Integrating Constructionism in Designing for Digital Fabrication

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Abstract

In this paper, we introduce FabCode, an online visual programming environment using which one can create designs that can be manufactured using digital fabrication techniques like 3D printing and laser cutting. This project is primarily about making accessible and enhancing the kinds of 'thinking' that the computational medium is capable of supporting and spreading. FabCode is situated in the context of design and engineering of objects, and is based on the premise that using programming as a tool to create 3D models for personal fabrication would enable practice of computational thinking for the same. Children will learn as they work on personally meaningful projects—building, describing, printing and playing with things, and debugging and discussing their processes and outcomes. It is aimed at being a child-centered, constructionist platform for FabLabs.

Keywords formatting rules, printing documents, citations

1. Introduction

Digital fabrication and "making" have been argued to be a new and major chapter in this process of bringing powerful ideas, literacies, and expressive tools to children. What Logo did for geometry and programming – bringing complex mathematics within the reach of schoolchildren – fabrication labs can do for design and engineering [1]. The pedagogical benefits of digital fabrication and FabLabs for children have been well established through research projects like FabLab@School [1]. FabLabs can also be argued to foster creativity, with creativity stemming from the iterative cycle of imagining, creating, playing, sharing, reflecting and imagining [2]. Two major skills for children that researchers have been trying to build platforms for are programming, and design and engineering through the more recent maker spaces and FabLabs. However, past research suggests that there has been little concrete attempt at creating a scalable platform that links these two skills. FabCode situates the above intentions in 3D digital design and fabrication. FabCode could serve as a 'Mathland' [3] inspired by LOGO, because through using programming as tool for designing of objects, one can let math do the making. All objects can then possibly serve as objects-to-think-with [3] while playing with them, and in the process of making them. Papert [4] said that students need to build models of parts of their world in order to more fully grasp those parts' meaning, substance and dynamics. Objects will potentially acquire new meanings through thinking, making, sharing and playing with them. Mathematics, here, can be used as a tool to generate designs that the mind hasn't imagined, with agency and intentionality as opposed to using it for implementing a pre-

meditated design. Imaginations will acquire meanings through visual representation and they can then be investigated and serve as starting points for further imagination.

2. FabCode

Papert has explained his pedagogical philosophy thus: “constructionism boils down to demanding that everything be understood by being constructed” [4]. FabCode can support thinking in ‘mind sized bites’ [3], where programmers, who here also become makers, start with one specific case, entirely understood, develop intuition and then gradually generalize, level by level, in a way that they still fully understand the program and object at each level of abstraction. Deconstruction of objects, both static and moving may lead to breaking of black-boxes, followed by investigation, and reconstruction or re-invention of objects through new methods and techniques. In this manner, our platform could be a realization of the computational medium acting as a material-to-think-with. By providing a method of programing for objects in the computer and then 3D printing or laser cutting the designs, FabCode provides two levels of iteration for thought and creativity- one on the computer to check visual correctness and the other in the physical world where you play with them to check if they function fine in terms of movement, stability etc. Creation is at the root of creative thinking. Also, creativity is an important part of the CT skill set. By providing programing as the tool for creation of objects, we situate problem solving and creative expression to be enhanced by the power of the computational media. Computational design benefits include: precision and automation, generativity and randomness, parameterization [5]. Aleatoricism, the incorporation of chance (random elements) into the process of creation, is a way to introduce new thoughts or ideas into a creative process, a characteristic of FabCode.

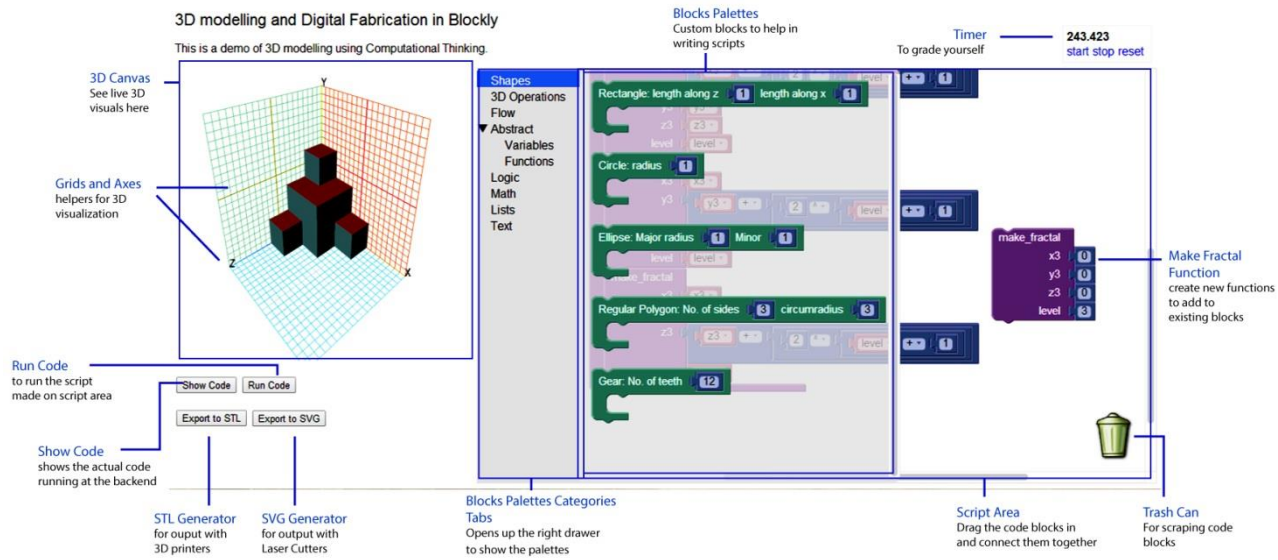

Figure 1. FabCode platform with different parts explained. The Blocks of code have been used to generate a fractal model.

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