shorting the thesis circuit:

From Computational Composites to Computational Learning

design journal_draft 1

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Thesis Research + Writing

design brief 1

Materiality, Craft, and Technology

MODULE:
DATE: 5 September 2011

CONTEXT

Based on my interests, at this crossroads, I see my thesis diverging at the scope of the role materials will play. After quite productive meetings with both Sarah and Scott, I feel as though the playdough that was my initial thesis schema is swiftly molding into a squishy circuit: while still just a lump of dough, I can see its potential function in bridging negative space between two discrete, though invariably similar parties.

I can either (1) focus on the materials as things in themselves and as an exploration of what is possible in a constrained context (e.g. interface and more specifically, input or feedback controls) or (2) using the materials as an opportunity to bridge the communities using them in order to further research and establish a grounded academic approach and language to the study of the materials as they relate to new interface design.

Until date my focus has mainly been on experimenting and designing new solutions that integrate hi and low tech materials from a craft-based approach. The base of my research comes from the Hi Low Tech group at MIT, as well as various crafty hackers via a broad community of soft circuiteers. I have avoided encroaching on the higher tech end of the conversation in wearable technology simply because it was the craft element that sparked my deep interest: how to engage a marginalized and disinterested audience. What frameworks and characteristics of the crafting community were already in place that allowed this new direction to flourish?

In exploring this direction, one of my constant battles emerged through language. The various monikers endowed on this field are beautifully ambiguous and, to a certain degree, problematic in cultural associations: soft circuits, wearable technology, computational crafts, e-textiles, smart textiles, and the list goes on and on. These are highly contextual depending on the community and their work, whether it be in fashion, in education, in nanotechnology, etc.

At the end of the day, we are all talking about the same exciting ideas, but we have all articulated different processes and solutions based on our research, our peers, and our user community's needs. As this field begins to grow, a shared language and networked approach to solutions and materials will be key for development and experimentation. I propose that the current obstruction lies in the following dichotomy: materiality vs. wearability. These two words have very different semantic meanings and implications. Why did we choose to use wearability? Is it more ethical than materiality? Easier to grasp? Or simply just more descriptive? Obviously, this is tied to the history of the development within this field, but at this juncture, it is crucial to return to the ramshackle taxonomies and language that began it all to discern a common language. To be completely explicit, not a common approach – this affords the community its vibrancy in problem-solving. It is the language to share it with.

CONCEPT

Craftsmanship is an essential part of culture, especially in the material culture that largely defines our sense of identity, both in the objects we make and the process by which we make them. With new materials comes new cultural contexts and new relationships with existing and emerging technologies through the interaction and use of these materials. We are engaging in a new form of computational, electro-embedded material culture that blurs the traditional boundaries of interface and the possibilities of interaction with objects.

DESIGN QUESTIONS

Craft

- In what ways has the rise of digital technology led back to ideas of craftsmanship and engagement in craft? How is craft defined?

Perception + Attitude

- What does the state of wearable technology and the supporting community reflect about our current attitudes toward technology?
- In what ways does this new form of material culture shift perceptions and attitudes towards technology?
- What role do these new possibilities of soft interfaces play in redefining our (identities) through the lens of material culture?

Community

- How is this community representative of crowd-sourced/created/reappropriated technology? In what ways is its growth and output unique?

Interface

- Do soft interfaces have a greater potential for metaphor? To what extent is this shift associated with this affordance?

Users

- What if people had the opportunity to reimagine existing tangible interfaces through these new materials?
- What might different configurations of components look like?
- Would this interaction with such a toolkit shape users awareness of interface?'
- Would it make users more apt to tinker with technology?

REFERENCES

Sennett, Richard. *The Craftsman*. New Haven: Yale University Press, 2008.

design brief 2

Framing Computational Composites: *From Use to Presence*

MODULE: Methodological
DATE: 14 September 2011

CONTEXT

Inspired Mental Tidbit
Presence and acts of acceptance as we integrate objects, actions/habits, and environments into our daily lives.[1]

I really like this distinction between use and presence. It makes for one of the more specific and vivid critiques of ubiquitous computing as unheard computational white noise. Moreover, these types of critiques answer, at least for me, deeper unsettling questions of the moral value of "smart" systems everywhere and of control that dissolves to chaos. Computers behind closed doors are much more disquieting than integrated into the fabric of our material world. This requires more consideration of context for the object or environment and it is this quality of the "material turn" in interaction that has piqued my interest deeply in this field. This is not to say that just because we consider materials more deeply, they will always be used for good or that they will always have positive influences on our lives. It does, however, call for more awareness of context – more appreciation for the micro and macro systems it is acting within (i.e. molecular, human, environmental).

There is something about a computer in a black box that evokes an imbalanced power structure in a variety of ways, almost as if it is a one way dialogue between the box and you and the box almost always wins. The box is the dictator of your information. I can't help but think of Sarah's most recent class as I wrote that, yet it often feels like a top down structure reminiscent of highly centralized governments. Trailing behind are libraries of dystopias where technology resides in a black box, if not literally then metaphorically as a entropic force. Its presence combats the energy and creativity of human life, leaving little room for it to have meaningful presence.

I digress on this windy tangent because I think that this mindset is still deeply situated in the inner recesses of people's minds. And yet we hold onto our "computational artifacts" [107] as security blankets and best friends. Presence is shifting into focus and the suspicions of pure use are blurring. A psychological/historical shift is perhaps happening that can be distilled to a new vocabulary (e.g. like black is totally the new green, but red is actually the new green, and the real unifier is that green is out). From use to presence, from functional to becoming, etc.

I think with such a shift comes a push for democratization of technological and computational processes – of which there has definitely been. Open source hardware and software have forced us to rethink the role, placement, and capabilities of computers in our daily interactions, but it has also forced us to rethink our role in creating them. It has in many ways imploded the black box with components mushrooming outward. We can meet computer on equal ground and adapt it to our needs and desires, whether functional or poetic.

Enter the computational composite – the idea of computer as material and the success of this approach deriving from the carefully examined and crafted relationships between materials in constructing contextual interfaces and experiences. I will not go into this here, but I wanted to mention it briefly. There are two issues in particular that recent literature, projects, and experts have articulated, both of which I find extremely interesting challenges

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[1] This began as a response to the article and ended up becoming more of an initial exposition of my thesis context and concept.

to tackle and respond to: (1) the lack of a conceptual framework and vocabulary for evaluation and collaboration and (2) the lack of a prototype catalogue on which to base the first.

I see a broader cultural issue I would like to address as well. There is still a vast population who feels uncomfortable tinkering with this black box

While this materials approach is still quite murky, it is oddly intuitive and familiar for a few reasons. First of all, it jives with our material essence and need for objects at a human level – we need to touch things and hold things and I will probably write a blog post soon meditating on the more philosophical undertones of that statement. Secondly, by focusing on the materials (traditional/functional and computational) interacting with each other at a micro level, perhaps we will craft a more resonant interaction at a macro level. Thirdly, by taking it out of the black box and even away from harder circuit boards, there is a vast opportunity to engage marginal populations to tinker. More than that, the more we tinker, the more we appreciate our environments that have been constructed. This combination taken together creates conditions on all ends and from all stakeholders for more expressive, enriching, and exchanging environments.

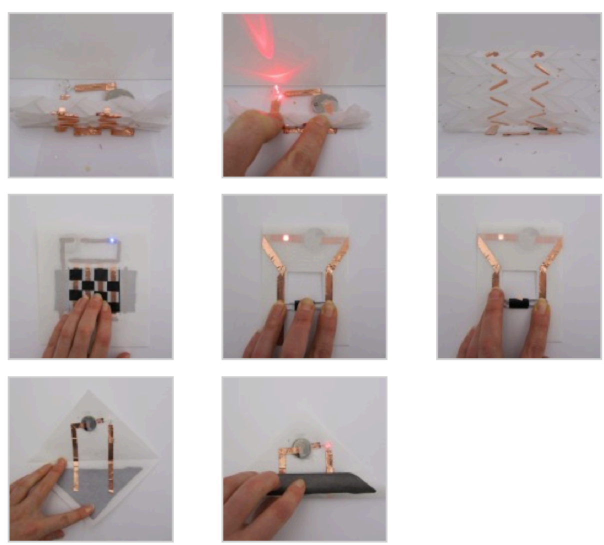
I feel that craft, specifically what some have been calling "computational craft", is well-positioned to extend this nascent framework and to captivate more makers. These are tinkerers who feel equal to their surrounding technologies such that they can distinguish a totalitarian black box from a valued personal object, but are still not afraid to lift Pandora's latch in the meantime.

This is in some ways the single goal of my thesis: if I can inspire and spur people to tinker, I will feel successful.

PROTOTYPE

Paper Circuits
For these circuits, I worked only on vellum as a substrate using a combination of copper tape, copper ink, liquid graphite, Velostat, annd paperclips to construct the circuits.

Goal
I sought to capture common interactions in new ways. The paper clip, for instance, still connects two sides, but in a different configuration and with a gradient of light. I think my favorite is the "roll" switch in which the user must roll the paper up and link the sides through liquid graphite. This also generates a spectrum of values, but I still need to tinker with the ratio inks to achieve a successful resistance.



Given my recent "material turn" in interaction (thanks thesis!), I approached these circuits in a way that would exploit the properties of the vellum. This particular vellum (Gilclear Oxford) is heavy, with matrices of perforations along its surface. These traits make for a beautiful crease, solid structure, and absorbency uncharacteristic of vellum, which was great for the conductive paint.

It was quite harder than I thought to find the patterns for these, but I had an enlightening hunt along the way. I have never played much with deployables or folding, and I found some of the most beautiful, intricate objects I have ever seen.

REFERENCES

Bergström, Jenny, Brendon Clark, Alberto Frigo, Ramia Mazé, Johan Redström, and Anna Vallgårda. "Becoming materials: material forms and forms of practice." *Digital Creativity* 21 (September 2010): 155-172.

Redström, Johan, and Lars Hallnäs. "From Use to Presence: On the Expressions and Aesthetics of Everyday Computational Things." In *Transactions on Computer-Human Interaction*, 9(2):106-124, 2002. http://dl.acm.org/citation.cfm?id=543441.

design brief 3

State Changes as Computational Properties: A Revised Approach to Research

MODULE: Methodological
DATE: 19 September 2011

CONTEXT

Recently I have been trying to tease out the distinction between tangible interfaces and the concept of computational composites. The latter is quite elusive to grasp as a whole, largely because its conceivers didn't provide the best examples. They were overbearing, clunky, and a tad too conceptual for my tastes. That being said, the theoretical foundation propping these prototypes up is brilliant and I still find much to take from it.

Lately I have been very inspired by the work of Marcelo Coehlo, especially his work around Shape Memory Alloys and paper-based computing. This particular paper he wrote with Jamie Zigelbaum crystallized some of the ideas I had thrown around, in particular how to define a computational composite and whether I should rethink that term.

On a technical level, computational composites are autonomous entities containing sensors, microcontroller, power source, and actuator that is not a mechanism for outside control. On a perceptual level, they are seamlessly integrated based on material choice and their form is closely aligned with its function. The second sentence below is crucial in how I want to articulate exactly what it is I am researching (emphasis mine):

Materials were seen by Polhem as static substrates from which to build complex systems, rather than dynamic and responsive elements, which could change their properties on demand and adapt to ever-changing design requirements. On the other hand, form and its ability to change in nature are the result of a harmonious orchestration between elements with disparate and changing physical properties. [2]

I have in the past week defined my research within the scope of the term computational composite. However, this term is too ambiguous and too broad in scope.

Coehlo's work is interesting to me at the moment because he addresses actuators: more than any other material, actuators exhibit a greater degree of computational properties in their ability to move, emit light, etc. and to be embedded into the circuit. Below are a few key passages and responses:

> The term soft mechanics refers to systems based on the use of shape-changing materials and their composites, which generate kinesis and physical transformation via transitions through different memory and elasticity states. [3]

Coehlo goes on to explain how

> this ability allows us to look at mechanical systems in a new light, where kinesis and transformation happen through changes in material properties rather than changes in how different mechanical elements, such as gears or joints, come together. [4]

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[2] Marcelo Coehlo and Jamie Zigelbaum. "Shape Changing Interfaces." Personal and Ubiquitous Computing 15 (2) (2011): 2.

[3] IBID., 4

[4] IBID., 4

The key idea here is changes in material properties. By focusing on the material properties for transformation vs. the connections between components, a more holistic approach is possible since the materials can become the actuators themselves. I see a commonality between Coehlo and Hannah Perner-Wilson, although she is on the front end of the rule set dealing mainly with sensors. Both focus on the material properties of their respective spheres, and both exploit them to explore the possibilities of combining different substrates with computational properties. At the moment, I will define computational properties as state changes; computational properties of a material can be measured by its temporal qualities, by its ability to transition between two or more states.

PROCESS

Given the above distinctions, below is a quick sketch of how I will approach the rest of the semester within the framework of the modules. My goal was to break it down as much as possible into stages, goals, hows, and deliverables.

This strategy was two-fold: 1) to keep myself on track when I get in a thesis pretzel twist and 2) to decide which research gathering strategies were necessary. For the moment I am very satisfied with this outline and will break it down even further in the coming days to include specific themes associated with goals and a calendar for deliverables.

STAGE 1: Review of current research setting

GOAL	to ask what has been done, what is being done, what could be done
GOAL	to situate my voice within the current conversation
METHOD	theory compilation + expert interviews
DELIVERABLES	annotated bibliography of research literature catalogue of precedents that are evaluated in terms of my heuristics synthesized interview notes initial list of evaluative heuristics

STAGE 2: Materials Research

GOAL	to gain a broad knowledge of the materials pertinent to my research interests to narrow the materials I will work with based on this overview
GOAL	to develop my own taxonomy of materials based on their relative computational properties (and their potential for expressiveness)
GOAL	to gain an expert familiarity with the chosen materials
HOW	finalized 3×3(x3) grid based on chosen materials (substrates x "becoming"/actuating materials x "doing" sensing materials); each square will result in a composite
DELIVERABLES	catalogue documenting all properties of chosen materials conceptual sketches for each composite

STAGE 3: Design Application

GOAL	to synthesize theory and materials research for the purpose of evaluation, both technically and conceptually
HOW	to develop a series of prototypes based on the grid defined above
DELIVERABLES	composite prototypes detailed documentation of building process (in a format similar to Instructables)

STAGE 4: Contextual Evaluation

GOAL	to evaluate prototypes within the defined heuristics
GOAL	to assess structural integrity in situ
HOW	ethnographic strategies (observation, interviews, etc)
DELIVERABLES	Video/written documentation of interaction with each prototype written evaluation of each prototype and material used

REFERENCES

Coelho, Marcelo, and Jamie Zigelbaum. 2011. "Shape Changing Interfaces." Personal and Ubiquitous Computing 15 (2) (February). doi:10.1007/s00779-010-0311-y.

Doering, Tanja. "Material-Centered Design and Evaluation of Tangible User Interfaces." 437. Boston, Massachusetts: ACM Press, 2009. http://dl.acm.org/citation.cfm?id=1935819.

design brief 4

Organic User Interfaces: Paperclip Lamp

MODULE: Methodological
DATE: 22 September 2011

CONTEXT

Organic User Interfaces (OUIs) are "user interfaces with non-planar displays that may actively or passively change shape via analog physical inputs."[5] There are three main characteristics of OUIs that differentiate them from other forms of computationally enhanced physical interfaces:

Input=output	The display is the input device
Function=form	The display can take on any shape; it is inspired like many others by the organic forms of Ernst Haekel
Form follows flow	The displays can change their shape; surfaces can be *deformed* to affect different behaviors or to gather data

GOAL

The goal of this thesis prototype was to create an object displaying traits of OUIs. This is a small scale lamp built with the intent of large scale implementation. For example, the surface to might run the length of the wall. The basic idea is the ability to move light where it is most needed in the space, and building the smaller lamps as discrete objects that can be added or subtracted from it. I gave myself the constraint of paper/vellum and paperclips, and I opted for more dynamic, winding forms for decorative power (literally – to conduct).

Originally, I wanted to make a paperclip chandelier, but opted to exploit the paperclip for what it does best. I began by constructing the boxes, soldering an LED and two parts of a paperclip on the backside, then securing the form with tape. To supply power to each box, I ran power to one side and ground to the other to create a parallel circuit. In the future I will opt for another strategy or power source or maybe just more resistance so the voltage drop isn't such a problem. In spite of this, I like the playful, jumpy interaction that came from sporadic connections and varying voltage requirements. Placing the boxes in different positions changes the "lamp" each time since the strength of connection depends on the weight.

Figure 5.1. Stages of making

PROCESS

Jonathan was so kind as to user test my lamp before class. One of the major issues in working with these materials is ensuring the connections are strong enough. Although the connections in this particular prototype were far from sound, it forced a new type of

[5] Holman, David and Roel Vertegaal. "Organic User Interfaces: Designing Computers in Any Way, Shape or Form." In *Communications of the ACM* 51(6), June 2008.

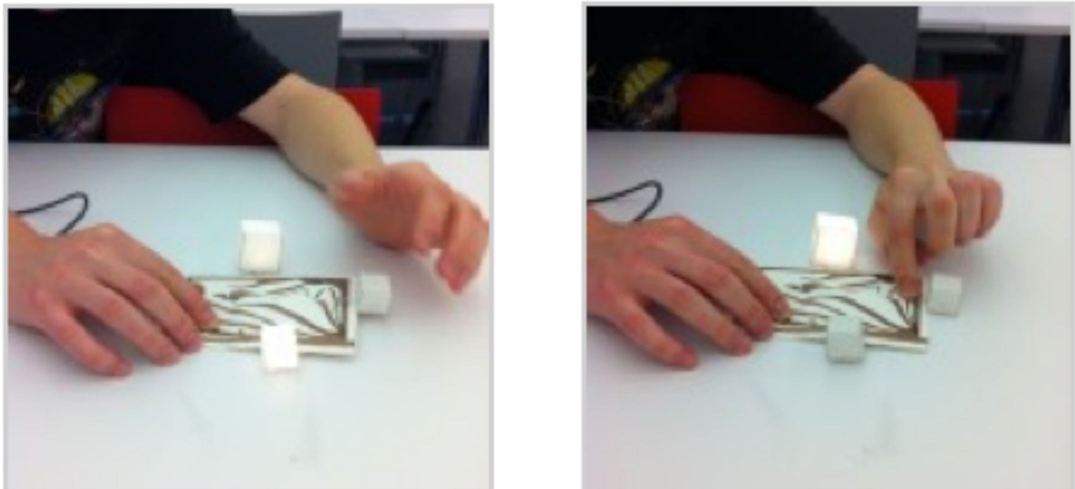

Figure 5.2. Jonathan user-testing the lamp.

interaction that I considered failure, but that he considered an emergent type of play.

REFLECTION

This is precisely the type of interaction that I am looking for: emergent actions based on the deformities of the materials or “bugs” in the construction that produce new opportunities for engagement. Although I had to show him where and how the connection was faulty for it work, he manipulated the state and position of the lamp boxes based on the feedback he generated and received. There was an interesting analog communication going on between him and the lamp that is worth diving into a bit more.

REFERENCES

Holman, David and Roel Vertegaal. “Organic User Interfaces: Designing Computers in Any Way, Shape or Form.” In *Communications of the ACM* 51(6), June 2008.

design brief 5

Interview Reflections: Cecilia Elguero

MODULE: Evaluative
DATE: 30 September 2011

CONTEXT

Cecilia Elguero is an artist who focuses on the intersection of fine art, computation, and materials. She has a background in film, electronic music, and graphic design, but has most recently been working with paper and porcelain. Graduating from MFADT in 2010, Cecilia has been key in expanding the Parsons e-textile movement outside of its fashionable tech focus. In spring 2011, Cecilia co-taught Soft Circuits and is currently teaching Soft Circuits 2. The difference between the classes is the substrate focus, which in turn changes the whole methodology and approach to constructing: the spring focused on sewing circuits with fabric and thread, while the fall is focusing on silkscreening circuits with paper and conductive ink.

GOALS

My objective in this initial interview with Cecilia was to question her about her own thesis process and to hear her thoughts on the state of the soft circuit field today. Since I will be meeting with Cecilia a few more times over the course of thesis, I wanted to focus more on her and her perspective as an expert, rather than immediately ask her for feedback on my initial concepts.

This interview danced around three themes: Cecilia's reflection and recommendations for thesis; the past, present, and future of soft circuits as a field; and using soft circuits as a learning tool.

Thesis
For her MFADT thesis, Cecilia created Wonder Garden, an installation using paper, fabric, and smart materials (specifically nitinol, a shape memory alloy) to generate a small world of moving characters.

Initially, her thesis focused on researching and cataloging different smart materials and possible substrates. She discussed the challenges she encountered in materials acquisition and development, both extremely time consuming processes. Over the course of the year, she developed an extensive library and wanted this library to become the thesis project. However, after feeling pressure from different sides to build something, Cecilia refocused her energies into synthesizing her knowledge into an installation.

It was interesting to hear her reflect on this decision at this point in my own thesis process. While she did not regret building out a project, she did mention that if given the chance again, she would have continued on with the material library. She felt that it would have been a much stronger process in the end. In later conversation, however, we discussed the importance of building things and not just catalogues: materials libraries do not promise innovation. (See below for more)

Her advice to me for thesis was a to focus on one material, such as paper, and to become imitate with its properties and potentials. As a result, I will be better equipped to translate this methodology to new materials. I hadn't thought in these terms specifically, so it was encouraging to hear, especially from someone who did focus on a range of materials. When it comes to different components (e.g. resistors) or making connections (e.g. soldering), she discouraged me from adopting a purist attitude. Instead it is necessary to understand the strengths, weaknesses and constraints of your materials and to exploit them for functionality and aesthetics.

Soft Circuits: The Field
During her survey of the soft circuit field, I found that Cecilia shared Katherine's sentiment, but seemed more optimistic in her perspective of its potential. Both criticized the lack of solid project implementation and the heavy focus on research. As of yet, it feels as though the possibilities have been exhausted because people keep reusing techniques and applications; in a world that is used to constant innovation and recombination, this is emerging as a craft – it requires time – both to grow and for its creators to get a solid understanding of the relationships between the materials.

One of the more interesting conversations to come out of our conversation was when Cecilia recounted her trip to the Tangible and Embodied Interfaces (TEI) conference in 2011. She described the atmosphere as one of solidarity and excitement. Solidarity, in having the opportunity to share research, projects , and gripes with like-minded makers. Excitement, in waiting for this field to do something great, to take this body of research and do something relevant and meaningful with it. (The way she described this general atmosphere reminded me of the excruciating hour right before you are allowed to go downstairs on Christmas morning.)

Soft Circuits + Learning
Rather than speak directly about my project, we focused outwards on the importance of learning through making, and the role that soft circuits might play. I explained my past project and the major objectives of developing such an interface. Cecilia summed up best the underlying philosophy of my thesis: "by building it you can understand it and change it."

She also took my analogy to a toolkit one step further by likening it to an instrument. She shared an anecdote of her musical childhood on the piano (I am almost certain it is the piano), and described how that type of learning had been foundational and applicable to so many other activities in her life.

I think this comparison is extremely interesting and want to spend a moment reflecting on it: a tool can be defined as anything that aids the pursuit of a goal, whether for a specific or spectrum of contexts. Tools can also be repurposed for other uses outside of their intended use. For me it connotes the thing of the "how". An instrument is a tool that pursues itself: it takes time and discipline to master. These are learned behaviors that can be applied in other contexts. For me it connotes a way of the "how".

REFLECTION
I need to become better about recording notes from an interview or conversation. Since we were at Joe's Coffee, the atmosphere and nature of the conversation dissuaded me from taking the notes I had wanted to take. I am usually a copious note taker for no other reason than I have a horrible memory. It is going to be a challenge to engage in both conversation and store nuggets of information to reflect on later.

I look forward to speaking with Cecilia further and about my project, both conceptually and technically. She has had much experience teaching soft circuits (albeit to undergraduates and older) and she will be a fantastic resource for technical troubleshooting and construction.

design brief 6

Revisiting the Past: Finding New Directions in Education

MODULE: Evaluative
DATE: 2 October 2011

CONTEXT

Recently I have been feeling a great deal of dissonance between my direction and its lack of personal foundation. In other words, more often than not, my projects need a function to stand on. Initially I felt some trepidation to integrate education and learning as a fundamental component of my thesis, but the past month has led me to see the importance of sticking with something you know well and something that you are passionate about.

Thesis is just as much as a process of self-discovery as it is a process of research, development, and creation. In many conversations with current and past thesis students, there comes a time for a pure, disruptive honesty of what you hope to accomplish and how it will help you grow. These are the major turning points and potential thresholds into the actual thesis.

After a long week of interviews, meetings, workshops and mini-conferences, I hit one of those points. By the end, I realized that my burning questions surround how we learn best about our world to encourage active dialogue with it. This has remained a stable thread throughout my research and presentations thus far. Moving forward with thesis, I am returning to my final project I began developing last semester, SnapToTrace (so catchy I will have to change the name):

If the focus here was more on learning the materials through development and testing and understanding the behaviors, the expanded focus is how developing an interface and it components generates agency and innovation: there exists a correlation between participating in the world and changing it. The more you “play” with the world, the more you tinker with its properties and behaviors, the more willing and adept you become to find innovative solutions. Throw in the current state of our education system and its STEM band-aid, and we have very fertile ground to play on.

Below is the abstract from my research last semester into the potential of approaching technology through a materials focus:

> Modular toolkits and electronic textiles have emerged as highly effective resources to engage new audiences in computational learning. This paper will briefly review past relevant research in these domains, paying close attention to different taxonomies that consider the role of personal fabrication. Based on this analysis and user research, I will then introduce an interface prototype that is pedagogically concerned with user scalability and multiple points of entry. A specific focus is placed on the role materials play in achieving these pedagogical goals. I will close with plans for future iterations of the circuit mat and possible directions for development.

PROTOTYPE

This is a prototype mockup for an interface that uses nails (or any other conductive protrusion) and conductive thread as input and thermochromic cells as output. Each “cell” will have three different types of thermochromic ink, i.e. each has a different temperature threshold, thus different parts of the cell will change at different speeds depending on how long the thread is wound around the nail to complete the circuit. Each nail is mapped to a cell, and the cells will be interchangeable on the display surface. An element of play and emergence enters since the user has no reference for which part of the cell holds which threshold of ink (ideally).

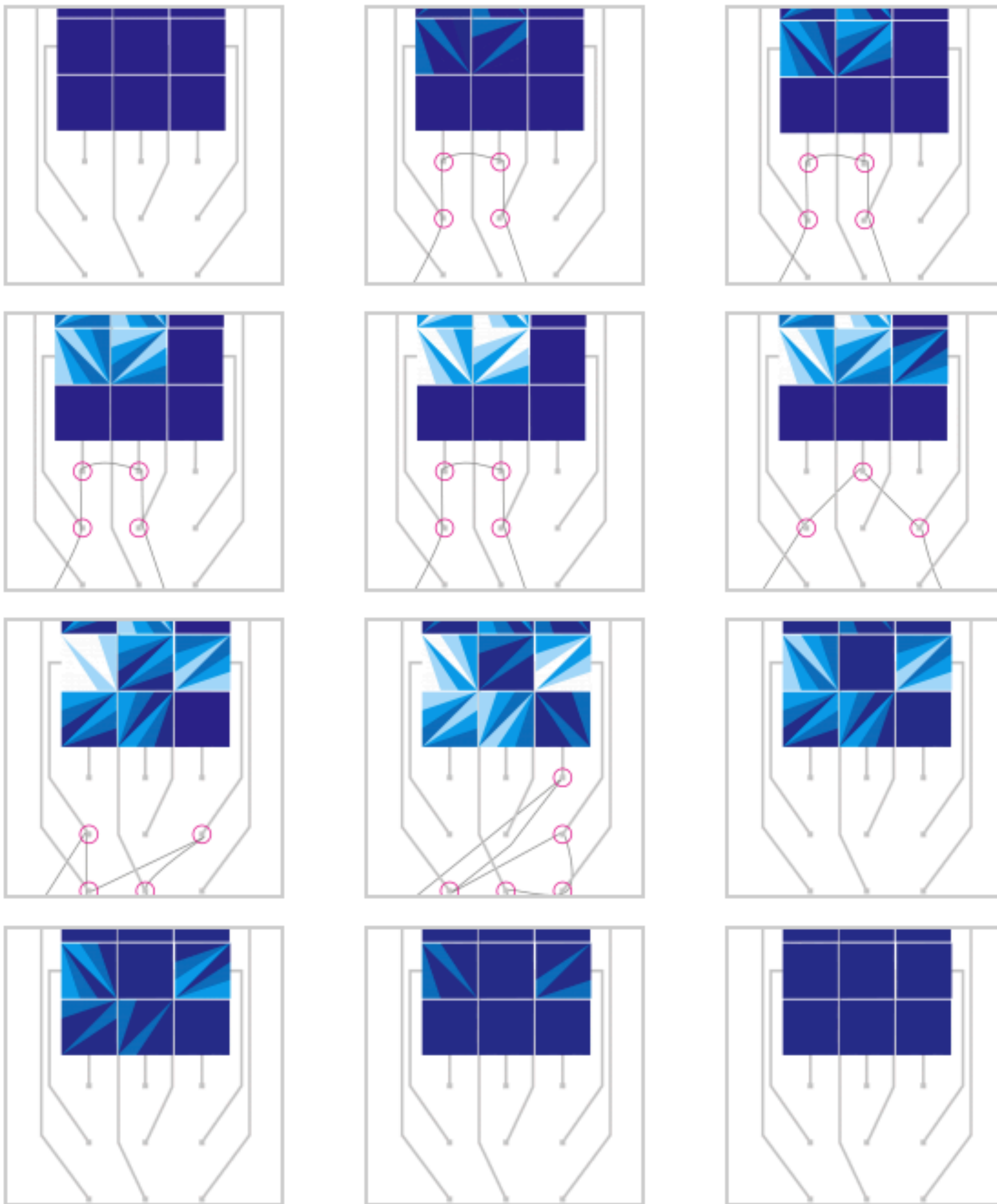

Figure 7.1. Storyboard of desired thermochromic progression

design brief 7

Modularity and Construction Kits

MODULE: Evaluative
DATE: 4 October 2011

CONTEXT

Construction kits are great. Construction kits that have a life span of two or more uses are even better. LEGO is by far and away the most pervasive (of current generations at least), and it is so successful because it allows innumerable recombinations. Lately I have been trying to decide the form of my project as it aligns with my conceptual goals. From here, I would like to classify the possible recombinations of such construction kits into two manifestations: the mini-world and the reconstruction of a object, device, or setting at a real world scale.

At this point in my research, I see an interesting opening in the recent toolkits that have been developed: almost all are descendants of the block paradigm. Perhaps modularity is easier to grasp as blocks, but this runs counter to the real power of modular components in the real world, i.e. being able to recombine objects of various shapes, sizes, and functions into new entities based on context. Indeed I believe that modularity can be abstracted to apply to the properties of any object or group of objects given the correct context.

Applying modularity from the top down in design denies the properties of objects that might make them most interesting and compelling to play with. It often results in a block like form, or at least a set of objects that are uniform in shape and usually size. While I am attracted to the idea of a modular set such as this to create a learning tool, I find the opposite approach much more intriguing. I think there is still room in the current environment for new and exciting programming and especially sensor integration into these type of construction kits, but so much has already been done. Some of the most interesting work being done is by Mike Eisenberg at University of Colorado (Craft Research Group) and Leah Buechley at MIT (High Low Tech Group), specifically for their introduction of personalization and greater ability for self expression based in the types of materials that they use.

This is the main reason I am focusing on the actual construction of the kit. I suppose you could say I am building an approach to modularity. By learning tool, I mean a physical object that learners can use to think about abstract ideas concretely, much in the spirit of Seymour Papert. This definition needs to be expanded, but this will suffice for the moment.

PROTOTYPE

Below is a concept diagram charting my statement of purpose:

Statement of Purpose Evolution

V1:
The goal of this project is to develop a new “soft” input/output interface that promotes scaffolded learning of computational processes and circuitry. Specific objectives include (1) creating a learning space that promotes experimentation, reflection, and self-expression and (2) investigating how the use of new and/or repurposed materials can engage new audiences in computation through craft.

V2:

The goal of this project is to develop ~~a new "soft"~~ a paper-based input/output interface that promotes scaffolded learning of computational processes and circuitry. Specific objectives include (1) creating a learning space that promotes experimentation, reflection, and self-expression and (2) investigating how the use of new and/or repurposed materials can engage new audiences in computation through craft.

V3:

The goal of this project is to develop ~~a new "soft"~~ a paper-based ~~input/output interface~~ modular toolkit that promotes scaffolded learning of computational processes and circuitry. Specific objectives include (1) creating a learning space that promotes experimentation, reflection, and self-expression and (2) investigating how the use of new and/or repurposed materials can engage new audiences in computation through craft.

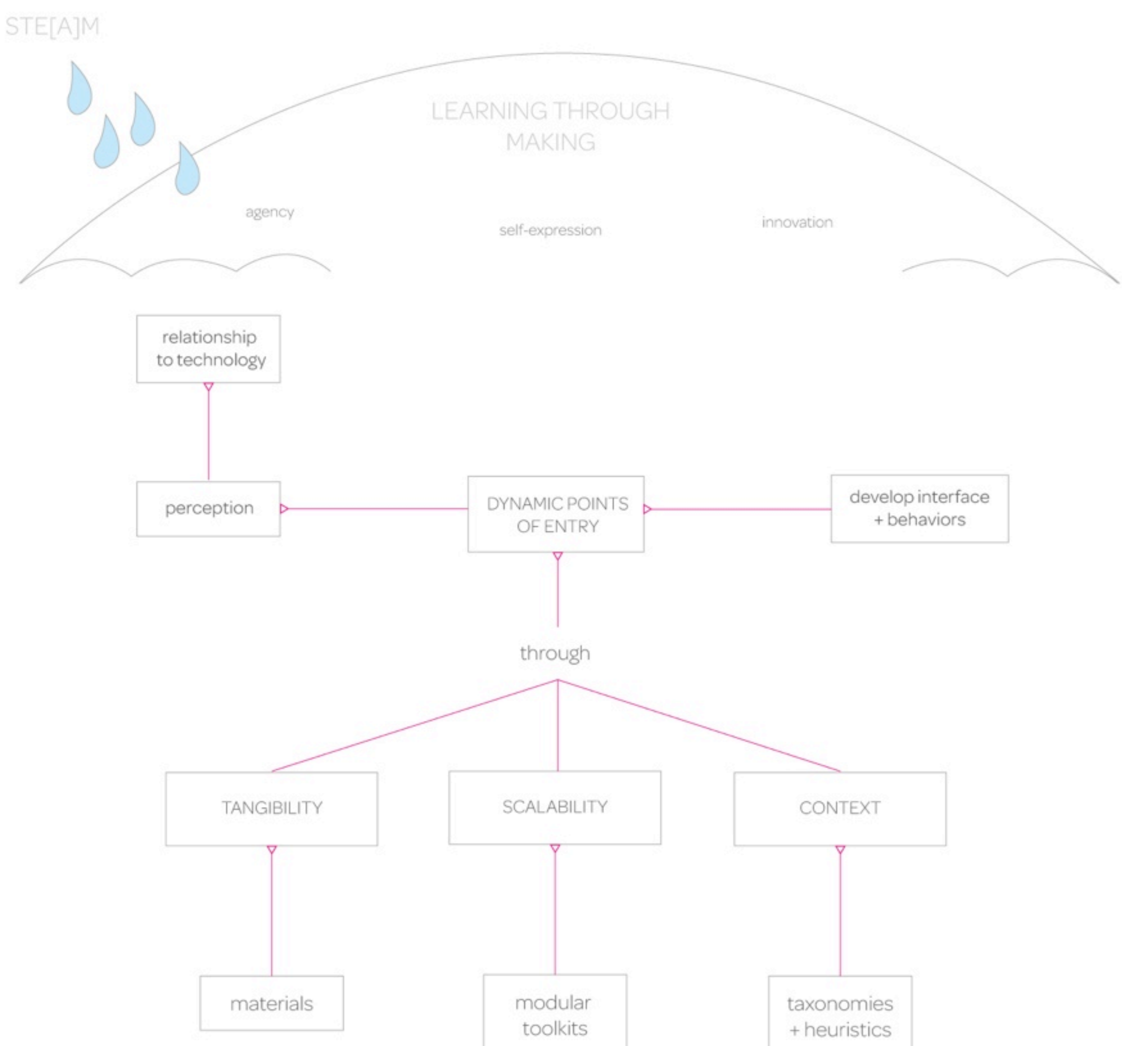

Figure 8.1. Concept diagram

design brief 8

Project Roebling

MODULE: Social
DATE: 12 October 2011

CONTEXT

Last Tuesday, October 15, myself and two Trans Design students held a Design Jam workshop for Mobility Shifts. It was the culmination of a three month research project we undertook in partnership with Eyebeam and Digital Democracy to research gaps that currently exist between education stakeholders, specifically middle school teachers and students, and different technologies. Initially we sought to identify effective tools and methodologies to increase the digital literacies of our stakeholders. We conducted an exhaustive review of the most innovative programs, schools, and curricula utilizing technology in learning spaces, documented observations from personal experiences in the field, and interviewed experts on their perspective of technology's role in the classroom and in informal learning spaces.

BACKGROUND

This project began two years ago as a collaboration between Eyebeam and Digital Democracy with the goal of creating a platform that would bridge gaps and connect teachers to students, students to students, and teachers to teachers. Ideally, this site would be run and populated with content by participating teachers and their students and require no formal upkeep by an outside party. The three of us entered the scene this summer and were tasked with reviving the project based on extensive research into what existed, what didn't, and where there might be possibility for innovation. This was a very broad initiative that left much to sculpt a research foundation around.
From our meetings with Eyebeam and Digital Democracy, we decided the qualities we were interested in exploring included open source, peer-to-peer learning, bridging informal and formal learning spaces, and modularity. We intended to create a platform for youth ages 7-18 and their teachers to collaborate on learning curricula.

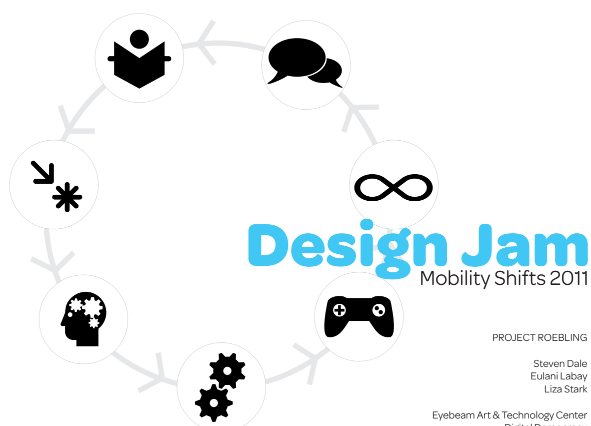

Figure 9.1. Poster for the workshop

RESEARCH GOALS

Our end research goal was to reframe the classroom as a design studio in which students and teachers collaborate to develop capstone projects using the design process. We saw the design process as a powerful approach to engage students in real world problem solving from a content and methodological perspective. It requires that students take more autonomy over their projects and also allows them insight into the challenges that arise when dealing with the real world. Rapid prototyping especially cultivates two crucial and underappreciated concepts in the education sector: the emergent nature of problem-solving and the willingness, even the desire, to make mistakes.

One of the fundamental assumptions we questioned was the role of the teacher. As we conducted our research over the summer, we had many heated and extremely productive conversations about the implications technology holds for the teacher's role in the learning process. Within formal educational settings, students and policy makers alike are pushing for a mass exodus to either blended learning or full blown screen-based learning, leaving the traditional teacher in a precarious position. Informal learning in afterschool and online spaces (e.g. P2PU, MIT Courseware, Open University, etc) are becoming a major force positioning learners at the center of their own learning, defining when, where, what, and most importantly, why.

Given this context, I maintain that the teacher is moving into more of a facilitator role as learners become their own teachers and move fluidly throughout learning spaces.

THE WORKSHOP

Participants

A diverse group of participants attend the workshop, from teachers, curriculum designers, and educational technologists to interactive design researchers, new media specialists, and design students, all spread across the K-12/higher education spectrum.

Long-term research goals

To explore the potential for self-guided and collaborative learning by applying the design process to a formal learning setting inspired by the following domains: open source, peer-to-peer learning, bridging informal and formal learning spaces, and modularity as a strategy to learning and to teaching.

Expected outcomes

We expected:

- To have designers and educators work together to explore potential methodologies and strategies to integrate the design process in the classroom.
- Participants to brainstorm the approach they would take to implementing the design process within the classroom by focusing on a specific subject and a technology appropriate to their subject and goals.
- Each group to come up with a project proposal for a specific subject area and to document ideas for approaching that project through each stage of the design process. Each group was provided with documentation cards, design briefs, and an outline of the design process.
- Our audience leave with new ideas for restructuring classroom dynamics to reflect more of a student driven process within the formal classroom setting.
- An appreciation for experimentation despite the constraints within the formal classroom setting.
- A degree of confusion and hesitation from the more education-focused participants regarding the design process.
- A degree of confusion due to potential inexperience within the classroom and unfamiliarity with the structure of our design brief. More specifically, how the design of lessons and curriculum work.

Process

After a presentation on research goals, inspiration, and project precedents, we reviewed the design process and outlined the course of the workshop and end deliverables (see the attached materials for further reference).

Figure 9.2. Group during the workshop

The participants broke out into groups of three and were given 50 minutes to outline their project. Each group was given the Design Brief, a handout explaining our stages of the design process, and documentation cards to outline their project. A variety of supplementary materials such as markers, post-its, butcher paper, and candy were provided to stimulate creativity.

Following the development process, each group presented their projects. After the presentation, the group came back together to discuss the process and give feedback on challenges, successes, and insights for future development.

OUTCOMES

A variety of different projects came out of the workshop: a scaled program aimed at visualizing the eating habits of an entire community and beginning with a small class, etc. (A separate post will detail example projects.) We had hoped that by developing a project around a particular subject that it would generate a framework for using the design process in that specific realm. For example, how might research approaches differ working in web design or mobile media? In what ways must the user be considered differently for each? Most of the groups, however, outlined a project without defining a prospective methodology. Had this not been the case, we would have gathered a fantastic set of heuristics for future iterations.

Many of the groups encountered confusion in developing their projects. This was for a number of reasons: lack of familiarity with the design process, time shortages, the open-ended nature of the workshop, and a lack of contextual considerations in some cases (for example, the role played by the group – were they to act as teachers or students). This last consideration was the most problematic for the groups that encountered it, and gave us amazing insight into future implementation and direction of project growth.

REFLECTION

Some of the confusion and challenges that occurred were the result of our presentation. We all agreed that our project instructions could have been scaffolded better and that the design process was not explained in enough detail for lay people. Despite these observable challenges, it is my personal opinion that the educators also had trouble in trying apply this framework because they were too focused on its pragmatic application to the classroom. This workshop required a certain “suspension of disbelief” in its application to the classroom. The main goal, however, was to start thinking outside the proverbial classroom box.

To that end, the three main takeaways for my thesis include:

Technology being used in improper settings

It is much harder to change approaches to education and learning than it is to change the tools used to engage and to teach. When questioned why they had decided to attend the workshop, most participants from the design sector answered that they wanted to learn more about the role of technology in education. Most participants from the education sector answered that they wanted to learn more about emerging technologies and the interesting ways that they are being implemented in the classroom.

Much more of a challenge to change perspectives

Teachers, curriculum developers, etc are constrained by ways they have been trained to define a classroom, and it was apparent during the workshop. Many of the more experimental projects came from groups dominated by designers. Groups dominated by educators tended to develop a project that worked within the constraints of the classroom. Both approaches are necessary to reach a balance.

The changing role of teachers and new forms of support

Teachers need more development in a facilitator capacity. This means being able to ask the right questions and to give critical feedback. They also need more tech support and curricular integration of tech across the board.

glossary

ARDUINO
An open-source electronics prototyping platform based on flexible, easy-to-use hardware and software. It's intended for artists, designers, hobbyists, and anyone interested in creating interactive objects or environments. [6] Increased popularity has led to the rise of a broad, worldwide DIY movement

COMPUTATION
Any type of calculation. Also defined as use of computer technology in Information processing. Computation is a process following a well-defined model understood and expressed in an algorithm, protocol, network topology, etc. Computation is also a major subject matter of computer science: it investigates what can or cannot be done in a computational manner. [7]

COMPUTATIONAL COMPOSITES
An object that gives form to computational processes by approaching its construction through the lens of its materials. [8]

COMPUTATIONAL CRAFT
Embedding computational components into craft-based activities; also used to teach computational concepts.

COMPUTATIONAL THINKING
Computational thinking involves solving problems, designing systems, and understanding human behavior, by drawing on the concepts fundamental to computer science. Characteristics of computation thinking include: (1) thinking recursively, algorithmic thinking; (2) using abstraction and decomposition when attacking a large complex task or designing a large complex system; (3) thinking in terms of prevention, protection, and recovery from worst-case scenarios through redundancy, damage containment, and error correction; (4) using heuristic reasoning to discover a solution. It is planning, learning, and scheduling in the presence of uncertainty. [9]

DIY (Do It Yourself)
A term used to describe building, modifying, or repairing of something without the aid of experts or professionals. The phrase "do it yourself" came into common usage in the 1950s in reference to home improvement projects which people might choose to complete independently. In recent years, the term DIY has taken on a broader meaning that covers a wide range of skill sets. DIY is associated with the international alternative rock, punk rock, and indie rock music scenes; indymedia networks, pirate radio stations, and the zine community. In this context,

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[6] "Arduino," accessed October 20, 2011, http://www.arduino.cc/.

[7] "Computation," *Wikipedia, The Free Encyclopedia*, http://en.wikipedia.org/wiki/Computation (accessed August 18, 2011).

[8] Anna Vallgårda and Johan Redström, "Computational Composites: Understanding the Materiality of Computational Technology" (ACM Press, 2007), 513, http://dl.acm.org/citation.cfm?id=1240706&CFID=42604048&CFTOKEN=25722255.

[9] Jeanettte M. Wing, "Computational Thinking," Communications of the ACM 49, no. 3 (March 2006): 33-35.

DIY is related to the Arts and Crafts movement, in that it offers an alternative to modern consumer culture's emphasis on relying on others to satisfy needs.[10]

FORMAL LEARNING

Structured learning time usually situated in a classroom setting where there is a defined relationship between teacher and student. It is assessment driven and goal-oriented,

INFORMAL LEARNING

Self-motivated , self guided learning that occurs outside the formal school environment (spatially and temporally) in places such as afterschool programs, libraries, museums, online massive multiplayer games, etc. Has recently received much attention because if opens opportunities for students to learn about their interests outside of school.

LILYPAD

A variation of the Arduino specifically developed for soft-circuit and e-textile creation.

MATERIALITY

Concept of or applied use of various materials or substances in the construction of a physical object. [11] I will largely use materiality as applied to abstract digital, computational forms and the different concrete properties that these forms might take.

MODULARITY

A general systems concept, typically defined as a continuum describing the degree to which a system's components may be separated and recombined. It refers to both the tightness of coupling between components, and the degree to which the "rules" of the system architecture enable (or prohibit) the mixing and matching of components.[12]

ORGANIC USER INTERFACES

User interfaces with non-planar displays that may actively or passively change shape via analog physical inputs. [13] There are three main characteristics of OUIs that differentiate them from other forms of computationally enhanced physical interfaces:

Input=output	The display is the input device

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[10] "DIY," *Wikipedia, The Free Encyclopedia*, http://en.wikipedia.org/wiki/Do_it_yourself(accessed October 17, 2011).

11[11] "Materiality," *Wikipedia, The Free Encyclopedia*, http://en.wikipedia.org/wiki/Materiality_%28architecture%29 (accessed September 14, 2011).

[12] "Modularity," *Wikipedia, The Free Encyclopedia,* http://en.wikipedia.org/wiki/Modularity (accessed April 14, 2011).

[13] Holman, David and Roel Vertegaal. "Organic User Interfaces: Designing Computers in Any Way, Shape or Form." In *Communications of the ACM* 51(6), June 2008.

Function=form	The display can take on any shape; it is inspired like many others by the organic forms of Ernst Haekel
Form follows flow	The displays can change their shape; surfaces can be *deformed* to affect different behaviors or to gather data

PHYSICAL COMPUTING

Physical computing is about using the relative limited computational power of the microcontroller to make connections between input and output of almost any material in all shapes and sizes. Thus, one of the key concepts is to understand the energy flow and the power of transduction. Objects like microphones, motors, and LEDs transduce one form of energy into another and thereby enable a host of possible forms and colors controlled by the computations. And it is "best understood by doing it rather than talking about it."[14]

SCALABILITY

The potential of a object or concept to work within different size systems and formats.

SOFT CIRCUITS

Electrical circuits made of "soft" materials such as conductive fabric, thread, inks, etc on substrates including paper, fabric, wood, etc. Usually associated with Makers, DIY learning, and the new craft movement.

STATE STANDARDS

Subject-specific criteria by which students are assessed in K-12 education.

STEAM (Science, Technology, Engineering, Art, Math)

A variant of STEM coined to reinforce the importance of art in a STEM-based educational economy. STEAM proponents seek to infuse creativity within the STEM curriculum, arguing that it is fundamental to the practices of each discipline, fosters innovation, and nurtures self-expression in non-traditional ways.

STEM (Science, Technology, Engineering, Math)

A US national educational initiative introduced to cultivate a STEM-literate citizenry and workforce needed to address the complex challenges of the 21st century. The goal of STEM is to approach these fields holistically and examine their interrelationships within broader systems. STEM is a defining element of No Child Left Behind and has had a profound effect on approaches to and opinions of standardized testing.

SYSTEM

An entity designed by humans or by nature that maintains its existence and functions as a whole through the dynamic interaction of its parts. The group of interacting or interdependent parts form a unified whole and are driven by a purpose. Systems attempt to maintain their stability through feedback. Hence, the interrelationships

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[14] Anna Vallgårda and Johan Redström, "Computational Composites: Understanding the Materiality of Computational Technology" (ACM Press, 2007), 513, http://dl.acm.org/citation.cfm?id=1240706&CFID=42604048&CFTOKEN=25722255.

among variables are connected by a feedback loop, and the status or behavior of one or more variables consequently affects the status of the other variables. [15]

SYSTEMS THINKING

The process of understanding how things influence one another within a whole. In nature, systems thinking examples include ecosystems in which various elements such as air, water, movement, plants, and animals work together to survive or perish. In organizations, systems consist of people, structures, and processes that work together to make an organization healthy or unhealthy.

Systems Thinking has been defined as an approach to problem solving, by viewing "problems" as parts of an overall system, rather than reacting to specific part, outcomes or events and potentially contributing to further development of unintended consequences. Systems thinking is not one thing but a set of habits or practices[2] within a framework that is based on the belief that the parts of a can best be understood in the context of relationships with each other and with other systems, rather than in isolation. Systems thinking focuses on cyclical rather than linear cause and effect.[16]

Systems Thinking as a form of pedagogy requires learners to become critical thinkers and forces learners to confront the emergent properties within dynamic systems as an added property.

TANGIBILITY

The concrete qualities of an object or idea.

TANGIBLE USER INTERFACES

Physical interfaces that control digital objects and environments.

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[15] Katie Salen et al., Quest to Learn: Developing the School for Digital Kids (Boston, Massachusetts: MIT Press, 2011).

[16] “Systems Thinking,” Wikipedia, The Free Encyclopedia, http://en.wikipedia.org/wiki/Systems_thinking (accessed June 14, 2011).

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