Assistive Device Team
LSME
Meet the Team

Jacob Bennet
Financial Officer
Co-Project Archivist
Chemical Engineering

Richa Prasad
Co-Design Lead
First Year Engineering

Ian Dekker
Project Partner Liaison
First Year Engineering

Samuel Zhang
Co-Project Archivist
First Year Engineering

Dean Lontoc
Co-Design Lead
First Year Engineering
Project Overview

Assistive Device

- A device that enables students with special needs (physical and cognitive) to engage in educational activities

Project Goal

- Create an organized project breakdown and lesson plan for K-12 EPICS students to enhance their STEM abilities as they create assistive devices
Project Purpose

- Assist the EPICS K-12 Program
- To work through a project and document the entire process to help K-12 Teams
- Will design lesson plans and learning activities for Our Lady of Grace Catholic School that will help enhance math and science learning for students with special needs
Project Timeline

- **Week 1**: Assigned Team Roles
- **Week 2**: Identified Project Goals
- **Week 3**: Specification Development & Research
- **Week 4**: Specification Development & Research
- **Week 5**: Conceptual Design
- **Week 6**: Conceptual Design
- **Week 7**: Conceptual Design
Project Timeline

- Week 8: Conceptual Design
- Week 9: Prototyping
- Week 10: Testing
- Week 11: Redesign
- Week 12: End-of-semester Transition

Sequence: Conceptual Design ↔ Prototyping ↔ Testing ↔ Redesign
### Why is this project necessary? Who is benefitting from it?

<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Needs</th>
</tr>
</thead>
<tbody>
<tr>
<td>EPICS K-12 Students</td>
<td>Guidelines, documentation, and lesson plans that will teach engineering design principles and skills</td>
</tr>
<tr>
<td>Elementary students with disabilities</td>
<td>An Assistive Learning Device that will provide cognitive and physical stimulation</td>
</tr>
<tr>
<td>Special Education teachers</td>
<td>A safe, educational tool that reinforces required curriculum</td>
</tr>
</tbody>
</table>
# User Analysis

Specific stakeholder traits allow for detailed specifications

<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Persona and Traits</th>
</tr>
</thead>
<tbody>
<tr>
<td>EPICS K-12 Students</td>
<td>• Minimal advanced science/math coursework&lt;br&gt;• Minimal/No programming or algorithm design experience&lt;br&gt;• Small project budget</td>
</tr>
<tr>
<td>Disabled Elementary Students</td>
<td>• Delayed cognitive skills and memory&lt;br&gt;• Shortened attention span&lt;br&gt;• Underdeveloped motor skills</td>
</tr>
</tbody>
</table>

Traits were identified and compared between common learning disabilities such as Cerebral Palsy, Down’s Syndrome, Autism, etc.
Can the stakeholders’ needs be quantified?

<table>
<thead>
<tr>
<th>Need</th>
<th>Specification</th>
<th>Technical Criteria</th>
<th>Target Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safe</td>
<td>Comfortability of materials</td>
<td>Depth of Indentation</td>
<td>25% of total depth</td>
</tr>
<tr>
<td>Usable</td>
<td>Required attention span</td>
<td>Time required to complete activity</td>
<td>3 minutes or less</td>
</tr>
<tr>
<td>Educational</td>
<td>Coverage of appropriate curriculum</td>
<td>Number of core curriculum topics covered per activity</td>
<td>1 topic</td>
</tr>
</tbody>
</table>
What can we learn from an experienced special education teacher?

Teleconference with Ms. Beth Wheat, Retired Educator with experience in elementary, middle school, high school, and special education

Takeaways

• Every student is different
  - the device has modular components
• In general, repetition is critical to develop arithmetic skills
• Positive feedback to award success
• There isn't a widely available device that is general enough for students with special needs
## What have we learned? What can EPICS K-12 students learn?

<table>
<thead>
<tr>
<th>Standards Supported Through Project Tasks</th>
<th>Engineering and Technology Education</th>
<th>Computer Science</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example</td>
<td>Standard #5</td>
<td>6-8.PA.2</td>
</tr>
<tr>
<td></td>
<td>“Work cooperatively and productively in groups to design and use technology to solve technological problems.”</td>
<td>“Implement problem solutions using a programming language that includes looping behavior, conditional statements, logic, expressions, variables, and functions.”</td>
</tr>
</tbody>
</table>

*Taken from Indiana Department of Education Academic Standards*
Which software platform suits our stakeholder?

<table>
<thead>
<tr>
<th>Software Design</th>
<th>Criteria To Compare</th>
<th>Scratch</th>
<th>Blockly</th>
<th>Hopscotch</th>
<th>Arduino IDE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Weight</td>
<td>Rating</td>
<td>Rating</td>
<td>Rating</td>
<td>Rating</td>
</tr>
<tr>
<td></td>
<td>5=high 1=low</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Simplicity</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Features</td>
<td>3</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Availability (Low-Cost)</td>
<td>4</td>
<td>5</td>
<td>5</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Hardware Compatible</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Totals</td>
<td>Rating *Weight</td>
<td>73</td>
<td>66</td>
<td>39</td>
<td>55</td>
</tr>
</tbody>
</table>
How does Scratch work?

**Drag and drop based visual programming language**
- Developed by MIT Media Lab

**Utilizes universal coding skills and concepts**
- Logic flow and operators
- Variable assignment
- Input / Output relationships
- Open source and online file sharing

**Benefits:**
- No syntax errors
- Natural and easy to interpret
What type of hardware is best?

MaKey MaKey

- Affordable ($49.95)
- Usable; USB Compatible
- Flexible, programmable to meet desired needs

Functions and Uses

- 6 circuit based sensors on the front, with additional on the back
- Transmits signals through any conductive material
- Maximizes options and creativity
How can we improve our initial prototype?
Software Iteration and Improvements
How does this work?
Where in the design process are we now?
What are some realistic short-term and long-term goals?

**Current Goals**
- Start testing our product, Visit a special-needs classroom
- Polish our design to make it more ergonomical
- Add elements to our code to make it more effective after testing it with a focus group.

**Long Term Goals**
- Ensure Scratch is understandable and engaging for students with a focus group study
- Develop guidelines / lesson plans for delivery to EPICS K-12 students
  
  Make software and hardware designs more comprehensible
  
  Research curriculum Standards
How can we transition into the detailed design phase?

- Review designs to make sure they are suited for K-12 EPICS
- Begin developing lessons
- Test our prototype in Special Ed classes.
- Review designs to make sure they are suited for K-12 EPICS
- Brainstorming, sketching, and building multiple designs

Continuous Improvement

Rapid Prototyping

Feedback

Research and Development
Would anyone like to try our prototype?
Thank you for listening

Any Questions
Estimation Team

LSME
Meet the Team

Colleen Gamache
Design Lead
First Year Engineering

Kassidy Scott
Project Archivist
First Year Engineering

Net Suwan
Project Partner Liaison
First Year Engineering

Pop Thira
Project Archivist
Computer Science
Background Information

Teach Concepts of Estimation

- Proportions
- Graphing

Design and Modify Mousetrap Car for:

- 8th Grade Use
- Ease of Use
- Safety
- Reliability
- Cost Reduction
Math Day
Educational Program

• 8th Grade Students with a basic knowledge of algebra
• Held at Purdue
• Lesson Plan
Mousetrap Car

What is it?

How does it Work?

Why do we need it?
Project History

Fall 2014
- Had Multiple Ideas for the Model
- Delivered on Math Day but had some flaws

Spring 2015
- Slightly redesigned model included gears
- Was unsuccessful

Fall 2015
- Improved on previous model
- Successfully delivered mousetrap car for Math Day
- Included a few flaws now being worked on
Purdue Math Day

- Last Years Success
- How Are we Involved this Semester?
Flaws from previous models

01 Performance
- Rocking
- Off Course

02 Wheel and Axle
- No Grip
- Permanent Attachment
- Bad Tires

03 Rod Attachment
- Unprofessional
- Duct Tape
Car One Design Changes

Chassis
Axle
Wheel
Car One Chassis

Lengthened previous chassis

- Helps prevent rocking
Car One Axle

Changes
- Shaped ends

Results
- No free spin
- Not a permanent fix
- Easy assembly / disassembly
- Bent during testing
Car One Wheel

Changes

• Shaped hole to fit axle

Results

• Removes slip between wheel and axle
• Easy Assembly / Disassembly
Car One Testing

Results

• Distance traveled vs. number of wheel rotations

• $R^2$ value: 0.9966
Car Two Design Changes

- Axle
- Wheel
- Brake
- Rod Attachment
Car Two Axle

Changes

• Bent during testing

Results

• Couldn't rotate wheel as many times
• Moved half the distance
Car Two Wheel

Changes

• Thinner
• Bigger hole to fit new axle

Results

• Reduced friction
• Used less material
Car Two Brakes

Changes

- Added brake system
- Cross piece and rod

Results

- Completely stopped car
- Stopped car from moving backwards
Rod Attachment

Changes

• Add a rod attachment

Results

• Allow for easy string removal
• More refine than duct tape
Lesson Plan

- Utilizes a practice and scoring mat
- Hands-on way of learning estimation
Goals for Next Semester

- Look into conserving materials
- Test any new ideas
- Expand lesson plans
- Make into a kit
- Deliver

EPICS / PURDUE
Thank you for listening

Any Questions

?
Nanotechnology Team
LSME
Our Goal:

To develop an interest in Nanotechnology amongst students at a young age through the help of Lesson Plans and Hands-on Projects.
Meet the Team

Pashin Raja
Project Manager
Co-Project Archivist
First Year Engineering

Wyatt Larkey
Webmaster
Project Partner Liaison
Computer Science

Mantavya Sharma
Co-Project Archivist
First Year Engineering

Liang Chao
Co-Design Lead
Electrical Engineering

Kerrie Spaven
Co-Design Lead
Electrical Engineering

EPICS PURDUE
Mrs. Holli Joyal and Mrs. Selena Scott

Our Lady of Grace Catholic Middle School

Noblesville, IN

Wishes to spark interest in STEM fields in 6th to 8th Grade Students

Create lesson plans and manipulatives to help students understand the concepts Nanotechnology
What we need to consider?

- Appropriate for middle school students (not too difficult or easy)
- Cost effective
- Actively engaging and interesting
- Hands on (manipulatives)
Lesson Plans

- Step-by-step instructions for teachers to guide students through the six activities:
  - Hydrophobic and Hydrophilic Properties
  - Nanotechnology in Material Science
  - Nanotechnology Research
  - Nanotechnology in Space
  - Carbon Nanotubes
  - Carbon-60 Buckyballs
Student Worksheet

- These worksheets follow along with the activities, allowing students to reflect on what they are learning.

**Student Resource Sheet**

Activity 1: Nano-fabric Experiment

<table>
<thead>
<tr>
<th></th>
<th>Fabric 1</th>
<th>Fabric 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coffee</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Syrup</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Discussion and Reflection:**

1. Think about what attire you wear in the rain. How do these clothing items (such as rain boots, rain jacket etc.) differ from other clothes and shoes? Draw a sketch of how rain interacts with these items.

2. Think about the test you have just completed. Discuss with a partner about how companies must test their product with various substances just as you have done with your pieces of fabric.
Hydrophobic and Hydrophilic Properties

Nano-Fabric Experiment
• This experiment helps students understand the difference between hydrophobic and hydrophilic properties.

“Magic” Sand Experiment
• Second experiment is continuation of the nano-fabric experiment. Allowing students to apply what they just learned through a different experiment.
Online Activities

- Nanooze Research Activity
  - Nanooze is a site designated to teach young students about science and nanotechnology.

- Molecularium Website
  - Molecularium is an interactive game that allows students to learn more about nanotechnology.
Manipulatives

Carbon-60 Molecule

Carbon Nanotube
A Change in Design

- How easy was it to replace?
- How much material was being used?
- Is the product easily breakable?
Goals for the New Design

- Require less material
- Easily replaceable parts
- Low cost for replacement of parts

New Manipulative Bond
Conceptual Design V1

Reason for Design

• To experiment and find out what type of extrusion would serve us best

• Uses a lot less material compared to previous design
Conceptual Design V1

Results

• Turned out to be lighter and smaller
• Extrusion with the same size of the straw diameter fitted best
Conceptual Design V2

**Reason for Design**

- To experiment and find out whether straws with larger diameters are a better fit
- All extrusions now have two parts in order to make it easier for teachers to restock on straws.
Conceptual Design V3

Reason for Design

• To redesign atom extrusion thickness according to experimental results

• All extrusions now have only 1 type of thickness due to a common diameter found in straws.

• Lengths reduced due to the presence of only one width of extrusion.
Carbon Nanotube Design

- Armchair Nanotube

- Design is similar to Carbon Buckyball with different angles

- Individual carbon atom is a part of a hexagon
  - 3 extrusions with 120 degree between them

- Carbon atoms are connected to form a layer of an octagon
  - Angle between the planes of extrusions is 108 degree
Straw Cutter

Reason for Design

- Help teachers cut straws of uniform length
  - Works for both, c60 and Nanotube
Products on the Market

Theirs:
- Limited Options
- $25 - $50

Ours:
- Cheaper
- Easier to replace
## Estimated Cost

<table>
<thead>
<tr>
<th>Material</th>
<th>Quantity</th>
<th>Cost per Unit</th>
<th>Subtotal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hatchbox 1.75mm Black PLA 3D Printer Filament (1kg Spool)</td>
<td>2</td>
<td>$22.98</td>
<td>$45.96</td>
</tr>
<tr>
<td>Straws with .64cm diameter (Pack of 100 Straws)</td>
<td>2</td>
<td>$1.59</td>
<td>$3.18</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td></td>
<td></td>
<td><strong>$49.14</strong></td>
</tr>
</tbody>
</table>

**Note:**
- 1 spool of Hatchbox 3D Printer Filament & 1 pack of straws will be enough materials to print at three C60 Molecule (less than $25)
Semester Summary

- Improve C60 Design
- 3D Print C60 Manipulatives
- Design Nanotube Models
- 3D Print Nanotube Models
- Deliver
Moving Forward

- 3D Printing Files Available Online
- Lesson Plans Available Online
- Print more over summer?
- Expand program?
Thank you for listening

Any Questions

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Thank you for listening

Any Questions

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