Lumifold: A STEAM Activity

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Abstract

Lumifold is a making workshop in which participants engage with specific mathematics related to elementary symmetries, iteration and translation. A glide reflection pattern is provided in pre-scored paper in order for participants to transform the two dimensional flat sheet into a three dimensional sphere or cylinder called the Lumiball or Lumitall. The geometric shapes constructed during the activity demonstrate contrasting physical properties of stability and flexibility. In their final state of construction, the shapes are illuminated with small LEDs to highlight the biomimetic nature of the forms and delight the makers.

Introduction

The concept of integrating ideas related to science, mathematics, engineering and art-making is the bedrock supporting the Lumifold project. Discovering engineering properties such as strength of materials, stability, tension and flexibility, by physically engaging with making, is a method of visibly blending teaching with learning. STEAM pedagogy actively embeds the Arts in learning science, technology, engineering and mathematics (STEM). Dewey tells us that while science states meaning, the Arts express meaning. Meaning is not limited to what is assertable. Dewey goes on to say that that the aesthetic cannot be separated from the intellectual, for the intellectual to be complete it must bear the stamp of the aesthetic. Having a nose for telling questions and a feel for incisive answers are not empty metaphors. [1] One might interpret STEAM education as a way of demonstrating STEM concepts via arts practice. This might be through dance, drama, visual arts, music or design. STEAM education can add another layer of meaning that may provide a deeper or more lasting understanding of STEM content. Rhode Island School of Design (RISD) champions STEAM as the "synergy of discovery". [2] We believe there are many ways to engage with mathematics via paper folding, as origamists have been demonstrating for centuries. The question inherent in the Lumifold activity is how to marry basic mathematical concepts with creating and making so that the experience of learning the specific concepts is memorable and not empty?

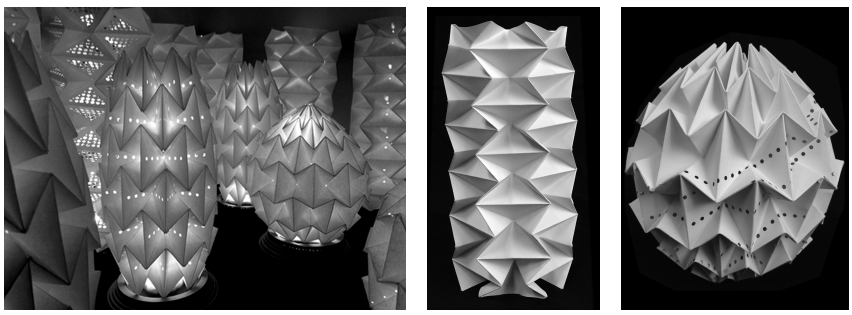

Figure 1: *Lumifold set, Lumitall and Lumiball*

Background

Lumifold has been delivered to a variety of audiences in both world hemispheres. The project was originally an integrated mathematics and design course for middle school where students investigated biomimicry as a foundation for art and design. The resulting paper folded structures were illuminated, often customized by reductive techniques, and exhibited in order for students to elaborate on the experience of their math-making in response to questions from a range of viewers such as kindergarten students to design industry professionals (Figure 1). Currently, this workshop is an abbreviation version, comprising of a presentation detailing the foundation math that underpins the construction of the lamps. Reference is made to biomimicry in design and ideas related to symmetry and iteration in mathematics *and* art/design. In past workshops, the construction process has challenged and delighted participants and although this might seem oxymoronic, we have observed the experience to be extremely rewarding with many participants eager to share the activity in their classrooms or homes.

Figure 2: *Lumifold completed lamps*

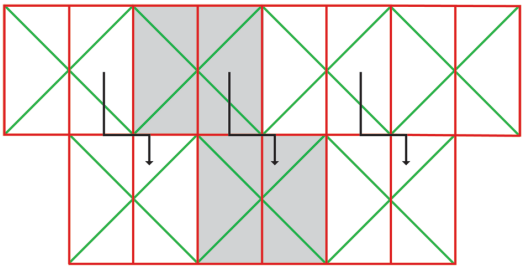

Figure 3: *A glide reflection*

Intended Outcome

The STEAM educational outcomes of the workshop are many. Firstly, participants engage in the realization of specific math theory in physical form to engineer properties of physical strength or flexibility. These learning explorations are easily transferable to inter-disciplinary classroom contexts, scalable for different ages and abilities. Our expectation is that participants apply some of the techniques used within Lumifold to their own practice, for theoretical understanding or simple pleasure. The construction of the lamps is straightforward. The process involves folding pre-scored paper templates into spherical or cylindrical shapes using the glide reflection pattern (Figure 3) to determine each shape's rigidity or flexibility. The difference in sphere and cylinder is produced by a 90° rotation of the glide reflection pattern. The paper is simply folded into hills or valleys (up or down) according to origami *sekkei* rules (technical paper folding). When folded, the paper no longer retains its two dimensional integrity and begins to curve. Small LEDs of varying colors are provided to illuminate each lamp after construction (Figure 2). Illumination provides the opportunity for learning extension due to the inherent geometric star patterns emitted by the lamp when lit. Consequent STEAM activities may be explored using the lamps themselves as a resource. These include constellation mapping, color theory, studies in form and function and mathematical pattern exploration. The information disseminated within the Lumifold presentation provides opportunity to engage with real-world applications of mathematics in making.

References

[1] Eisner, E. (2002). What can education learn from the arts about the practice of education? *The encyclopedia of informal education*. Retrieved from http://www.infed.org/biblio/eisner_arts_and_the_practice_of_education.htm (as of April 14th 2016)

[2] RISD. Retrieved from http://stemtosteam.org/ (as of April 14th 2016)