LumiDance

David L. Harmon¹, Barton E. Green¹, Francis R. White¹, Bonnie Destakasi², Joseph Chase², Lea Ann Smith², Joshua Pauly², Carla Beecher and Mary Harmon¹

Blending Artistic and Technological Creativity in STEAM Education

¹Create It Lab & IBM Systems & Technology, ²Essex High School, Essex Junction, VT USA
The LumiDance Project

- A collaborative STEAM project developed by Create It Lab with the STEM Academy, the Robotics Club and the Academy of Visual and Performing Arts at Essex High School (Essex Junction, Vermont)

Goal

To enhance high school education
In such a way that
all student participants are motivated
So that
they are better prepared to manage
Design/Build challenges in
post secondary school...

...and in the real world
Lu•mi•Dance /lʊˈmɪdæns/, noun
The intensity of light emitted from a dance per unit area in a given direction

Prototype LumiDance Costume
Create It Lab

The LumiDance Project

Educational Objectives:

(1) Engage nearly all students by integrating STEM into the Arts
   => STEAM

(2) Create Hierarchical Teams with a motivational, unifying purpose

(3) Introduce the Design Cycle for Project-based Learning in the Arts

(4) Coach students in Brainstorming and Design Focusing

(5) Provide a real-world application of Mathematics (Programming)

(6) Explore Collaborative Education in a high school environment
The LumiDance Project

TEAMS: The Best Way to Spell STEAM

The LumiDance Project used Hierarchal Teams, reflecting a real world design project.

The Dance 2 subteam engineered the Dance & the Robotics Club engineered the Lights.

Synchronization of the lights with the dance required the collaboration between subteams.
Create It Lab

The LumiDance Project
The Dance Design Cycle

PERFORM
LumiDance 4...
LumiDance 3
LumiDance 2
LumiDance 1

RESEARCH

REHEARSE IN COSTUMES

PRACTICE & BUILD COSTUMES

CHOREOGRAPH & DESIGN COSTUMES

The Design Cycle is a natural fit for Project-based Learning in the Arts
The LumiDance Project

Question: What would make this dance cooler?

Answers:
- Illuminated Musicians
- Lasers & Fog
- More Lights
- Vary Brightness
- More Robust Wiring
- Better LED Attach
- Improve Box Attach
- EL Wire Lights
- Improve Sync
- More Accessible Programming
- Non-Stretch Costumes

Brainstorming Areas
The LumiDance Project

Design Focusing

**Question:** What is the benefit/value and the cost/difficulty for each idea?

**P.I.C.K. Chart**

**Answers:**
- P: Illuminated Musicians
- P: Lasers & Fog
- I: More Lights
- I: Vary Brightness
- I: Robust Wiring
- I: LED Attach
- I: Box Attach
- C: EL Wire Lights
- C: Improve Sync
- K: More Accessible Programming
- K: Non-Stretch Costumes

**Constraints:** TIME and MONEY
Create It Lab

The LumiDance Project
Costume Building Flow

LED Wiring

Sewing

Synchronizing

Control Wiring

Programming
The LumiDance Project

LED Controller Decision

<table>
<thead>
<tr>
<th>Choices</th>
<th>Selection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personal Computer</td>
<td>PIC 16F1823</td>
</tr>
<tr>
<td>Tablet</td>
<td>8 MIPS</td>
</tr>
<tr>
<td>Raspberry Pi</td>
<td>Flash (3.5KB)</td>
</tr>
<tr>
<td>Arduino</td>
<td>RAM (128B)</td>
</tr>
<tr>
<td>TI-430</td>
<td>Oscillator (32MHz)</td>
</tr>
<tr>
<td>Beagle Bone</td>
<td>EEPROM (256B)</td>
</tr>
<tr>
<td>PIC</td>
<td>ADC (8 Ch, 10b)</td>
</tr>
<tr>
<td>FPGA</td>
<td>PWM (ECCP)</td>
</tr>
<tr>
<td></td>
<td>MI2C, SPI, EUSART</td>
</tr>
<tr>
<td></td>
<td>TIMERS (2) 8b, (1) 16b</td>
</tr>
<tr>
<td></td>
<td>Watchdog Timer</td>
</tr>
<tr>
<td></td>
<td>Price: ~ $0.99 ea.</td>
</tr>
</tbody>
</table>

Over 12 Billion PIC microcontrollers have been sold...
The LumiDance Project

Control Box Design

Custom PIC pc board* with voltage regulator & LED output drivers (second PIC optional)

* Custom PIC board* designed by B. Green
The LumiDance Project

Programming Decision

Choices

“C” Language
Assembly Language

Selection

Lower required memory allowed more complex programs
Provided students with a new skill
Small RISC instruction set, easy to learn
The LumiDance Project

LED State & Timing Notation

- LEDs indirectly synchronized to the choreography via the music

- Music staff adapted for LED notation

![LED State & Timing Notation Diagram]

Legend:
- R: RED LEDs
- G: GREEN LEDs
- B: BLUE LEDs
- P: RED & BLUE LEDs
- W: RED, GREEN & BLUE
The LumiDance Project

Design Issues

**Issue A:** LED strips not staying in place

**Issue B:** Wires pulled off the ends of LEDs

**Root Cause Analysis:** Sewing fixed-Length LED strips tightly to stretchy costume material strains the wire connections and pulls LEDs out of place

**Solutions:**
1. Sew tulle pockets over LEDs and sew each section down hard at just the top
2. Develop more robust wire attachment scheme

**Issue C:** Internal LED strip wires breaking

**Root Cause Analysis:**
Bending LED strips during dance weakens the connections between LED segments

**Solutions:**
1. Remove end segments at max flex points
2. Reinforce joints with clear heat shrink tubing
Create It Lab

The LumiDance Project

Performance!

Design Pass 1: Fine Arts Night, April 1, 2014

Design Pass 2: Final Dance Recital, May 28, 2014
Create It Lab

The LumiDance Project

Awards

Create It Lab Awarded Emily Moehn the TEAM STEAM Award for Participating in Both STEM and Dance Subteams

Honorable Mention

Dance and Choreography: Erin Johnson

Electronics and Programming: Ian Ballou and David St-Pierre
The LumiDance Project

Thanks!

Choreography
Erin Johnson

PIC Programming
Ian Ballou
David St-Pierre

Electronics
Ian Ballou
Jon Bonning
Elijah Danyow
Emily Moehn
David St.Pierre
Riley Wilbur

Dance
Sarah Abeling
Nipunika Coe
Cheslea Faure
Brittany Gratton
Sade Hankey
Megan James
Erin Johnson
Allie Matthews
Emily Middleton
Emily Moehn
Holli Trudo
Alyssa Wieland