changes were successfully implemented and well received among the public. Applying a modular installation system allowed the design team to setup and takedown quickly, and to make repairs more quickly. The electrical components were encapsulated within each module, minimizing the wiring and connections that were exposed to

the elements. The new design allowed multiple interactions from all sides of the car, reaching more participants at a time and allowing families and groups to work together. Adults were also interested in the computer control and programming elements of the installation, and more likely to engage in conversation with the design team about engineering and technical integration. The inclusion of diversity and global engineering thematic elements also appealed to all ages, and resulted in the inclusion of the art car in the 2015 city Pride Parade.

This Maker poster-and-instructions submission will outline instructions for using a Makey Makey system and programming language Processing to create conductive circuits as featured on the art car, which may be used for any educational or hands-on display.

Wind and Earth

Fire

Water

Conductive Art with Makey Makey and Processing

- Art cars and other educational displays are meant to be engaging for audience members. To help create a cohesive look for your final design, choose a theme that is relevant to the intended audience or students. For example, K-12 students respond well to themes that follow their own curriculum content, such as weather science or sky science. Repeating classroom lessons helps to reinforce the educational and informational content of your display.

- Decide what elements of your design will be conductive. In the Star Car example above, the fire, water, and wind creations are each used as a contact point for their respective circuits, with the earth creation being used as the contact point for a common ground.

- Regardless of artistic elements or materials, each handhold or connection point must have some sort of metal or conductive material that can be touched by a participant. Aluminum foil is a powerful tool for creating craft circuits. It can be used to reinforce loose connections, increase the size of a conductive circuit, or increase the conductivity of a particularly resistance surface or material. These contact points must be secure enough to withstand multiple uses, ideally thousands if exhibiting for several days.

- Connect wires to the conductive connection points using alligator clips, soldering, or some other sturdy connection method, making sure to tightly bind any loose connections. A "touchy" circuit is very frustrating for people to use, particularly younger audience members. Use your artistic vision to hide the power source and wires. Wires can be camouflaged into the surface of your art car or educational display depending on the chosen wire colour.

- Using a Makey Makey board, attach your ground wire to the group connection, and your other wires to the desired keyboard connections (a, s, d, f, etc.). This will be used to create a connection between the computer keyboard and the conductive circuit. When one conductive handhold is connected to the ground connection, the circuit will be completed and the computer will interpret the corresponding key as being pressed.

- A customized computer program (example attached) can be used to create an action that will be played when the circuit is connected. For example, lights or sound elements may be generated and should be prominently displayed as a feature in your thematic design.

- This design requires the Makey Makey to be connected via USB and the Processing environment to be running for real-time interaction and execution. Suggested code may be found at the end of these steps.

- Test your circuit by holding the two contact points at the same time. If the lights/sound begin to flash/play, you know your circuit and program are working!

- Encourage audience members to try holding hands to create a giant human circuit. Skin-to-skin contact is necessary, but not limited to hands. Feet, foreheads, and elbows are

other fun places to try. Remember that younger audience members may need a reminder about appropriate touching boundaries, and about mature behaviour when asked to hold hands with the opposite gender!

- Note: Human skin is more conductive when warm. If this experiment is done outside, cold hands may increase the resistivity of the circuit.

```
//This code was implemented in Processing, available for free
from Processing.org.
//This program uses the Makey Makey board, connected by USB.
Four connections are made form the Makey Makey to the conductive
circuits.  The A, S, and D key connections should be to any of
the conductive handholds, and the other side of each circuit
should be connected to the board's ground.  User will complete
circuit contacts between each separate key connection and the
ground in order for this program to work.
//This program will play a sound for each connection that is
made.  When the connection is released, the sound will stop.
The sound files will be continually looped until the program is
stopped.


//You will need to import the Minim library from the Tools menu.
import ddf.minim.*;

boolean playA = false;
boolean playS = false;
boolean playD = false;

int positionA = 0;
int positionS = 0;
int positionD = 0;

Minim minimA;
Minim minimS;
Minim minimD;

AudioPlayer playerA;
AudioPlayer playerS;
AudioPlayer playerD;


void setup() {
  size(100, 100);
  minimA = new Minim(this);
  //Load desired sound files.
  playerA = minimA.loadFile("Wind.wav", 1024);
  minimS = new Minim(this);
  playerS = minimS.loadFile("Fire.wav", 1024);
  minimD = new Minim(this);
  playerD = minimD.loadFile("Water.wav", 1024);
}
```

```
void draw() {
  background(200);

  if (playA == true) {
    if (playerA.isPlaying() == false){
      playerA.loop();
    }
  }
  else{
    playerA.pause();
  }
  if (playS == true) {
    if (playerS.isPlaying() == false){
      playerS.loop();
    }
  }
  else{
    playerS.pause();
  }
  if (playD == true) {
    if (playerD.isPlaying() == false){
      playerD.loop();
    }
  }
  else{
    playerD.pause();
  }
}

void keyPressed() {
  if ((key == 'A') || (key == 'a')) {
    playA = true;
  }
  if ((key == 'S') || (key == 's')) {
    playS = true;
  }
  if ((key == 'D') || (key == 'd')) {
    playD = true;
  }
}

void keyReleased() {
  if ((key == 'A') || (key == 'a')) {
    playA = false;
  }
  if ((key == 'S') || (key == 's')) {
    playS = false;
  }
```

```
  if ((key == 'D') || (key == 'd')) {
    playD = false;
  }
}

void stop()
{
  playerA.close();
  minimA.stop();
  playerS.close();
  minimS.stop();
  playerD.close();
  minimD.stop();
  super.stop();
}
```