Learning in the Making:
Leveraging Technologies for Impact

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Abstract
The Learning in the Making Lab explores how engaged participants learn within Makerspaces. In this process paper we describe the three iterations of our design process for software interfaces and platforms that emphasize cooperative and asynchronous critique and feedback as well as serve as a documentation portfolio. We look at data on makers’ use of these platforms, and offer insights for how iteration and critique might be meaningfully incorporated into the making process.

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ACM Classification Keywords
Design; Documentation; Experimentation; Human Factors; Reliability; Theory

Introduction
Makerspaces, while once only limited to informal learning sites, are growing in popularity as innovative places for the creative production of art, science, and engineering projects. Makerspaces blend age groups, interests, and digital and physical technologies to explore ideas, learn technical skills, and create new products. These spaces are a key component of a larger Maker Movement comprised of internet communities, magazines, and “Maker Faires” in various local, regional and national sites. The Maker Movement coincides with the growing interest in creating supports for learning in the making in museums, libraries, community centers and schools.
The Learning in the Making (LitM) Lab has been working for the past three years to understand what engaged participants learn within makerspaces across the US (Sheridan, Halverson, et al., 2014). Our lab is now utilizing these ethnographic accounts of practice to design and further explore makerspace experiences across numerous. Our initial work has revealed that the arts play a vital role in learning through making. While many researchers have focused on the engineering aspects of making, Learning in the Making studies have found that successful making sits at the intersection of art, engineering, and entrepreneurship, and that the most engaged learners are those who are given access to all three of these disciplines together (Halverson & Sheridan, 2014). Makerspaces have increased in popularity, yet young makers can be disconnected from experts. Because of the lack of access to expert practices, many youth-serving makerspaces have become expert at “make-and-take” experiences but lack ways to engage young people in sustained practices that require feedback and iteration. It is in this cyclical process that young people often become makers and we have seen a need to develop tools that scaffold making as an iterative and interactive process.

In addition, we sought to create a program to train on-site facilitators to use the critique and portfolio software that they might be able to guide the development of the maker’s reflective writing and iterative documentation as they worked with young people across a range of makerspaces. From a research perspective, the software environment allows us to trace how the use of the critique and portfolio system impacts young makers’ learning, development, and self-efficacy and the role asynchronous documentation might play in the makerspace environment. In this process paper we describe the three iterations of our platform design process, provide some data on makers’ use of these platforms, and offer insights for how iteration and critique might be meaningfully incorporated into the making process.

The Importance of Critique and Documentation in Making
The practices of critique and portfolio creation are crucial to successful learning in and through the arts (Hetland, Winner, Veenema, & Sheridan, 2013) and in learning to be a maker. Critique practices promote learning as students use the results of their critique experiences to build a series of successive representations that require both technical expertise and content understanding. These representations, in turn, develop students’ metarepresentational competence (MRC), the ability to know when to invoke representational tools to solve a given problem at a given time (diSessa, 2004). As a learning outcome, MRC has been used to demonstrate students’ knowledge in mathematics (Azevedo, 2000; Enyedy, 2005), science (diSessa, 2004), and art (Halverson, 2013) and holds promise as an alternative means of assessing students’ competence beyond standardized tests.

The initial conception of the software was that of a platform where makers could upload images and reflections of projects-in-process. Facilitated by mentors in the makerspaces with expertise in the software as well as contextual project knowledge, the young makers would use the software to submit projects for critique from peers and more expert makers. With the facilitators acting as technological troubleshooters and in situ educators of documentation
and constructive criticism the makers would be able to experience feedback via their local space and from their peers viewing their work via the software. The makers would then apply these critiques in an iterative process captured further by the documentation software. The design of this software, however, paralleled the iterative process of the young makers it was supposed to support requiring multiple technological, methodological, and administrative experiments.

**Iteration 1**

_This Porridge Is Too Cold_

LitM initially partnered with Scholar, (http://cgscholar.com) an on-line "writing space for learners of the social media generation." Created by researchers of at the University of Illinois, Scholar is an interface designed with the goals of peer critique and documentation process in mind ([Figure 1.1](#)). Scholar allowed its target student users to utilize multimedia and text to showcase their project iterations with numerous options for instructors to create customized scaffolds for writing and reflective writing skills ([Figure 1.2](#)).

The site tests of Scholar over Summer 2014 with LitM teams across the country resulted in a resounding chorus. Scholar was too structured a platform for the informal learning sites that hosted the makerspaces. The documentation tool needed to be easier to use by students in their individual makerspace environments. The facilitators in these spaces found the administration and use of the interface to be too much of a distraction from the process of actual making. The design of the user interface and multimedia tools made the documentation process an additional task rather than a process integrated into the making process.

Scholar was created for classroom environments where users are interacting with the program at the same time in a more regulated process. Makerspaces are anything but regulated. The learning curve and adaptability of Scholar for use as a companion tool to the making process was the main point of frustration and ultimately, incompatibility with LitM’s goals.

**Iteration 2**

_This Porridge Is Too Hot_

In Fall 2014 LitM partnered with Tackk (http://www.tackk.com), an on-line multimedia platform. Tackk is a tool designed for quick and easy use combining familiar iconography and multimedia functions as found on Tumblr, Facebook, and Twitter ([Figure 2.1](#)). Tackk even has a mobile app that allows for documentation using smart devices. However, efficiency and ease of adoption sacrificed the most valuable aspect of Scholar – the infrastructure to create scaffolding for project and critique skill development. Tackk was not created for that purpose ([Figure 2.2](#)). While Tackk did offer partnerships with third-party educational sites, the creation of digital environments suitable for participant privacy as well as for LitM’s research purposes required extensive reverse engineering, even with support from within the company. To get Tackk to do what LitM hoped it would do took as much behind the scenes tinkering as did Scholar resulting in no fewer user end frustrations.
**Iteration 3**

*Is This Porridge Just Right?*

Build in Progress ([http://buildinprogress.media.mit.edu](http://buildinprogress.media.mit.edu)) is a web-based interface created for the very purpose of documenting Do-It-Yourself style projects, with the stated emphasis on the overall process of creation (Figure 3). A product of the MIT Media Lab ([http://media.mit.edu](http://media.mit.edu)), Build in Progress captures the utility that LitM seeks as administrators and researchers as well as a straightforward approach to documentation that allows student makers to interact with each other as they refine their projects. Not as flashy as Tackk with social media bells and whistles, but more user friendly and adaptable than Scholar, Build in Progress provides what LitM sees as the most important part of the maker experience—the act of making and a reflective tool for the student participants to build critique skills. LitM will begin testing Build in Progress in the Fall of 2015.

LitM concludes that a successful tool has to have scaffolding for critique; It cannot be an open-ended platform. The operation of the software must be almost immediately apparent; young people will not take the time from their making practices to engage in a separate documentation practice. The ultimate key for the integration of the documentation, critique, and portfolio processes into the making projects is via a means that neither the student makers nor the on site facilitators are forced to make an "either/or" choice. For, LitM the perfect tool enhances interdisciplinary makerspace environments as a natural extension of the community’s social experience. With the right software—the right tool—seamless application of the documentation and scaffolding critique by technological and on-site facilitator support allows the making process to organically become a interdisciplinary workshop literally built on the foundation of “hands-on” work.

**References**


