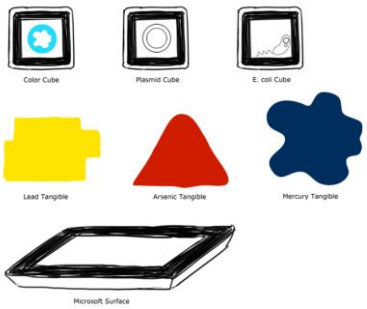

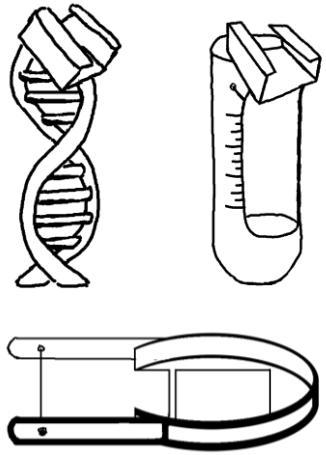

Figure 1: The components of SynFlo

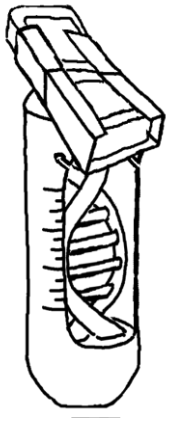

Figure 2: DNA with part selection cube is placed inside test tube connecting with plasmid tube.

From Wet Lab Bench to Tangible Virtual Experiment: SynFlo

Wendy Xu
Wellesley College
Wellesley, MA 02481
wxu2@wellesley.edu

Consuelo Valdes
Wellesley College
Wellesley, MA 02481
cvaldes@wellesley.edu

Kimberly Chang
Wellesley College
Wellesley, MA 02481
kchang2@wellesley.edu

Robert Kincaid
Agilent Technologies
5301 Stevens Creek Blvd.
Santa Clara, CA 95051
robert_kincaid@agilent.com

Nicole Francisco
Wellesley College
Wellesley, MA 02481
nfrancis@wellesley.edu

Orit Shaer
Wellesley College
Wellesley, MA 02481
oshaer@wellesley.edu

TEI 2013, Febrary 10–13, 2013, Barcelona, Spain
ACM

Abstract
SynFlo is an interactive installation that utilizes tangible interaction to make core concepts of synthetic biology accessible to the public. This playful installation allows users to create useful virtual life forms from standardized genetic components through the manipulation of augmented object that mirror scientific instruments in order to explore synthetic biology concepts and protocols. These virtual *E. coli*, can serve as environmental biosensors that when deployed into an environment represented by a tabletop computer, detect toxins and change their color as an indicator. The goal of this project is to explore ways to develop effective interactive activities for outreach in STEM without the limitations of access to a lab bench while communicating the excitement of cutting-edge research.

Author Keywords
Tangible interaction; Sifteo cubes; Microsoft Surface; synthetic biology

ACM Classification KeywordsB
H.5.2 [Information Interfaces and Presentation]: User Interfaces.

General Terms
Design, Human Factors.

Figure 3: Shaking interaction "pours" DNA into awaiting plasmid and sound emits from test tube rattle

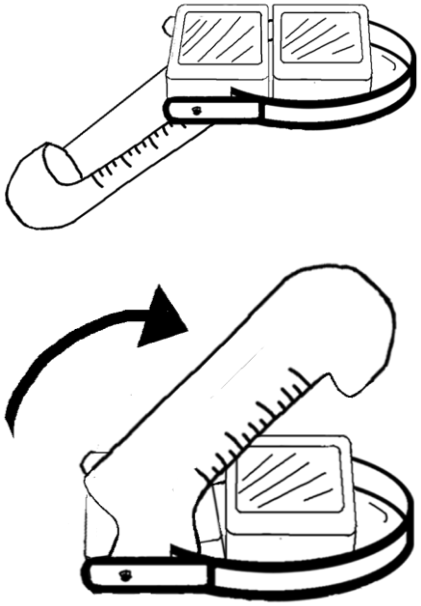

Figure 4: The test tube (shown without DNA) placed next to the E.coli cube and flipped, pours the plasmid into bacteria.

Introduction

SynFlo is an interactive installation, designed to illustrate core concepts of synthetic biology to the public through playful tangible interaction. SynFlo mirrors actual protocols used in wet labs to manipulate the genome of *E. coli*, the most common model organism in synthetic biology. SynFlo consists of triplets of Sifteo cubes, which can be used to modify the genome of virtual *E. coli* to serve as biosensors for environmental toxins. The virtual bacteria can then be deployed into an environment represented by a tabletop computer. In this environment, the *E. coli* can interact with other bacteria and with environmental toxins. Following, we describe the design and implementation of SynFlo.

Design and Concept

SynFlo draws upon a well-known synthetic biology experiment called E. chromi [1], in which genetically engineered E. coli bacteria act as biosensors. This experiment has three basic procedural tasks: 1) Combining biological parts (i.e, BioBricks) to create a genetic element capable of producing a particular color in response to the presence of a particular toxin; 2) Inserting the selected BioBrick into a plasmid, a circular DNA strand that replicates independently from chromosomal DNA; 3) infusing E. coli bacteria with the engineered plasmids; and 4) deploying the modified bacteria into a testing environment.

SynFlo utilizes tangible and embodied interaction to allow users to experience an interactive and playful simulation of the E. chromi experimental process. It employs triplets of different Sifteo cubes: 1) a toxin selection cube, denoted by color and shape and scrolled through by pressing the screen. This cube is embedded in a casing shaped as a DNA strand 2) a plasmid cube, embedded in as test tube and 3) an E. coli cube embedded on a petri dish.

To create a modified E. coli users place the plasmid cube next to the DNA cube, then mimicking vortexing or shaking to making a rattling sound. To insert the plasmid into the bacterium, the opening of the test tube is placed next to the petri dish holding the E.*coli* cube and poured the plasmid, effectively flipping the plasmid Sifteo cube. To mirror a real-world application of E.coli as biosensors, the user deploys the E. coli onto a multitouch Surface (Microsoft Surface) computer, by placing the petri dish on the surface and pouring by flipping. The E. coli move around toxins, tangibles placed by the user, and if the E.coli is near a certain toxin there were assigned to detect, they would change color.

Conclusion and Future Work

We presented SynFlo, an interactive installation that utilizes tangible and embodied interaction to bring the wet lab bench experience to the virtual world by illustrating core concepts of synthetic. We plan to further refine the experience to more accurately portray the scientific protocol. We already deployed SynFlo in various outreach programs and plan to evaluate its effectiveness in informal science learning settings.

Acknowledgments

We thank David Olsen from Wellesley College, Traci Haddock and the Boston University iGEM team. This work is partially funded by the NSF grant no. IIS-1149530.

References

[5] Davies, M., et al. (2009). *E. chromi Cambridge*. Retrieved from http://2009.igem.org/Team:Cambridge

[2] Sifteo, Inc. https://www.sifteo.com/