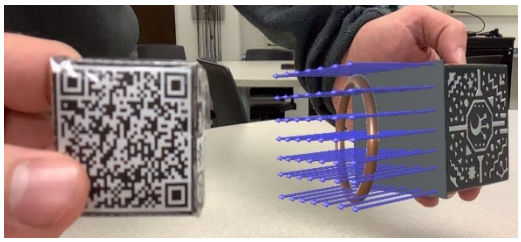
**STEM in the Palm of Your Hand**

Jason Morphew, School of Engineering Education, Purdue University, jmorphew@purdue.edu
Michele McColgan, College of Engineering, Siena College, mmccolgan@siena.edu
ENGR 131 – Purdue University

Learning within STEM entails developing robust conceptual understandings and theoretical models involving abstract and complex concepts. Cognitive science is converging on the fact that our understanding of abstract concepts is grounded in embodied experiences and spatial representations. In this view, visuospatial skills such as mental rotation and representational fluency are critical for learning in STEM. These skills represent a barrier for recruitment, success, and retention in STEM fields, a barrier that is often higher for students who are underrepresented in engineering. A collaborative effort between Purdue University and Siena college is addressing this problem by developing a cutting-edge augmented reality interface, Manipulative Augmented Reality Visualizations to Learn Spatially (MARVLS). MARVLS presents a method for teaching complex and abstract concepts in STEM while also helping student develop spatial reasoning skills. Using Merge Cubes as manipulatives, students as able to hold and rotate three-dimensional representations of STEM concepts. Recent innovations have expanded MARVLS capabilities to allow groups of students to manipulate cubes and observe how objects interact in the AR visualization (see figure to the right).



We propose to develop an interactive environment with a large screen, a camera, and a MARVLS application that will create multiple visualizations allowing multiple students to hold Merge cubes. The MARVLS application will utilize the distance between cubes and the orientation of the cubes to allow the visualizations to interact with each other to create dynamic augmented reality visualizations. In this space, students can collaboratively engage in scientific inquiry, collaborative problem solving, or in artistic exploration depending on the MARVLS application. The physical system for capturing the Merge cubes, displaying the visualizations, and incorporating other interactive features will be developed through the design project in ENGR 131. In this course, teams of 3-4 students learn about engineering design while engaging in a design task. Teams will propose designs to use microcontrollers and augmented reality to design an interactive experience for students and visitors to engage with the MARVLS application. The MARVLS application will be designed by Michele McColgan in collaboration with the design team at Purdue University.

The MARVLS project currently operates via individual smart phones and tablets, which makes the AR experience limited in terms of social engagement. However, this proposal seeks to pilot a larger and more collaborative interface for the MARVLS system. The research team is actively applying for NSF funding for the MARVLS project through both the RETTL and IUSE programs to scale the project for collaborative learning activities in classrooms or museums. This pilot would provide a proof-of-concept design to help obtain additional funding for this reconceptualization of AR instruction in STEM.

**Budget**

| | |
|---|---|
| Materials: | |
| - Projector: | $900 |
| - Tablet: | $400 |
| - Screen: | $100 |
| - Framing, curtains: | $200 |
| - Microcontroller, Sensors, and lights: | $100 |
| Labor: | |
| - Student Stipends: | $600 |
| Installation: | |
| - Installation Costs: | $100 |
| Promotion: | |
| - Merge Cubes – Paper/Printing: | $100 |
| Total: | $2500 |