

The author, inspecting a construction site mid-project.

Transformative Learning Spaces – Fabricating The Genuine

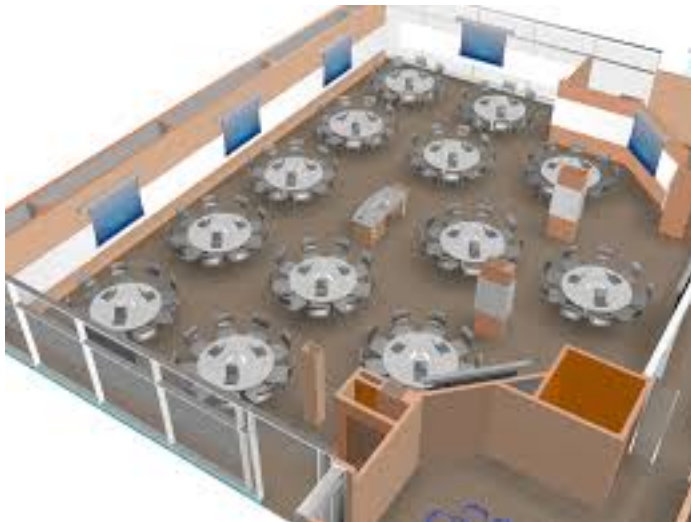
**Final Report – CRCRTH 692, Processes of
Research and Engagement**

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How can we design technology-infused classrooms so that they support curricular and programmatic needs while supporting the ongoing transformation of learners, spaces, technologies, and learning objectives?



The Brody Learning Commons at Johns Hopkins.



The TEAL classroom at MIT, designed for collaborative work.

As a designer of classroom spaces for higher education, I have often been pressured by architects or fellow administrators to adopt what seem to be the latest design trends – “have you got a (design style ABC) space like they have at (Institution XYZ)” – where ABC is any of the recent trends in design: group collaborative

spaces like TEAL and SCALE-UP, hands-on design and fabrication environments sometimes called makerspaces or fablabs, informal learning commons, and so on, and where Institution XYZ is either a peer, an aspirational peer, or a well-known innovator.

Often these innovative designs are coupled with exciting claims about the

educational benefits of the design paradigm: group collaborative spaces support a shift toward collaborative learning instead of the much-maligned “sage on a stage” lecture-hall style; hands-on spaces are extolled as developing self-efficacy and empowerment in students alongside their 21st-century skills; informal learning areas are described as supporting any number of student-centric learning activities (Holland 2014, Narun 2013, “TEAL: Technology Enabled Active Learning” n.d.).



A classic lecture hall.

My observation in these cases is that the pedagogy of the intended instructors, and the needs of the students, should come first – not the design, no matter how exciting the style may seem to non-educators and non-students. In order for a classroom design to be effective, the teaching strategies in use during the course must match the space, and students must be prepared to take advantage of the kind of learning that the space affords. If you build it, they may not come – and function does not always follow form.

New technology presents a

classic chicken-and-egg dilemma. As a long-time IT staff member, I've certainly seen any number of apparently-exciting and innovative technologies turn into expensive failures because they do not match the needs, interests, time allowances, support requirements, or expectations of the instructors using the tool. Making use of audience response systems (“clickers”) means designing a lecture meant for clicker-style response (and not, say, deep discussion); fancy 3D projectors only provide extra value for people with 3D content to display (rather than artifacts to hand around); video conferencing classrooms only enhance learning if there's someone to conduct a video conference with (rather than visit in person).

On the other hand, new possibilities may be easily discarded if the technology is unavailable, and instructors may not even be aware of the state of the art in instructional technology if it is not demonstrated and supported on campus. An instructor eager to try out teaching in a TEAL style (in-class small group collaboration with technology support) might find this impossible if no supportive space were already in existence; bringing about such a space might take years and require broad coalitions of campus stakeholders – difficult for anyone to generate, and probably impossible without deep commitment to use the space once built.

This circumstance of mutual dependency (the builders cannot justify building without users who want what will be built, the users cannot use what is not built, and may not even know if they want to do so unless it already exists) points to the need for flexible partnerships and dialogue between instructors and support staff – with a shared goal of *co-evolving the techno-teaching environment* – a notion I will return to later in this report.

Expectation trumps design. A university administrator, surveying a gorgeous informal lounge located in the student union, lamented to me that the space was used entirely for silent solo work, and that anyone speaking above a whisper was shushed and glared at – even him! The space was outfitted with plush chairs and conversational groupings, but the resulting use was not the relaxed conversational space intended by the design team. And yet what the students were seeking – or at least what those who set the tone for the space were seeking – conflicted with the design intention. Attempts to make the space into a lively social lounge – the type of space one might naturally assume to be present in a college campus student union – were eventually abandoned, and the room is a silent study space.

Beware the tsunami caused by a butterfly's wings. Design can have substantial unintended consequences. In one of my design projects, I was doing an initial site survey when I

was accosted by a faculty member who said, “This classroom has destroyed my teaching style!” Looking around the room – a typical seminar classroom – it was not immediately apparent to me what the room could have done to cause so much trouble. The room was typical of the building it was in: long tables arranged in an “O” or rectangle, 19 loose seats, chalkboards on two sides and a bank of windows along the other, projection and a cabinet of connectors and AV equipment situated to be used while standing beside the main teaching wall.

In surprise, I asked her to tell me more. She explained that in the building she had used



previously, the classrooms had tables in a U shape, and her style once had been to conduct her class as a discussion in which every member was expected to participate: she would walk around the internal perimeter of the “U”, engaging directly with students in a very physical way. The topics were challenging and the class would grapple with them as a team.



In the new building, she had been essentially moved from a “U” to an “O”. In an “O”, she observed that her style had shifted

away from discussion and instead toward lecture – she could see her students tuning out, or readily taking on her ideas rather than vigorously developing meaning together. The room was too small for her to circulate outside the table arrangement or to move the tables aside to enter the O, and the 10 minutes passing time allowed between classes discouraged more elaborate re-arrangements. The obstructing table was also useless – no one sat at the top of the O, since it would place their backs to the locus of the projection screen, podium, and chalkboard. A single table had created an unassailable wall for her – and suggested a very different teaching style, which she had adopted.

I have observed these risks:

- how wasteful it is to implement designs or technologies for teaching without building effective partnerships with those who will do the teaching
- how powerful the role that the culture and habit of space users plays in shaping or subverting the use of spaces, regardless of designer intention
- how palpable the potential problems caused by even small design alterations.

Informed by these risks, my philosophy of classroom design is:

to readily explore new ideas for the use of technology in teaching, but with as firm a grip on critical evaluation as I can summon.

All this is to say, as discussion of the role of makerspaces and other hands-on environments has spread through education, communities, and industry, accompanied by hype and high praise, I have found myself uncertain and skeptical of these spaces. In this report, I will share four miniature case studies – field reports of makerspace design and operations, as implemented in existing spaces, as I experienced them during live workshop activities.

Although these field reports are heavily anecdotal, their intention is to serve as an example of both the successes and problems that might arise with these kinds of spaces in general. These field reports cannot be construed as typifying their hosting organizations more broadly and should not be considered an indictment or vindication of any particular space; my intention is to anonymize the locations as much as possible, although a little bit of sleuthing would render this effort moot.

It is important to note that the spaces I am visiting are located outside of higher education (in a museum, public library, elementary school, and a community space). My intention was to capture authentic experiences in the types of spaces that universities are seeking to learn from, in settings that allow public and generally anonymous interactions.

After describing these four experiences, I'll suggest a set of general principles about key ingredients in innovative hands-on design and fabrication spaces in promoting learner empowerment. Equipped with these key ingredients, I'll share two additional examples, drawn from global makerspaces – one in Asia and one in Africa – that typify these principles.

Location A: The Bounded Room

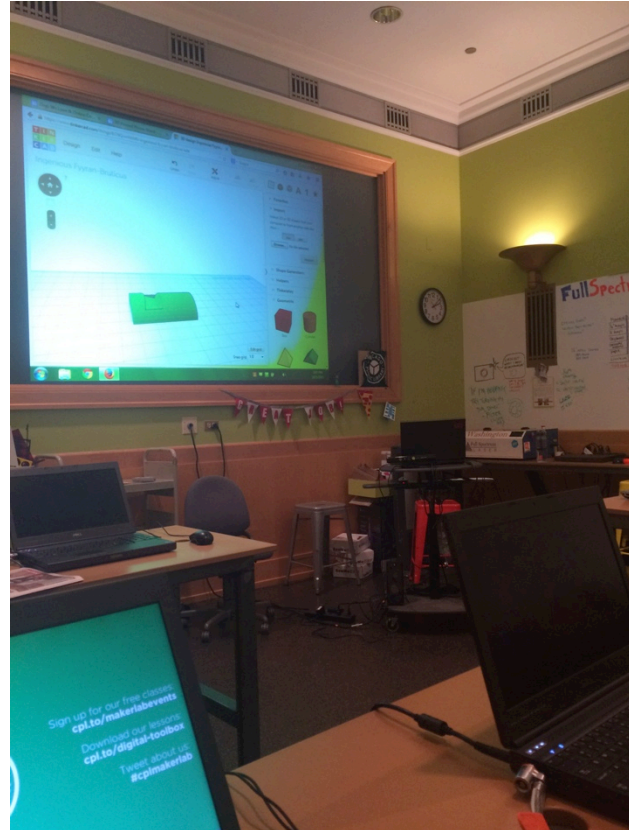
Institution-sponsored

1:2 facilitator-student ratio

When I walked into the space I'll call the Bounded Room, my first impression was of a training lab — participant tables were positioned in rows perpendicular to the wall, two laptops to a table. A big workbench style table ran almost the length of the room, dividing it in half, and all of the equipment was positioned along the wall opposite to the computer stations. With a small number of students, everyone chose to sit one to a table. The instructor sat at what was clearly the front of the room, with a projector screen showing what was on his computer and a

cable-laden podium that hid most of his face and body.

The workshop in the Bounded Room also began like a typical computer training session – we were told to establish accounts on a system, and then walked through a series of steps which was also described on a printed recipe that was available on our tables. It was apparent that the facilitators were unfamiliar with the recipe, since several of them mentioned that they had not read it prior to the session. We embarked on



a series of stop-start frustrations – halfway through an instruction, we discovered we needed to take a different approach and start over. Most of the final designs failed – we had complete freedom in our designs, we did no prototyping, and we did not have any suggested design constraints (such as recommended depths or angles). I left feeling disillusioned, having spent two hours – my only opportunity -- for no result.

In general, the facilitation offered by the instructional staff was oriented towards the technology rather than individual learning. Multiple times I heard the facilitators respond to a “how do I...” question with: “What did you do? I don’t know how you did that. Just delete and start over.” The experience reminded me of teens disparaging their parents’ lack of tech savvy. It was an enlightening experience for me – it’s not often that an IT professional with a CS degree sees “user support” from the other side. It was my overall observation that the session was not



oriented to support learning per se; it was something like a hands-on demonstration.

Lessons & Observations:

1 – Space design matters. Layout suggests usage, and usage determines function.

2 – Facilitation matters. Whether a space has a strong or a weak design, leadership within the space shapes the experience.

Location B: The Rounded Zones

Institution-sponsored

1:5 facilitator-student ratio

When I first walked into the Rounded Zones, it was not immediately clear where to go or what the center or front of the space might be. I could see many different traffic patterns and flows between different areas – a parabolic gathering of computer stations, a zone with lab tables and stools, some larger machines in the corners, and several banks of 3D printing stations. We started out standing in the center of the space, then sat at the computers to learn first a little about the science concepts underlying the technology in the space, and then the basic mechanics of the task at hand.

The workshop was very tightly facilitated – well practiced, moving along at a very



intentional pace. Facilitators provided abundant tips on how to make sure a design was successful, and it was apparent that they would not let anyone fail. Later, the facilitators and I discussed their approach, and they described how much work

they put into making sure participants can have a good experience within the boundaries of an hour — to be creative, have fun, learn things...and finish a project they can walk out the door with. Attendees at the session I attended were adults, and ranged from appearing to be in their early 20s to perhaps 70s. The content was pitched a little bit more towards the middle/high school level (trivia games, lots of jokes) but the adults played along reasonably well.

The facilitation style of this session also drew strongly on the training background of the facilitators — they displayed an interest in science, engineering, fabrication technology, and education as well as improv theater. The session didn't feel rushed, but it did feel very planned, and somewhat targeted at an audience that did not quite match those in the room. Participants moved from first scanning their own heads, to manipulating those heads on a computer, to printing out their heads, learning about each technology along the way. Facilitators spoke with passion about the application and purposes for 3D printing in medicine, industry, and creative expression; even though a sculpture of your head is playful, it was clear that the use of the technology to achieve social and business goals was important to the message of the workshop.

I was also able to view the facilitators pursuing a more laid-back variation of their facilitation style. The sessions included an opening circle and closing circle, and the facilitators circulated to offer encouragement, asking open-ended questions for consideration as well as answering direct questions.

Students were tackling projects that were largely of their own design within a theme, and doing their own research in the field, online, and in the local library. As they considered the design of their models, they were assessing the different advantages of different styles and shapes.

During these longer-term sessions, I was able to observe how easily students and facilitators were able to move through the space. I was able to observe some shoulder-surfing and cross-pollination among the small teams of students, as well as an intensive post session debrief among facilitators to discuss what went well and what could be improved for the next session. I realized later that I saw very little “down time” for participants – even when the technology imposed a wait time, there seemed to be other activities available – artifacts to look at, additional research to pursue, and so forth. Facilitators rarely sat down or disconnected from the activities around them, maintaining an “always available” posture that was not in evidence during my visit to the Bounded Room.

Lessons and Observations:

1 – Successful facilitation is learner-centric and intentional.

2 – Learning goals and facilitation styles may need to vary as a function of session duration. Short-term programming needs tight facilitation to make sure participants succeed; longer-term programs allow for a less orchestrated experience.

Location C: The Blank Canvas

Not Institution-sponsored

No formal facilitators; 2 organizers, 2 teaching artists, 10 attendees



The space before we set up our makerfest.

For the Blank Canvas, I helped to organize and then attended a community event hosted in what was essentially an empty storefront. The storefront had been rented by a local artists' collective to host various art happenings, but had not really found its audience yet. Since the collective had also

positioned the location as a makerspace, I found myself in conversation with the space director, and soon I was a volunteer. By participating in the event organization, I could see first hand how this workshop was firstly, a ton of work – without a built-in audience, we were doing everything from scratch: promoting, finding materials, setting up, and then tearing down the space. It's clear that the ad hoc nature of this event worked against our success – we received dozens of inquiries and RSVPs, but low attendance.

The director had a specific vision about connecting a “teaching artist” with the participants, although in practice the artists seemed unable to make a connection with the participants and instead worked on their own projects. The objective of the session was to provide materials and tools for making homemade Halloween costumes. Sewing machines, glue, fabric, paint, etc. were provided. As people walked in, the coordinator would introduce them to the space and talk to them about different possibilities, encouraging them to give different materials a try. We did not

promote any specific techniques or design processes – overall, the space was what people made of it.

What we found was that adults and children both seemed to arrive without necessarily having a plan, and expressed a distinct feeling of “what do I do?” A few arrived with perhaps too specific a plan for the first attempt of an event like this (“I want to make a Cinderella dress that looks just like the movie” – which is a challenge even if you have a pattern and a lot of know-how, and essentially impossible if you have no matching fabric, no guiding photo, no sewing skills, etc.). Some of the tools were inadequate – dull scissors were frustrating, the paper mache was hard to work with, and all of the glue guns were hot glue, which is dangerous for kids and difficult to work with if you don’t have a good table and chairs (the glue station was on the floor). More furniture and better tools would have eased a lot of frustration, but then again a session like this is dependent on donations, ad hoc gathering of materials, and so on – we didn’t have a budget per se, and no one paid the optional workshop fee to defray the cost in any case.

On the more positive side of this event, the participants seemed to enjoy themselves, and they all walked out the door with something – although they might not have ended up using it for their costume, they did make wearable items and practice “maker” skills in the process.

The most valuable aspect of the experience for me was to see how a little knowledge can go a long way when shared. I do not identify myself as a maker per se, but I do know how to sew fairly well. Although the machines were unfamiliar to me, I was able to pick up enough about how to use them that I could help some children to sew their costumes. I was able to practice a little facilitation myself when a woman commented in passing that she wished she knew how to sew.

It was a little thrilling to be bold and volunteer myself, saying, “Want to learn? I can show

you how to get started.” A little leap from me (there is vulnerability in offering to be a teacher), a little leap from her (there is vulnerability in agreeing to be taught, too), and then we were both committed. And it worked – I did a quick demonstration of both the concepts and the physical motions, had her follow the same steps with me watching, and let her go from there. I checked back in a few times, and by the time the session was over, she was not only working with confidence, she was helping others. This gave me a strong impression of how simple a “maker” effort can be: one little spark of know-how, passed from hand to hand.

Lessons and Observations:

1 – Creating a makerspace is a lot of work – not only are there substantial demands on the originators, but also the participants have to come prepared to contribute and to manage their own experience, especially if the session is an “open shop” rather than a pre-determined activity. And yet despite all this effort, there can be tremendous value in simplicity – the act of putting on a garment you’ve made yourself, the sharing of a little knowledge, and the gaining of a new skill.

2 –Spontaneous creativity can be difficult, even if primed in advance. It seems fairly straightforward to invite children to play and create, but success is not a given. Younger ones may need to overcome some initial diffidence, and the older ones may declare themselves “too old” (as two teenagers did during our session). Adults may look for rules and explicit guidance, or slip more readily into a “parent” role to facilitate their own child’s experience rather than act as makers themselves. This is a lesson that will be echoed in my experience in Location D.

Location D: The Zoo

Institutional: part of a designated curriculum, affiliated with a national non-profit, and held in a school

One formal facilitator, 100+ participants



When I walked into the elementary school cafeteria, my immediate impression was that I had wandered into a zoo. The room was a standard cafeteria space – tables through the middle, with supplies along the wall and

jamming the aisles, arranged on carts. Cardboard was piled up into a mountain along one side.

Children were everywhere, and projects were everywhere. I heard a number of shrieks to the effect of, “Don’t step on that!” The event held was right after school, so the kids were rowdy and loud. The room was sweltering, and soon the floors were covered in coats and backpacks. We had been given some forms to fill out before attending, but there was no one to collect them.

Looking around, I felt a strong confusion – what were we supposed to do? The name of the event was the “Cardboard Challenge” – and there was indeed a lot of cardboard – but what was the challenge? What was the point? Was anyone in charge? Other parents were wandering around asking each other the same thing. The organizer was nowhere to be seen. One mom walked up to our confused clutch of parents and announced, “I’m a volunteer. What do I do?”

We had to laugh at that. Eventually I saw all the volunteers gather into their own little circle in the corner, chatting, which is where they stayed for most of the event.

The event had been widely advertised as a capstone to a learning unit that most of the students had been working on for weeks. We were expecting some kind of structure to the event, and a program that bore some relationship to the learning unit. At first I thought that perhaps we were killing time before some kind of announcement and further direction. But no



announcements or direction was forthcoming. Eventually we all decided to make the best of what was in front of us, and the kids started to clump up with friends and to play around with materials, gluing and duct-taping things together.

One of the kids (who I already know to be a junior engineer – his grandfather reports that he has filled the house with his creations) spent the time refining his marble game, while a collection of older girls made a dollhouse. The kids at my table worked on making a turtle cottage, an idea that was suggested by one of the parents as we all grasped at straws trying to figure out how to turn this chaotic and confusing event into something that would fulfill the kids' expectation of being able to do or make something. Once the general direction was set, the other moms and I settled in to shuttling back and forth between tables – glue seemed to be in short supply, tape was metered out by the inch from one of the volunteers not spending the time chatting in the corner, and snacks were always in demand.



The turtle cottage.

We occasionally encouraged what we saw the kids doing, or suggested different ways of working with the materials. And we said yes to their ideas, such as when they asked if it was okay to use an item in a particular way. The supply carts had some stacks of donated items – hundreds of stickers, little beads, foam shapes, strips of paper – and we tried to keep the kids supplied with interesting items to work with. When the organizer emerged, she was harried with questions and then retreated again.

As with the event I helped to organize, this event was clearly a lot of work, and the setup and tear down was visibly exhausting. Volunteers were on hand but had no direction. The work being done to manage and facilitate the event was not mutual or shared by the participants. Kids came in and cut loose on the piles of stuff, and a few adults scurried around to try to keep things from going completely off the rails. I'm normally the sort of person who sticks around to help with cleanup, but when this event was done, I joined the pack of parents bolting for the door. We were grateful to be out of the noise and heat of the room, drained by the experience of the event, and feeling a little burdened as to what to do with the strange and bulky paper contraptions our children had constructed.

I am not sure if the specified objectives for the event were met, although the time was certainly enjoyable for the children. Typically when I hear discussions of the value of makerspaces, I hear a mix of terminology referring to design thinking as well as the value of open-ended or self-directed work. In this event, no “ideation” phase and no problem finding were evident – it was pure play. As a consequence, I found myself considering the overall benefits of unstructured play.

On the one hand, experts seem to agree that free play is beneficial and necessary to child development (“Play and Children’s Learning”, n.d.). But standing around in the chaos made me wonder if there are any limits to that benefit; presumably children benefit from a mix, and perhaps from an environment that provides for more reflection and consideration than a hectic cafeteria of over-stimulated children and a clutch of harried parents who wanted to go home, get dinner started, and nudge our children through the required homework regimen.

In programming more established community spaces, it is common to incorporate a mix of “open shop” hours (where self-directed activity is the only direction of the day), with specific workshops (where the outcome is specified and to some degree guaranteed), and instructional periods (where an individuals can be certified on a piece of equipment). Typically a person must be certified on a piece of equipment before using it during open shop hours.

The multi-tiered access approach to programming seems valuable for spaces that are persistent enough to support it – but for ad-hoc spaces and events, it may make sense to choose the programming style very intentionally, and to be aware of the value of those events that have more fixed outcomes, even when the overall goal of the space is to support self-directed activity. Had the children been working with materials more sensitive, costly, or complex than paper,

tape, and fabric, they could easily have yielded little to no results for their time, caused damage, or injured themselves.

Lessons and Observations:

1 – Whether your attendance numbers and facilitator-participant ratio is high or low, **expectations and intentional facilitation make a huge difference.**

2 – **It may require deliberate effort to slow down the pace of thinking, and to draw individuals into feeling sufficiently invested in the event and space – especially if you want any help doing cleanup!**

The Story So Far

After exploring the potential shortcomings of space programming and design in a traditional college campus which has informed my philosophy of space design, I've shared four case studies of the kinds of events and spaces that some have suggested represent the future of learning and learning spaces. This seems like a useful time to tie a few threads together and discuss the lessons that can be drawn from this diverse set of experiences.

Theme 1: Design. When people walk into a space, they are looking for cues about how the space is to be used. If there are barriers between where participants are guided to sit and where equipment is located, they may not approach the equipment. If the space is sparsely or randomly furnished, or has material in stacks all over, some people may hover at the edges, while others dive in perhaps too enthusiastically. A zoned space shows intention for each area, and curved shapes tend to invite collaboration more than sharp angles do.

Theme 2: Context. Locating an event or space inside a known and established institution sets expectations for what will go on inside. The materials and equipment available are likely to substantially guide outcomes.

Theme 3: Facilitation. Intentionality is the key here. Hence it is not the specific answers, but the careful attention to the most relevant questions that matters most. What kinds of interactions are expected among staff and learners, or among beginners and more intermediate participants? Are there steps, prompts, or strategies that will be employed? Does the kind of facilitation being used match the objective of the space?

Theme 4: Expectations. Here also, intentionality is key, and so there are many right answers, so long as the community of space-creators goes through a reflective process to explore the questions. When participants walk into a space or attend an event, what are their beliefs about what will happen once they are inside? What kinds of interactions are they prepared to participate in? Do their desires match the design of the space? To what degree will they be shown, taught, or expected to perform new tasks? What role does their own identity, preferences, and interests play in the event? One does not typically go to a ballet performance expecting an opportunity to sing karaoke.

An unresolved question I have in this investigation is the role of ambiguity – a notion which might be used as a lens to further interrogate all four themes: the way that ambiguity versus certainty can play out in design; the role of uncertainty as organizers plan events for an unknown group of participants; the value of leaving questions unanswered and constraints undetermined versus providing enough direction to get a team “unstuck”; the role that facilitator training or the lack thereof might have on the way a session unfolds; the value of setting expectations versus opening possibilities. This suggests a fifth theme: ambiguity.

Theme 5: Ambiguity. In a world of exhaustively documented learning objectives and metrics, what is the role of not knowing whether an instructional idea will work? In a multi-billion-dollar capital construction budget, as universities might have in constructing new

facilities, where is there room for trying things that might fail or might not produce the expected results? How might a lack of ambiguity serve to limit the creative and critical thinking that is supported by an instructional environment? These are significant questions that this investigation raises rather than answers.

Returning to the themes above (design, context, facilitation, expectations, and ambiguity), this investigation now turns to two additional case studies. The first location, in Kenya, is documented in the film *Making, Living, Sharing* (Dyvik 2013). The ARO Kenya site demonstrates the power of aligning design and context with the purpose of a space. In their exploration of the Shanghai Hackerspace, Lindtner and Guimarin (2014) explore a problem that I would characterize as a question of facilitation and expectations. Both show how the ambiguities in a space can be resolved – through mutual action, as in the ARO Kenya space, or through the creation of subordinate support strata within the community, as in the Shanghai space.

ARO Fablab, Kenya

This space, located in a poor rural village in Western Kenya called Majiwa, serves as an empowering social hub and entrepreneurial resource for the village. (Dyvik 2013, Jin n.d.) Grid electricity is unavailable in this area, and participants in ARO have produced gravity lights (which provide brief illumination while a weight falls on a chain), created solar cookers, invented termite catchers (termites being a popular but labor-intensive form of food in the area) and assembled solar panels to support the operation of the makerspace. Local people with ideas can visit ARO to develop their designs and then create new products for sale. While many makerspaces are characterized by 3D printers that use extruded plastic to produce objects, and vinyl cutters for making stickers, the cutter in ARO can be used to cut fish leather produced

locally from Lake Victoria. Sandals made of this fish leather are a popular product for export and sale.

The way that the equipment has been selected, as well as the use of ARO equipment in the building and expansion of the ARO itself illustrates the power of using space programming and space design in a mutually beneficial way; the use of local products and connection to local conditions shows the utility of being sensitive to context in the creation of a makerspace which has transformed people's lives. ARO's latest ambition is to develop a "solar school", which will allow people from across the region to learn to make solar panels and solar-powered devices (such as cookers, stoves, and water purifiers). In a region struggling to develop due to lack of infrastructure, this adoption of solar technology alongside learning opportunities is empowering individuals to devise and implement their own solutions to the problems they face.

Shanghai Hackerspace, China

Lindtner and Guimarin (2014) explore a challenging gap in the makerspace movement: the rhetoric of "maker as identity" and the primacy of producing objects, sometimes at the exclusion of the role of the teacher, the caretaker, or the critic. Lindner and Guimarin describe the example of the "hackerspace mama" in Shanghai – she is the person who welcomes people into the space, helps them to get started with their projects, settles disputes, and keeps the space clean and organized. The hackerspace mama is intrinsic to the successful operation of the Shanghai Hackerspace, essentially playing the role of chief facilitator, but she does not see herself as a maker. Her unheralded work also serves to lower expectations on other community members, who can have their needs met without necessarily contributing to the upkeep of the space and community.

By focusing on the production of objects over the making of community, the movement can blind itself to not only the tremendous effort required to maintain these spaces, but also the significant empowerment that self-maintenance offers a community. Other communities have embraced the role of self-maintenance – children are asked to clean up after themselves, parent teams gather to beautify school grounds, and clean-up days at beaches and parks are part of how a community grows to take responsibility for its own continuity. Clean-up is not “someone else’s job” – it is your responsibility as a participant and member. Being part of maintaining a space builds a sense of ownership and investment, and participating in upkeep sets an expectation that those who use the space are not customers or participants, but rather full partners in a community.

Concluding Thoughts

Through numerous anecdotes and case studies, this report has sought to first open the question of how learning spaces can be designed in order to support transformation: what principles and key lessons can be learned from the experiences of others. The starting point for this investigation was my own philosophy as a classroom designer – my observations of the way access and intention interplay in the chicken-and-egg dilemma of innovation, my sensitivity towards the gaps in culture and expectation which can separate design intention from actual usage, and an awareness of the ripple effect of change – seasoned by a healthy skepticism towards broad claims in general.

From investigating a range of makerspaces from the perspective of a participant as well as an erstwhile organizer and facilitator, I’ve observed not only the enduring relevance of space design and context as learning environments are developed, but also the significance of programming, as it plays out in facilitation and the expectations participants bring and adopt. As

space designers and participants seek to adopt new technologies and new ways of relating to our environment, we must return again and again to the key question: how can this space, in this surrounding place, with this calendar of events, and this designated facilitator, more fully empower the community which it serves and is served by?

Absolutely the curricular needs of the sponsoring entity must be met – a business school wants to generate entrepreneurs, a biomedical engineering program wants to create medical devices, a library wants to open new avenues of literacy to citizens. Yet these needs can be met in more than one fashion: facilitation can be directive and hierarchical or exploratory and mutual; space design can be prescriptive or responsive; projects can address theoretical scenarios or local needs; consumables can be a matter of convenience or respond to the local environment.

Reflection and community participation in spaces helps to surface such seemingly-simple dilemmas as the “O” versus the “U” in the arrangement of classroom tables before they boil over into conflict. Embracing ambiguity in space design creates the possibility of breaking out of the chicken and egg dilemma – and makes possible the co-evolving of the techno-teaching environment. Shared effort in design and maintenance, as well as facilitation and programming, turns users into participants. Considering carefully the local environment – the challenges and opportunities, the materials and cultural forces – creates a kind of connectedness between those participants and the wider world, supporting exploration and discovery with impacts far beyond the walls of the makerspace: carried in the hearts of the participants, and woven into the lives of their communities.

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Appendix A

The following materials may be of interest to anyone exploring makerspaces and fab labs as transformative learning spaces.

<http://www.fabfoundation.org/> — This is a “cookbook” for creating spaces according to the MIT Fab Lab paradigm — a particular set of technologies, a “clean” environment (not messy, but also not transgressive) focused on modern engineering and design.

Barton, A. C. (2008) Creating Hybrid Spaces for Engaging School Science Among Urban Middle School Girls. *American Educational Research Journal* March 2008, Vol. 45, No. 1, pp. 68–103 DOI: 10.3102/0002831207308641 — This article illustrates how holding space for innovation and idea-following can allow a young girl to transcend and blend her cultural identities to meet her own goals in her own way.

For more expansion on the identity-oriented critique I have referenced in passing above:

Debra Chachra’s “Why I Am Not a Maker” describes how the maker movement places what she considers undue emphasis on objects and the making of stuff — to the exclusion of care taking, criticizing, fixing, analyzing, educating. The article is available at:

<http://www.theatlantic.com/technology/archive/2015/01/why-i-am-not-a-maker/384767/> —

For additional angles of critique:

Peter Troxler and maxigas have collected a range of critiques under the title “We now have the means of production, but where is my revolution?” They survey the hype as well as the on-the-ground experience within the makerspaces themselves, which often does not match the general public narrative. Available at: <http://peerproduction.net/issues/issue-5-shared-machine-shops/editorial-section/editorial-note-we-now-have-the-means-of-production-but-where-is-my->

revolution/

Anna Waldman-Brown's "Are we apolitical bourgeois hobbyists promoting a materialist patriarchy?" is a collection of quotes and critiques. <http://district.life/2015/09/29/are-we-apolitical-bourgeois-hobbyists-promoting-a-materialist-patriarchy/>

Emily Eakin's "The Civilization Kit" is an account of a single individual's movement, trying to create a collection of plans and machines to create a self-generated village, which illustrates the level of very basic and backbreaking work that needs to be done so that more refined parts of life are possible. Available at:

<http://www.newyorker.com/magazine/2013/12/23/the-civilization-kit>.