MAKE & ARTICULATE

Developing Holistic Designerly Ways of Knowing Through Making

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A thesis submitted to the School of Design, Carnegie Mellon University,
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Abstract

Fueled by the value of "Design Thinking" as an innovation and problem solving tool, a rising number of engineers have been entering graduate programs in interaction design to learn how to design. However an engineer's strong emphasis on the end product stands at odds with design's emphasis on the process. This predisposition oftentimes impedes with an the engineer's ability to fully engage with their new culture of design where they must employ new ways of knowing. The fact of the mater is, designerly ways of knowing is not something simply learned by books, or sifting through literature. It is instead a new way of knowing by approaching making as a process of discovery, clarity and craft while iterating towards refinement and articulation. For technically rational minded individuals a career change into design points to a larger challenge beyond learning tools and methods, where the act of change represents a necessity to transition in worldviews; going from a field filled with certainty to a field that deals with uncertainty, in design. Without understanding the value of designerly ways of knowing and having the agility to navigate through the uncertainty in the form of designerly ways of making, technically minded individuals can easily feel stuck and disoriented stuck while experiencing a full on "culture shock." This thesis looks to aid in the process of transition by uncovering pre-understandings, roadblocks, and opportunities of a cultural transition from engineering to design. Using human centered design methods and informed ways of making, the goal is to create a model to engage in designerly ways of making in order to better navigate uncertainty and begin to know in designerly ways.

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Introduction

The UK Design Council reported that between 2003 and 2009 the number of design students grew from 139,130 to 173,825; a 45% increase. This rise was evident both at the undergraduate and graduate levels and illustrated the growing interest and reach of the design in the world. Fueled by the perceived value of "Design Thinking," a growing number of engineers continue to enter graduate design programs to problem solve on a wider scale, change sensibilities, and become successful designers in their own right.

Yet, for engineers switching careers into design, the switch from engineering to design is often an emotional journey where they find themselves transitioning between who they are and who they want to be. The further apart these two "selves" are, the more likely the transitioning individual feels disoriented and disenchanted. For the specific transition we are dealing with here from engineering to interaction design the discrepancy is quite large. While engineering focuses on dealing with certainty, interaction design constantly deals with uncertainty. For a transitioning engineer, without a proper understanding of self and how to navigate through the uncertainty of transition, they can experience culture shock, and furthermore, self shock, a realization of self.

For the interaction design community, this influx of non-design designers has lead to a broad band of design thinkers that has decentralized the core design practice of making into that of design strategy. What is meaningful to interaction design as a discipline is a return to what was once a rich making culture with new and improved perspectives. In fact, those coming from engineering are well suited to advance interaction design by bringing their qualities, skills, and competencies to the discipline.

This thesis focuses on helping transitioning individuals develop the agility to deal with uncertainty by help them know in designerly ways by making in designerly ways. For this to be the case, design interventions must be able to provide a platform for transitioning individuals to embrace making as a personal, informative, and meaningful process.

Significance

Uncertainty in transition refers to when a decision needs to be made but the options lie outside the realm of a person's expertise or experience. Therefore in such cases, it is nearly impossible to determine a preferred outcome based on information alone. How people choose to deal with this uncertainty depends on their prior experiences, learning habits, and circumstance. This thesis deals with the discipline of design where this type of uncertainty is commonplace and treats it as a model for navigating through that uncertainty.

This thesis deals with 2 different uncertainties. First, the specific transition of engineering into design, a transition that involves two fundamentally diametric perspectives. Second, it looks to enrich the discipline of design by introducing multiple perspectives on the practice of design. The outcome is a model to address the uncertainty in a cultural transition into design that looks at transitioning an individual's approach to making, decision making, and knowledge through designerly ways of knowing.

Method of Approach

User centered design is focused on creating holistic experiences based on research that identifies user needs. The challenge when designing for transitions is that there are stages of needs; a sequence of needs rather than simply a list of needs. This means that the research for transition design must go beyond typical user centered design methodologies so that it uncovers the appropriateness of needs in the form of series, sequence and priorities.

Therefore, the approach I took to my research was to gather a list of needs, then situate those needs within a transition. I used designerly ways of making as a catalyst for navigating through the uncertainty and understanding priority and sequence. The first step of identifying needs in the transition process was performed by using user research methods of interviews, literature reviews, and observations. The next step of situating these findings was performed by personally immersing myself in designerly ways of making and using the articulations of needs found in the previous stage to articulate the uncertainties as a series of needs with order and priority. Directly working with uncertainty brought valuable insights on a myriad of roadblocks that often prevented individuals from transitioning from technically rational to designerly ways of knowing. These findings were later used to inform a framework used to create an example of a design intervention for transition.

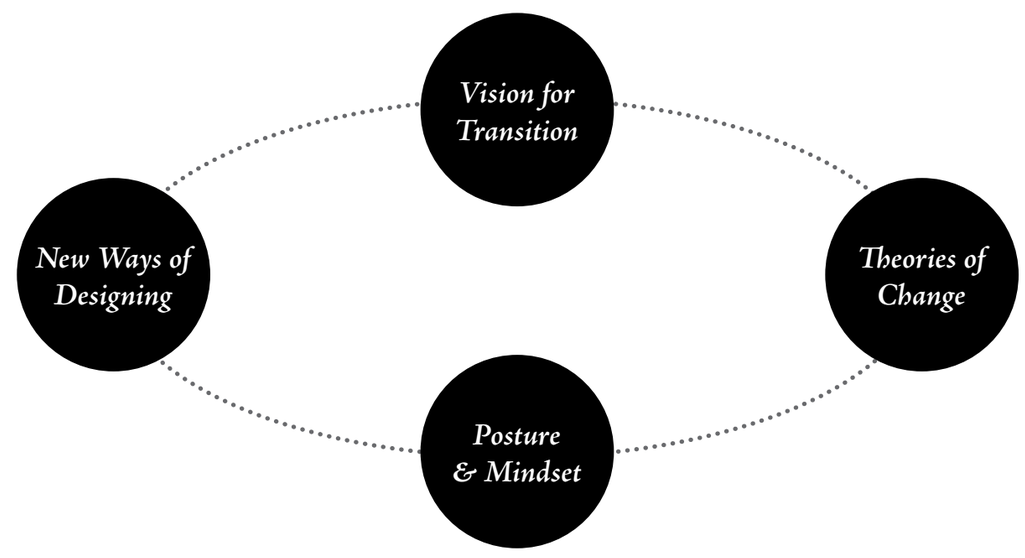
Transition Design Framework

As Director of Design PhD studies at Carnegie Mellon University, Cameron Tonkinwise defines transitions as a "process or a period of changing from one state or condition to another." Designing for transitions, according to Tonkinwise, "requires a vision of where the audience wants to go and proposes the re-conception of whole lifestyles and addresses quality of life issues within the context of the everyday." It is this notion of designing for the whole lifestyle that highlights the challenge of a cultural transition. Changing the lifestyle of an individual signifies a transition of "being" or dasein, and this change must be placed in "the context of the everyday" in order to be implemented and sustained.

In Cameron Tonkinwise's Transition Design framework, he mentions two unique design considerations: designing for initial conditions and a need for a solution to "evolve and change over time." This raised two areas of focus that must be assessed by a new design methodology. Therefore, the first step was to identify uncertainties that lie in the transition process using user centered design methodologies. Secondly, to create an intervention that evolves over time, I explored conscious, informed, making habits over time. I set out to identify the various states of transition as a collection of needs, situate them into a describable sequence, and personally evaluate them for their appropriateness. In fact, the cultural transition from engineering to design closely follows the Transition Design framework laid out by Tonkinwise.

Before moving forward, I must point out a critical difference between my interpretation of transition design compared to the design framework of Cameron Tonkinwise and Rob Hopkins, whose work with the Transition Movement highly influenced the transition metric I implored for this thesis project. Both Tonkinwise and Hopkins refer to transition as a communal change and vision. However I believe the transition of an engineer entering into design is fundamentally personal. If we are, for instance, aiming to make the world a more sustainable place, we can force people to recycle but we cannot force them to care. On the other hand, if they already care, we can provide a holistic vision, communicate the value of change and offer an outlet for action.

Tonkinwise's framework, pictured below, speaks of requiring a vision for transition, theory of change involved, new ways of designing that enable the change, and the necessary change in mindset to properly engage with the transition



A Vision /// For Transition /// 1

We begin by looking at a designer's worldview being understood through the lens of an engineer's worldview. The task at hand was to situate and communicate designerly ways of knowing based on what engineers found valuable.

In order to understand an engineer's transition into design, I researched what motivates career change, how career transitioners approach change, and what engineering ways of knowing looks like compared to designerly ways of knowing.

Research in this section looked to understand:

A. why do transitioners transition?
B. how do they approach change and transition?
C. what are the differences between disciplines?

A. Motivation For Change

Understanding the motivation for a career change into design from a non-design background iss the first step in situating design into the everyday life of a transitioning individual. The goal here is to understand who transitions and why they choose design. My research began with interviewing 9 graduate students studying interaction design who did not have a background in design. The interviews were not limited to engineers in order to 1. identify a sequence of transition 2. differentiate any "engineering culture" specific issues that may arise.

Who:	9 participants studying design from non design backgrounds
What:	Interview career changers about their motivation for change
How:	Contacted people about interviews
	Conducted individual interviews in person
Duration:	45 minutes
When:	October 2013
Where:	Carnegie Mellon University, Margaret Morrison, 215

I asked these individuals about their background, a snapshot of their lives before graduate school, during graduate school and what triggered their career change. To put the need for transition into context, I also asked them to self assess their level of fulfillment both before and after the career change.

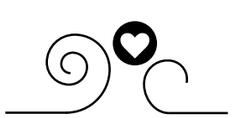
Highlights

"Some of the greatest moments of your life come when you hit rock bottom."

"I knew I needed to change but I had no idea into what."

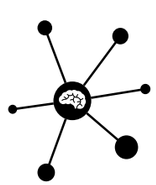
"I am aligned and tuned into something true and meaningful."

By the Numbers



78%

Felt the need to change before feeling the urge to design



44%

Wanted to apply their problem solving skills to a breadth of topics

67%

Design was an outlet for individuals to actualize a sense of purpose through utilizing their talents

Participant List

Person A: Female, 22
Studied Biology
no working experience

Person B Female, 23
Studied Electrical Engineering
no working experience

Person C Female, 25
Studied Management Science
3 years working experience

Person D Female, 26
Studied Political Science
2 years working experience

Person E Female, 27
Studied Computer Science
3 working experience

Person F male, 28
Studied Industrial Engineering
5 years working experience

Person G Female, 29
Studied Writing
4 years working experience

Person H Female, 30
Studied "everything"
5 years working experience

Person I Female, 30
Studied Political Science
4 years working experience

Findings

Typically the need to change came before the need to design. Based on that observation, motivation could be divided into two segments: The need to change and the choice to change. The need usually came from experiencing a personal conflict, often a personal low point. The choice to change came when a discipline connected to an individual's sense of purpose. This confirmed my initial hunch that this type of transition was first and foremost personal as transition was bound to personal conviction not to an argument. The need preceded the vision.

B. Approach To Change

Describing the difference between a novice and an expert in the "maker" culture, Phillip Torrone in "Zen and the Art of Making" points to the personal reaction towards mistakes, celebrated by novices and hidden by experts, as a key indicator of an attitude conducive to growth. (Torrone, 2011)

The attitude of a career changing individual is a component that plays a key role in determining the speed of transition. Often the hardest thing to do is to leave ones expertise at the door and approach transition as a novice. The willingness to be a novice speaks about who is open to admitting mistakes, learning from mistakes, and accepts new teachings with no preconceived notions.

One successful transitioner said "the most important change in mindset was going from a place of master to giving up the perks of being a master and being a complete beginner." When asked about the entire experience they added "it was such a gift to leave all that responsibility of being a master. Don't cheat yourself out of the experience and appreciate the process you're in."

Interviews

To research this, I followed up with 6 of the 9 individuals. The questions in the interviews were aimed at understanding the transitioners' approach in mindset by contrasting what they currently do, opposed to what they used to do. I asked what they missed about their previous disciplines, their process of designing, and had them identify points in the design process they felt particularly "stuck." From their responses, I gathered whether the individual was approaching their transition as a novice or expert. Also, based on the backgrounds of interviewee, we were able to determine whether an individual's pre-understandings were interfering with their ability to engage in their new discipline as a novice.

Highlights

What do you miss about "(previous occupation)"?

"I miss the certainty in engineering, there was always a right answer."

"There was always a specific process and you knew what came next."

Have there been any difficulties, moments when you felt "stuck?"

"I wish someone told me how emotional it (design) was going to be."

"People with design degrees make me feel like a 2nd-rate citizen."

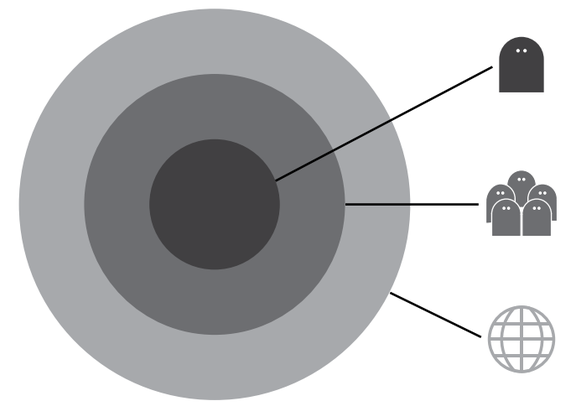
"I never can figure out when I should start to make."

"It would take me forever to make something beautiful."

Why do so few people succeed when promoted or when they take on a new job? "They continue in their new assignment to do what made them successful in the old assignment and what earned them the promotion." (Drucker, 2012)

Findings

Expert transitioners were novices, while novice transitioners were experts who were desperately holding on to their past expertise. The research showed, however, that there are many forces that act as barriers against an individual taking on the mindset of a novice. These barriers could be categorized into personal, social, and environmental factors and are articulated below.



Sphere of influence

Personal Barrier
It is not easy laying down the perks of being an expert
Transition and design are both an emotional process
Engineering is fundamentally unemotional

Social Barrier
Those entering design without a design background felt like they were treated as "second rate citizens" by those already in the design discipline

Environmental Barrier
Because of their graduate student status, transitioners are still perceived as experts to the outside world

C. Articulating The Gap

The one constant about education is that an individual who is "educated" shall come to care about the valuable things involved, that he shall want to achieve the relevant standards of his/her education.

On the surface level, what separates a designer from any other discipline is that designers make; they create artifacts. However making for designers is not just a tool or a skill. It is a way of being and living with the process of making that fundamentally informs their thinking process, ideas, and solutions. Yet, graduate students entering into design from non-design backgrounds often lack the necessary means to execute making at a high level. Designing is a process of pattern synthesis, rather than pattern recognition. The solution is not simply lying there among the data, it has to be actively constructed by the designer's own efforts. For these demographic of students, making in designerly ways is seen as a desired skill but not quite a different perspective. Articulating the states of engineering and design helps to create a picture of the initial and future perspective of this transition as a consumable list of attributes. Excerpts from various literature sources were included in this section as evidence to support the notion that "the gap" is a difference in processes, values, perspectives, and being.

Different types of problems

It is widely recognized that design problems are ill-defined, ill-structured, or 'wicked.' What designers tend to do, therefore, is to seek, or impose a 'primary generator' which both defines the limits of the problem and suggests the nature of its possible solution. (Cross, 2011, p. 21)

Approach to problem solving

A number of observational studies have been made of how designers work in a distinctly 'designerly' form of activity that separates it from typical scientific and scholarly activities. The essential difference between these two strategies is that while the scientists focused their attention on discovering the rule, the architects were obsessed with achieving the desired result. In other words, they learn about the nature of the problem largely as a result of trying out solutions, whereas the scientists set out specifically to study the problem. Scientists problem solve by analysis, whereas designers problem-solve by synthesis. (Cross, 2011, p. 24)

Judgment & Making

The designer is constrained to produce a practicable result within a specific time limit, whereas the scientist and scholar are both able, and often required, to suspend their judgements and decisions until more is known - 'further research is needed' is always a justifiable conclusion for them. A central feature of design activity, then, is its reliance on generating fairly quickly a satisfactory solution, rather than on any prolonged analysis of the problem. (Cross, 2011, p. 23)

Knowledge

Design has its own distinct 'things to know, ways of knowing them, and ways of finding out about them. It is like learning an artificial 'language', a kind of code, which transforms thoughts into words, words into patterns, then encoding patterns into objects thus making it real. Designerly ways of knowing are embodied in these 'codes.' Those who have been trained as designers will be using just such a code, which enables the designer translate individual, organizational and social needs to artifacts. (Cross, 2011, p. 22)

Dealing with uncertainty

In order to cope with ill-defined problems, the designer has to learn to have the self-confidence to define, redefine and change the problem-as-given in the light of the solution that emerges from his mind and hand. People who seek the certainty of externally structured, well-defined problems will never appreciate the delight of being a designer. They go as far as to say "to base design theory on inappropriate paradigms of logic and science is to make a bad mistake. Logic has interests in abstract forms. Science investigates extant forms. (Cross, 1981, p. 196)

Findings

Main differences between engineering and design

Engineering	*Categories*	Interaction Design
natural world	***Phenomenon Of Study***	man-made world
how things are	***Concerned With***	how things ought to be
truth	***Main Concern***	appropriateness
causal	***Nature Of Problems***	wicked, non-causal
controlled experiment, analysis	***Appropriate Methods***	pattern-formation, synthesis
objectivity, rationality, neutrality	***Values***	ingenuity, empathy
iteration on defining problem space	***Problem Solving***	iteration on defining solution space
objective	***Nature Of Knowledge***	subjective/experiential
efficiency and progress	***Driven By***	appropriateness and process
rigid	***Judgement***	fluid and flexible
is a sequence	***Making***	follows judgements and decisions

Theories /// of Change /// 2

When transitioning through the gap between engineering and design there are often moments of "stuck" but very little is communicated about it. Without knowing why you get stuck, it is that much more difficult to become un-stuck. Coupled with a lack of experience, it is almost impossible at times to know whether the issue lies within yourself as a transitioner or the process itself. Identifying pre-understandings that create "natural" roadblocks is a good step in making "stuck" real and actionable.

Typically this section of theories of change deals with identifying theories in philosophy, psychology, anthropology, etc. that describe theories of change involved in transitioning. However since most theories lacked insight into the emotional transition caused by pre-understandings as they spoke from a 3rd person's point of view.

Research in this section included:

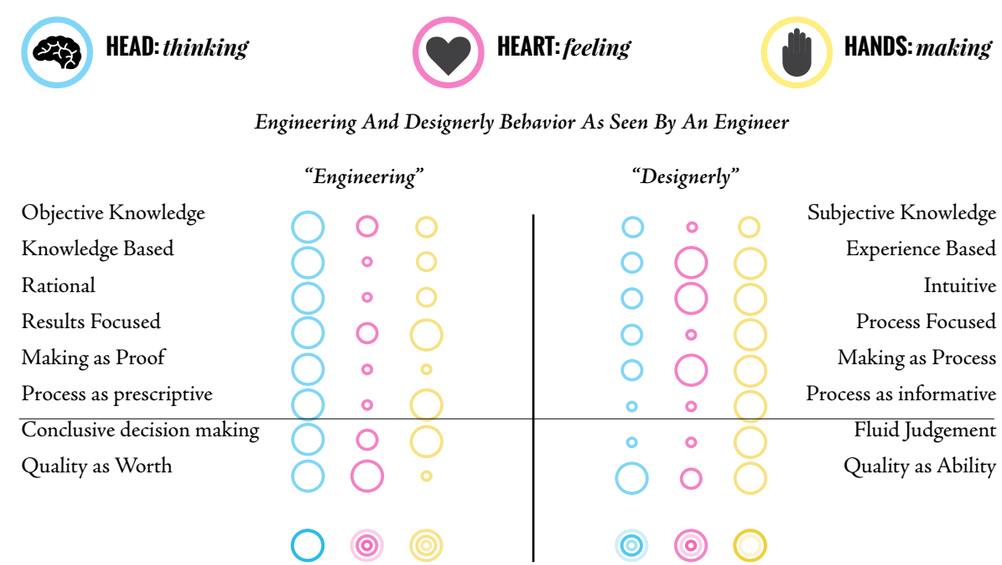
A. "natural" barriers towards transition
B. understanding learning habits
C. situating learning
D. situating barriers

A. "Natural" Barriers

We do not know what we do not know but we still face things in our lives new, drastic, yet still seemingly exciting and desirable. But "before we could become open to the relevance and importance (of new ways of thinking) "we need(ed) to take a preliminary step towards un-concealing the tradition in which we live(d), recognizing that it was in fact open to serious question." (Winograd & Flores, 1986, p. 38)

There is a major difference between the challenges of a graduate level transition of disciplines as to a undergraduate level of transition into college. Graduate level transitioners, unlike undergraduates, have a way of thinking and learning already ingrained in them via their prior education. As Winograd and Flores state, we seldom know what we do not know, and "we need to take a preliminary step towards un-concealing the tradition in which we live, recognizing that it was in fact open to serious question." In fact, the more experience one has working in a particular field, the more difficult a transition may be. Hence, merely laying down the gap as a guide towards transition is insufficient. The purpose of this section is to un-conceal the tradition that engineers come from, and how "natural" barriers that effect transition exist due to previous training.

If we revisit the list of differences mapped out in the previous section, we can see many attributes are not just different, but in opposition to one another. These elements are perhaps the most "natural" barriers. In order understand the degree of opposition, using the metric proposed previously, I visually broke down how an engineer might approach certain topics by the metric of thinking, feeling, making. The size and shape of each element was based on personal experience. This allowed for identifying patterns and articulating uncertainties in a transition.



From this breakdown of engagement we can clearly see that engineering and designerly behaviors appear very differently to an engineer. The attributes most closely associated with engineering are thinking heavy, while those typically associated with design are based on making and feeling. It is a glimpse into why it is so difficult for engineers to engage in designerly ways of knowing.

"Stuck" Moments

In the initial interviews, I had the participants map out their process and articulate where they got "stuck." Out of the transitioners who specified they had a difficulty making process. Many issue flared up in the decision making process because there they were without a prescriptive process and objective knowledge of "good." This resulted in a lack of time for the individual, a lack of fidelity regarding the outcome, or a lack of patience to stick with making as a iterative, refinement process.

Articulating "Stuck" as different types of "I don't know"

Lack Plan Knowledge		"I do not know what comes next"
Lack Procedure Knowledge		"I do not know how to do it"
Lack Practice		"I know "what" to do and "how" to do it but I don't know where to get started"

"Stuck" as lack of progress

The lack of improvement could be largely categorized into two issues. One was the lack of knowledge, the other is the lack of informative experiences. In the first case, transitioners lacked knowledge of "what comes next," or "how to do it." In the second case, transitioners knew the process and procedure, but did not know where to start.
The second issue points to a cultural issue where engineers typically are trained to make as proof of concept versus design where it is an informative experience. An example of this comes in the form of ideation. Oftentimes when asked to ideate, engineers transitioning into design ideate a variety of mechanisms or themes. However ideas were typically limited to current technology trends and feasibility issues. On the other hand when designers ideate, they would be thinking visually, making and continue to think of "what can be" and conclude with "what should be." The minimum distinction between thinking and making for designers allowed them to make as an informative experience.

> *Maturana recognized that the old terminology carries within it a pre-understanding that is a trap for new understanding. (Winograd & Flores, 1986, p. 40)*

Findings

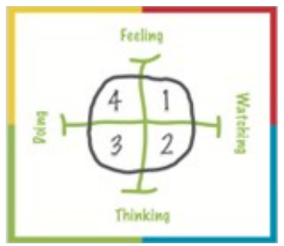
Since the making process is different from engineering to design many transitioners had "stuck" moments and were resistant to fully engaging in designerly ways of making; receiving feedback, showing unfinished work, approach to learning tools, iterating towards refinement, failing etc. Based on how transitioners dealt with such verbiage, I suggest redefinitions of design concepts in engineering terms.

A Redefinition of Common Terms Associated with Design

	why it can lead to a "stuck" moment	*redefined for an engineer*
Fail fast, fail early (Failure)	"Failure" has a severely negative connotation in engineering. It often points to a lack of knowledge and often suggests a lack of ability.	iteration is partial problem solving. Make to find out. Test hunches and assumptions to understand the nature of the problem and create appropriate solutions.
Feedback & Critique (Fear of Judgement)	In disciplines where critiques are not commonplace, showing unfinished work often elicits a fear of judgement.	understand where there is a gap between what you want to communicate and what is actually being communicated.
Iteration (Making in the face of uncertainty)	in thinking heavy disciplines there is a premium placed on efficiency and certainty. "I need to do more research" is a perfectly acceptable and a solution that is not the final form is often seen as a waste of time, effort, and resources.	the act of actively bridging the gap between what you want to communicate and what is actually being communicated.
Learning New Tools (Tools	learning tools can be a hinderance to ideas. The endless amount of learning involved in mastering a tool, only to realize there's a new tool can be daunting.	imagine tools as mediums that have their own potential; instead of learning how to draw, learn to discover what a sketchbook can do. Learn to stretch tools to their limits and let your ideas be inspired by the ability of tools.

B. Learning Habits

We are a product of our environment and we learn based on how we are taught. However what happens when we are already conditioned to learn a certain way based on our previous education? A common misconception about learning is that we can "unlearn" behavior. Transition is not about unlearning but re-learning new ways of learning. I asked the quesiton "what is falling through the cracks of graduate school design education because of a student's prior training in engineering?" Based on literature, interviews, class room observations and personal experience, I investigated the teaching environment of design versus the learning environment of engineering. I categorized learning habits by the 4MAT system created by Bernice Brown, explained below, to draw upon educational insights.



Understanding the 4MAT system
The fundamental assumption of the 4MAT Model, that humans learn and develop through continuous, personal adaptations as they construct meaning in their lives, is derived. ("4MAT Web", 2014)

Type 1 - wants to know WHY
The imaginative type likes being absorbed into feelings and spending time reflecting, seeking personal meaning and involvement. Type 1 is focused on personal values for them selves and others and making connections. Favorite question: Why?

Type 2 - wants to know WHAT
The analytic type likes listening to and thinking about information, seeking facts, thinking through ideas, formulating ideas - and learning what the experts think. Favorite question: What?

Type 3 - wants to know HOW
The common sense type likes thinking and doing. Type 3 are most happy experimenting, building and creating usability. They like tinkering and applying useful ideas. Favorite question: How?

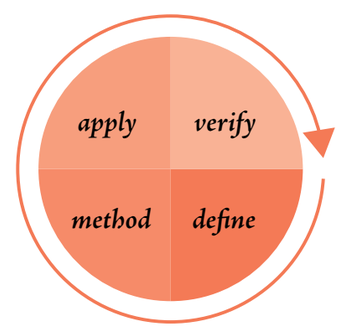
Type 4 - wants to find out WHAT IF
The dynamic type likes doing and feeling. They are constantly seeking hidden possibilities and exploring ideas to create original adaptations, they learn by trial and error and self-discovery. Favorite question: What if?

Research
Interviews typically focused on professors and understanding their teaching goals and methods. This was followed up with classroom visits where student engagement and learning habits were observed.

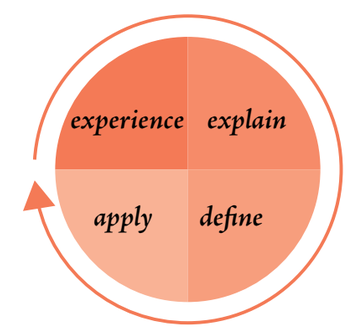
Interviews:	7 professors from design (interaction, communication, industrial, furniture etc)
	2 professors from engineering (mechanical engineering, computer science)
Classroom visits:	Processing for the Arts (Carnegie Mellon University)
	Notational Sketching (Carnegie Mellon University)
	C++ for engineers (University of Pittsburgh)

Engineering	*Categories*	*Design*
Pre-determined by next class level	*Teaching Goals*	Panned out by professor
Rigid schedule	*Schedule*	Flexible based on student response
Lectures were a one way street	*Methods of Teaching*	Lectures were like a dialogue
Lectures supplemented with lab	*Instruction*	Studio setting feedback, discussion
Students wait to be given answers	*Student Response*	Students ask questions freely
Tests and research papers	*Measure of Learning*	Projects and papers

Theory preceded practice.	*Teaching Behavior*	Practice preceded theory.
Students need to understand the value of an action before wholeheartedly engaging.	*Learning Behavior*	There was an emphasis on trying something before understanding or being told its value.
Knowledge stacks, therefore in order to apply learning you must know it from the ground up.	*Knowledge*	Students were encouraged to explore, examine, and to self-define concepts as they built a design lexicon.
Type 2 Learner Wants to know "What"	*Learning Habits*	Type 4 Learner Wants to know "What if"



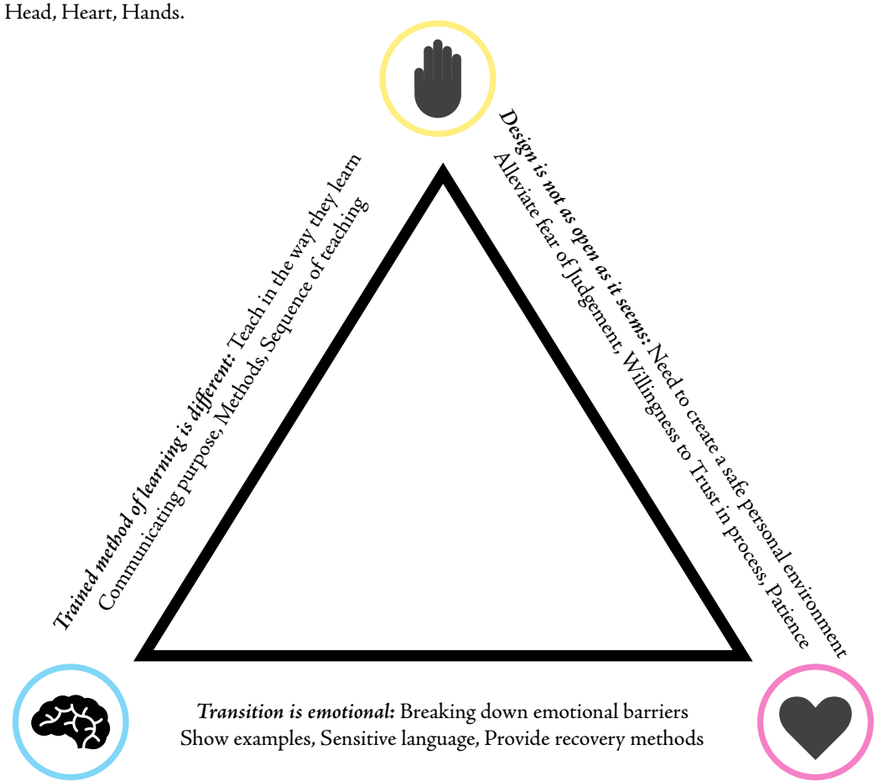
Learning Process



C. Situating Barriers

"We are too immersed in our own understandings about "what is" to be aware of the assumptions of the rationalistic orientation of our prior training in science and technology (that we carry)."
(Winograd & Flores, 1986, p. 40)

In order to navigate through the uncertainty between engineering and design, one must first acknowledge that the certainty found in engineering cannot be achieved in design. In short, there is a different type of "figuring out" that is just as valuable in its own right. The problem is typically we do not know what we do not know. However being able to take a step back and gain an awareness of self, can we see the possibilities and limitations of our own way of thinking and only then can we become open to truly appreciate different models of existence. At the end of the day, it is more of an appreciation for the value of a completely different cultural perspective; one based on experience rather than research; informed by intuition rather than scientific proof. Having articulated the natural barriers underlined by a pre-understanding in engineering values, we can place them into the metric of transition determined in the onset of this project: Head, Heart, Hands.



New Ways of /// Designing /// 3

After having articulated natural barriers to transition based on an engineer's pre-understandings, the uncertainty becomes very real. It also gives us a glimpse as to why it is so difficult to freely transition between cultures. New ways of designing speaks to finding new ways of living in the face of constant uncertainties.

Designerly ways of making is an approach to making that brings clarity in times of uncertainty by subjectively informing decisions. It is a catalyst to knowing in designerly ways that helps raise self awareness and work through personal predispositions.

Designerly ways of making is not a method, but a fluid approach to making that brings clarity, confidence, and builds sensibilities over time.

Research in this section included:

A. understanding the value of making
B. examples of embodied making
C. situating makings
D. framework of understanding
E. design opportunities

A. Understanding The Value Of Making

Uncertainty: Transitioning Mindsets

Transitioning into design represents dealing with a diametric perspective that is not covered in engineering. New ways of designing speak to new ways of living and new ways of being, in opposition to simply trying to learn a new behavior. When it comes to truly transitioning, it requires a transition of worldviews. In her keynote speech at the AIGA conference in 2010, Terry Irwin, head of the School of Design at Carnegie Mellon University defined worldview as "the shared idea in the minds of society, the big unstated assumptions that constitutes a society's paradigm or deepest set of beliefs about who they are and how the world works." A cultural shock occurs when the belief based assumptions differ between individual and environment. It is those differences that make it difficult to make clear cut decisions based on a transitioning set of values. This is the source of uncertainty and the great difficulty and emotional distress that is observed are merely symptoms.

Limits of thinking in decision making

Where Design Thinking exhausts its limits is when it must make visions into realities. Without the deliberate act of situating knowledge and needs through the process of making, an idea and intent alone oftentimes lack feasibility. Feasibility and actual impact are both more realizable when designs can make a small but deep cut compared to a broad but shallow cut into a person's self awareness. When it cuts deep, it has a higher chance of connecting to the core of a person's being. Designed interactions lead an audience to question their own beliefs and become open to trying different ways of being.

When speaking about stuck moments in a decision making process, without the ability to project the alternative outcomes there is no certainty in a decision. On the other hand, the act of making helps realize and situates alternate outcomes in a way that decision making becomes a conscious choice.

New ways of designing

Designerly ways of making as a new way to design represents an approach to uncertainty that helps designers navigate through the mental and emotional uncertainty by gaining clarity through the act of making. As a making culture, designers have the ability to both understand uncertainty through decoding what messages objects communicate, but also create new objects which embody new messages.

In his book titled "Making is Connecting" David Gauntlet states, "through making things and sharing them in the world, we increase our engagement and connection with our social and physical environments." It is the idea that when we come up against something unfamiliar, or foreign it causes uncertainty. However he says that "going through the thoughtful, physical process of making something, an individual is given the opportunity to reflect, and to make their thoughts, feelings, or experiences manifest and tangible" (Guantlett, 2011, p. 33)can help lead to clarity. Donald Schon suggests that "the exploration is almost conversational between the external representation and the designer's internal cognitive model of the problem-and-solution: the designer shapes the situation, in accordance with his initial appreciation of it; the situation "talks back", and he response to the back-talk." (Schon, 1983, p. 22) In such cases, the end goal is to gain clarity and understand priority through "a process of discovery... through the process of making." Through examples, he conveys that in general, 'invention comes before theory'; the world of doing and making' is usually ahead of the world of understanding" and because what designers know about their own problem solving processes remains largely tacit knowledge, it is important to look and appreciate the knowledge carried in the objects of our material culture. If in fact making is about communicating, then an artifact, an image, or physical object is the highest fidelity and also the most direct form of communication.

Mastery and making as thinking

Kavakli, and Gero compared the cognitive performances of a novice and an expert architects. "Over a similar time period, they were able to measure expert's protocol showing 2916 actions, divided into 348 segments of simultaneous cognitive actions, whilst the novice's showed 1027 actions, with 122 segments of simultaneous cognitive actions. The cognitive processes were much faster, efficient, and well organized." Kavakli et. al, 2002, p. 25)

B. Embodied Making

As a transitioner, I purposefully sought out experiences in making to both learn through doing, but also to test the theories of the connection between making and designerly ways of knowing. Going back to the notion of transition and the role of choice, (covered in motivations) I wanted to align my thoughts and actions including a willingness choose electives based on their engagement with making.

Why Making?

Making engages the senses. It gives rise to rich experiences and dialogue rather than simply speaking over ideas. When evaluating ideas based on thought alone, people question the rationality behind the idea. When an idea takes physical form, an artifact elicits feedback and affords "feeling."

Why Make?

When engaged with embodied making, a process of making in order to gain insight, the act of externalizing your thoughts builds clarity and associations that lead to novel connections. This helps articulate intent to yourself as well as communicate with others. In a team or group situation, this helps build rapport, understandings, and consensus in a team environment.

Why Now?

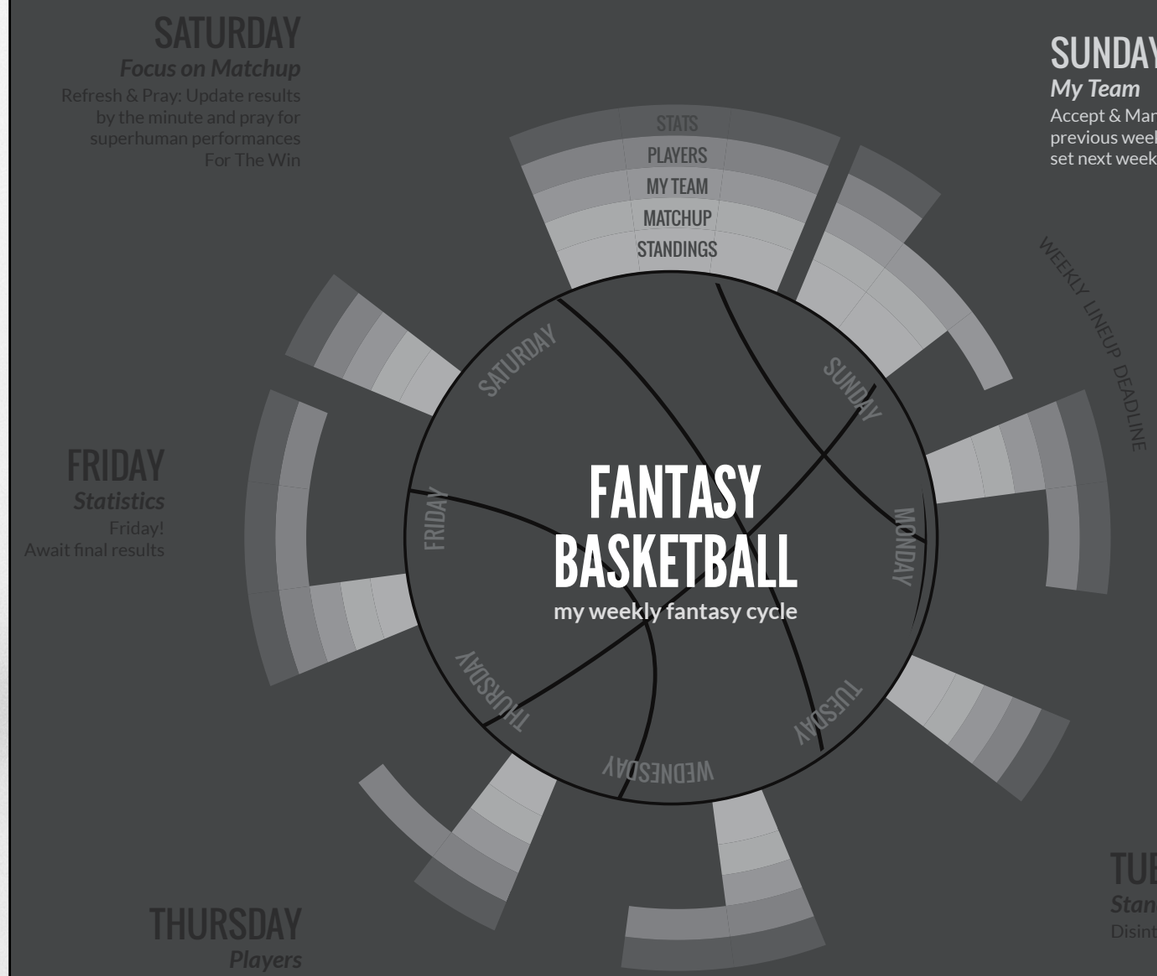
Only by moving from procedure to process and truly embracing design making in their design process can transitioners gain the agility needed to cope with the uncertainty of non-causal problems and other wicked problems of the future.

Audio Visualizer ///

Glass Blowing ///

Experimental Form ///

RANK	RECORD	WINNING	TRAILING	SEASON
3/12	83-66-4	55.6%	6.5	WEEK 18/24



Mapping & Diagramming ///

C. Situating Making

Based on the activities I engaged in, I was able to situate findings based on my own reflection in action and reflection on action. The most notable experiences were the initial ones where social permission allowed me to give myself permission to engage. It was truly the journey and not the destination where the most learning occurred.

Activity Name	Bike Buildoff	Audio Visualizer	Glassblowing Class	Experimental Form	Mapping & Diagramming
Context of Reflection	Despite having no bike building experience,I did not know the difference between a front tire and a rear tire. This did not prevent me from spending a full hour sweating and covered in grease looking for a "good" used tire. I never found one.	Building a sound visualizer first required building a shopping list of items. Wanting to get it right, I spent hours createing the most efficient shopping list. Finally, a professor stepped in and said "Don't worry! Just buy every~thing you might need."	This was the first class I ever took as an adult that had completely no "use." Working with glass while focusing on creating a cup often resulted in mistakes. When I switched to focusing on the process, every step was enjoyable and resulted in finished pieces.	Working with wood was unlike working on a screen. It had natural grains built into it but also no "undo" function. Each decision was a risk but also final. Accepting the limitations of the medium led to allowing myself be guided by it.	For class, I visualized my fantasy sports habits. During critiques, realizing there was a gap between what I was trying to communicate and what was being communicated made me accept rather than react to criticism.
Learning environment	A safe environment for discovery	A safe enviroment for success	Judged on process not outcome	Encouraged to explore form and function	Begin to explore form, function, and communication
Permission	by mentor, friend, project, class	by mentor, friend, project, class	Permission to fail - no grade	gain the ability to iterate	critiques and feedback
Activity Focus	Procedure based personal project. No previous expertise.	Something familiar but new	Something completely foreign that is process based	make something that has attributes but no defined outcome	work with a discrete medium and tool
Reflection-in-Action	I realized I did not know what "good" even meant. I realized had a fear of not appearing to be an expert and knowledgeable.	"You are expected to fail." So prepare to succeed by accepting failure as process.	The best way to come about a desired outcome is by immersing yourself in the process.	Working within the medium, a natural form emerged rather than be artificially designed.	Performed iteration upon iteration until the professor said "you made it work!"
Reflection-on-Action	"I don't know!"	"Permission to fail."	"Process over outcome."	"Content informs form, form informs content."	"Making to communicate"

D. Framework of Understanding

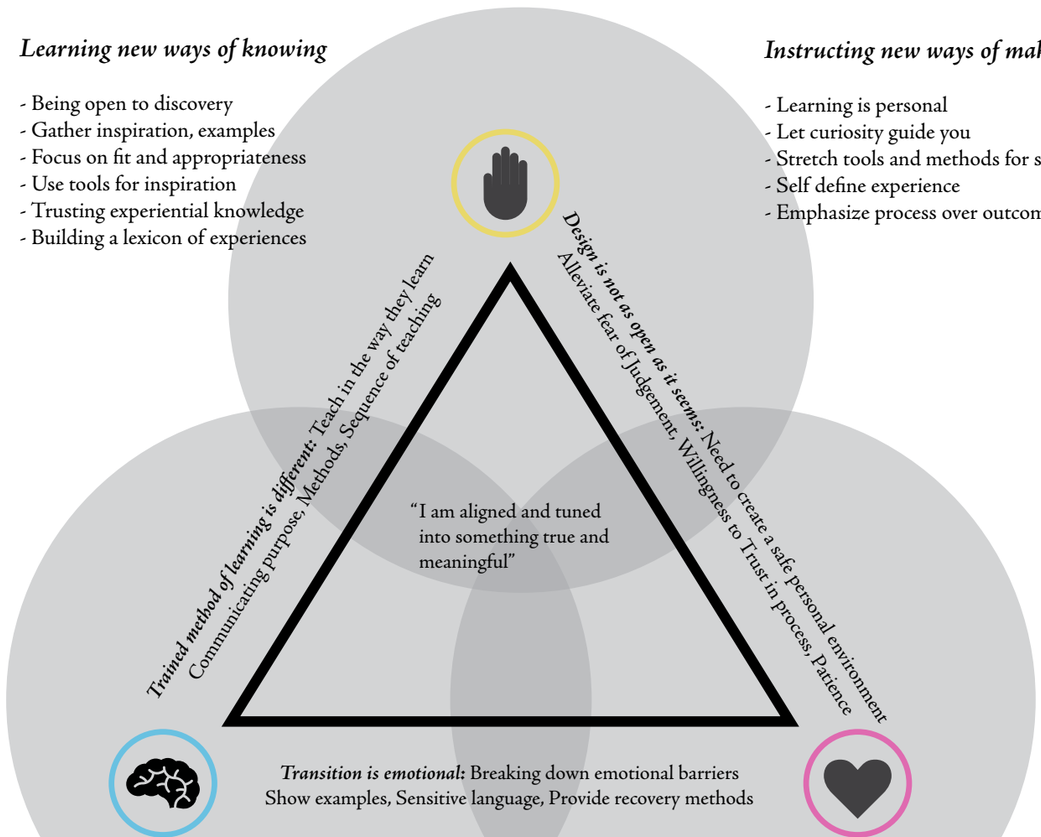
Having articulated mental and emotional barriers, I could now identify opportunities for design. this section allows me to place the needs in a sequence that helps make even barriers actionable.

Learning new ways of knowing

- Being open to discovery
- Gather inspiration, examples
- Focus on fit and appropriateness
- Use tools for inspiration
- Trusting experiential knowledge
- Building a lexicon of experiences

Instructing new ways of making

- Learning is personal
- Let curiosity guide you
- Stretch tools and methods for self discovery
- Self define experience
- Emphasize process over outcome



Creating a safe environment

- Physically safe environment
- Emotionally non judgemental
- Little to no repercussions to failure
- Permission to take risks and fail
- Novice mindset
- Letting go of perks of being an expert
- Commitment to making

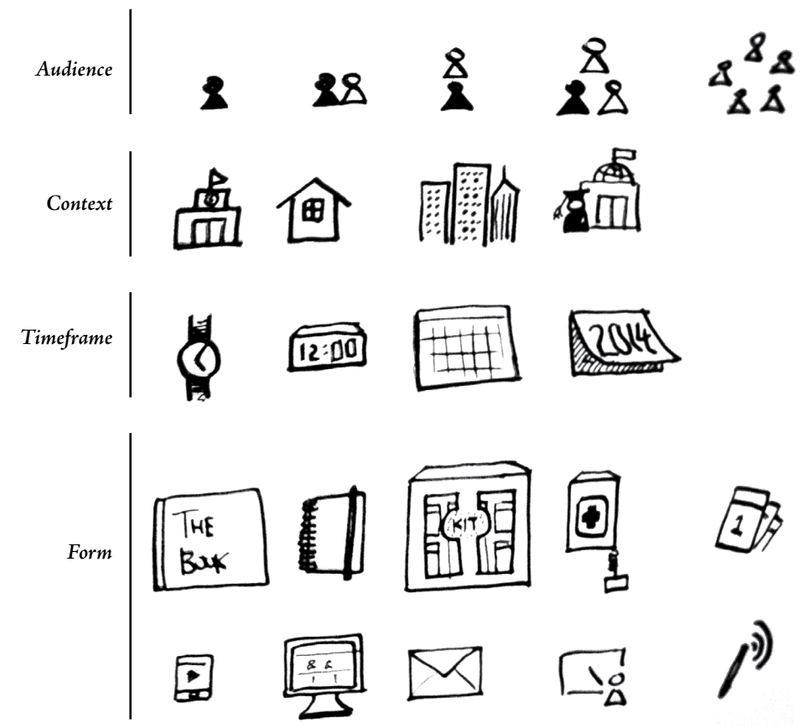
E. Design Opportunities

1. Learning environment: Create a non-judgemental environment for making
   embody attitudes & develop a personal process of making

2. Teaching: Instruct in the ways engineers process information
   modeling behavior through writing, workshop, curricula, apprenticeship

3. Communication: Combat stigmas & give relevant examples
   communicating the value of making as thinking tool

Breakdown of Design Variables



Once the variables of for whom (audience), accessed where (context), time of engagement (timeframe) are determined, form and content research should begin. Considering all factors what is the relevant form that informs the content and content that informs the form?

Posture /// & Mindset /// 4

As an example of a design intervention, I looked to create a primer experience that was focused on helping individuals see and interact with small everyday details.

The purpose of a design intervention was never to create a seamless transition, but rather to help a transitioner persist on their journey of transition. It should provide a safe environment for exploration, be mindful of stigmas and verbiage, and sensitive to the transitioners' state of mind.

In designing activities to encourage designerly ways of making, the focus was to treat making as an approach of seeing, making, and articulating that was informative and reflective in nature.

This section included:

A. utilizing the framework
B. an example of design implementation

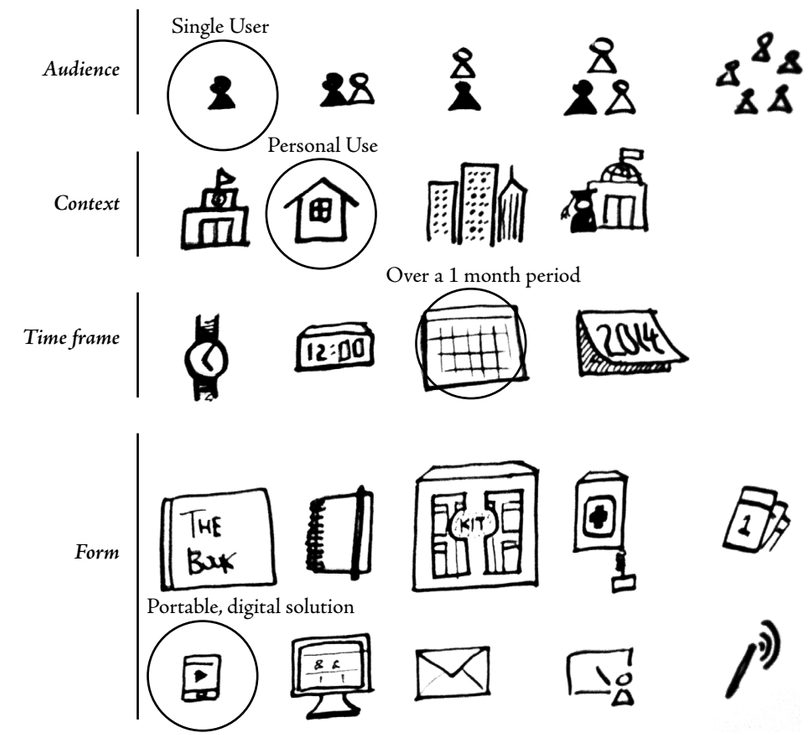
A. Utilizing the Framework

Having done the research there were many opportunity areas that jumped out. First there was working in the barriers themselves, communication pieces, building mentorship guilds and programs. However there needed to be a push for feasibility in transition. In that regard, time was a key limiting factor. Given the fact that a transition may take months or years to occur, it was not likely that a single design intervention would be able to accommodate the entire length of transition. I decided to focus on the initial engagement with making as a primer experience to making as an approach.

Solution Framework

1 Grant permission to engage, try, fail with no judgement
2 Activities must be designed where self is the audience
3 Must create a safe environment where participants are willing to make small bets
4 Participants must engage with process over outcome
5 Solution must be able to track growth over time

Choosing design variables



Content Considerations

1 Affordances of different forms (Physical vs Digital)
2 Structure of engagement
3 Level of engagement
4 Appropriate content for form
5 Implementation considerations (Feasibility)

B. An Example of Framework Implementation

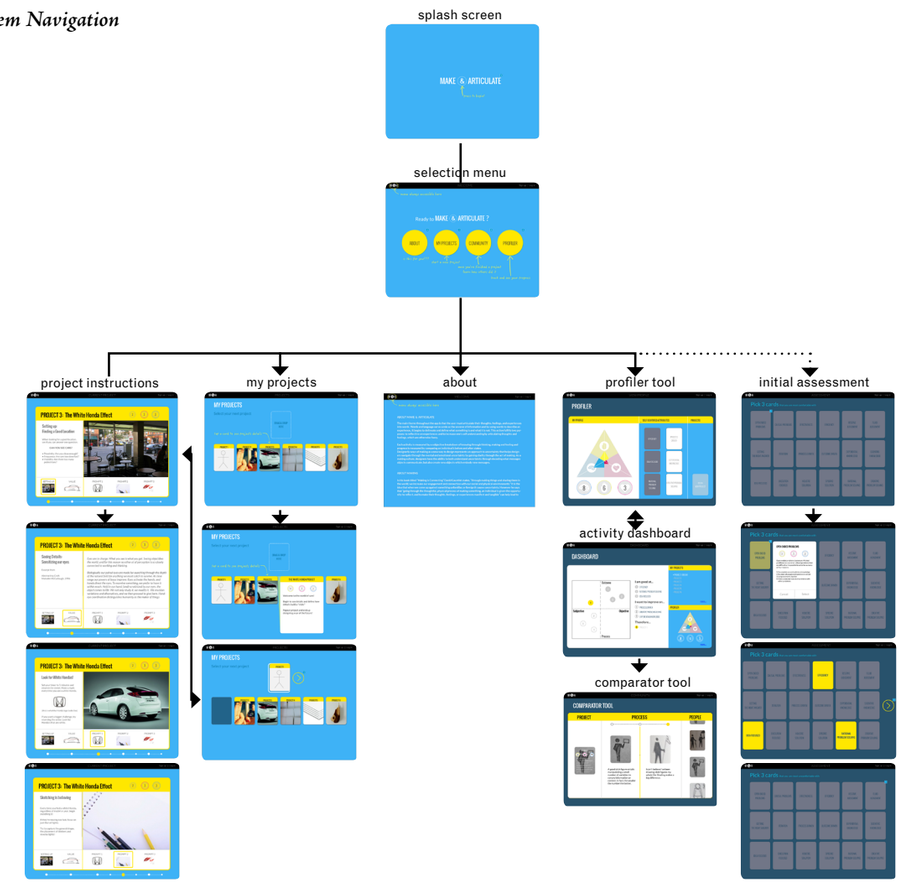
Make & Articulate is an iPad productivity tool that is aimed for the early stages of a transition. It helps build an engagement with making as an informative experience by providing a safe environment to engage with making as a process. It subsequently helps them experience small victories in the face of uncertainty.

The main theme throughout the app is that the user must articulate their thoughts, feelings, and experiences into words. Words and language serve a role as the severer of information and by using words to describe an experience, it begins to delineate and define what something is and what it is not. This action fulfills two purposes: to reflective on experiences and to increase one's self understanding by articulating thoughts and feelings, which are otherwise fuzzy.

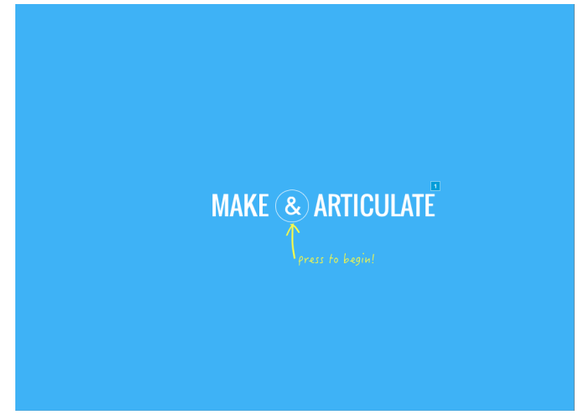
Unlike method cards and design workshops, it is not outcome driven, meaning it will not teach methods nor be a problem solving tool. Rather, it helps prime individuals towards building a mindful and reflective practice through making that give them the agility to deal with uncertainty in their transitions & future.

Each activity is measured by a subjective breakdown of knowing through thinking, making and feeling and progress is measured by comparing an individual's before and after states.

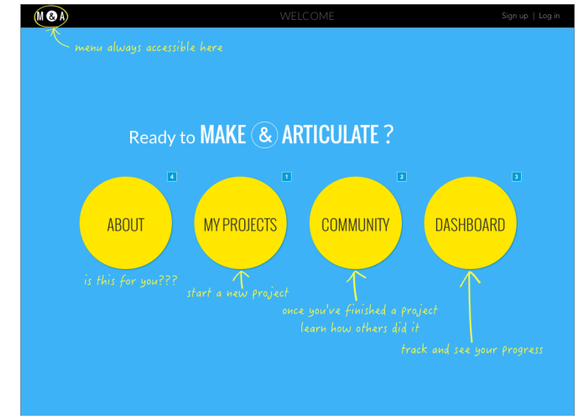
System Navigation



Opening Screen

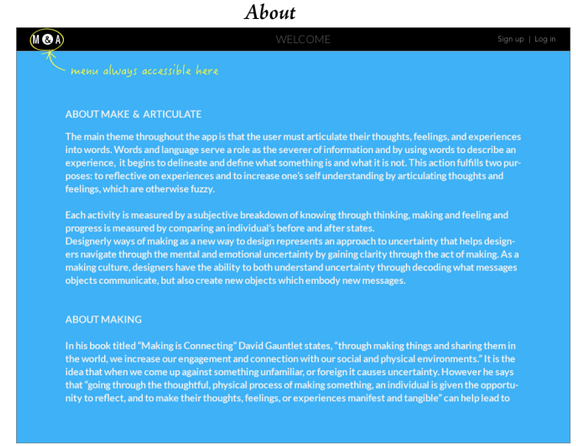


Selection Menu



About
Includes a brief introduction of the app and value of making
My Projects
Review past projects and select new ones
Community
Learn and be inspired from others' work in the community
Dashboard
Track and visualize your growth and progress

About



The About page contains literature on "the value of designerly ways of making." The inclusion of the about section reflects the principle of communicating the value of an activity to help an engineer better engage with it.

Initial Assessment

Initial Assessment

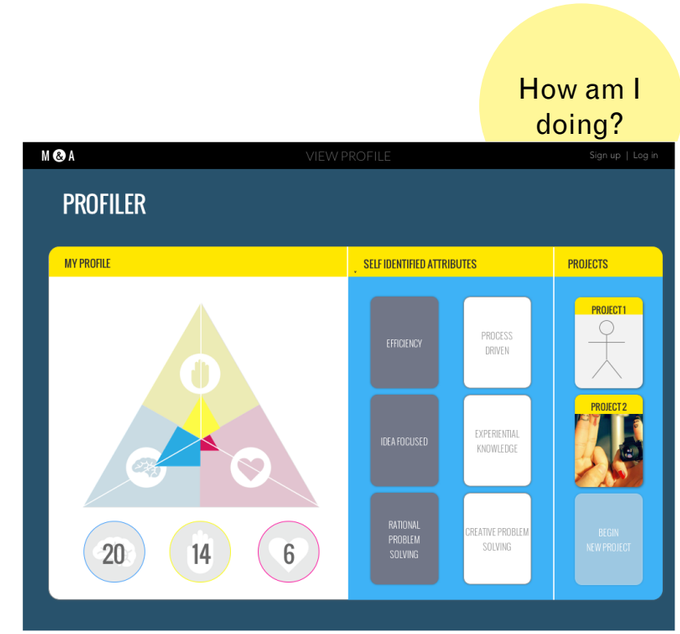
The user starts with a self assessment. Since transition is personal and subjective, there is a strong onus on the user to be articulate. This begins that process. The Initial Assessment page pops up only once and it asks two questions for which the user must choose 3 words that best represent them. The two questions are "What are you comfortable with?" and "What are you Uncomfortable with?" Each word is attached to a card, which on the back has a definition of the word and how it breaks down into hands, heart, and head. This information is fed into the profiler tool and used to visualize their initial "shape."

Profiler

In Make & Articulate, growth is seen and felt rather than measured. Using the Profiler tool, the user can "see" their progress as they grow in the metric of head, hands, and heart or thinking, making, feeling.

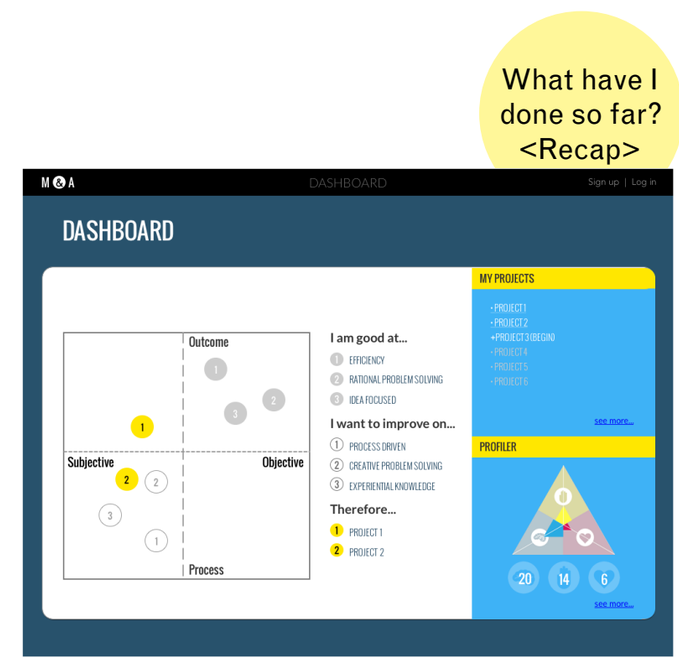
The Profiler tool is initialized using information pulled from a user's initial assessment which is shown as a reminder. The shape of the profiler tool grows as the user partakes in different projects as each project is broken down for the value it adds to head, hands, and heart.

On projects column, users can view their past projects and jump to the My Projects page to begin a new project.



Dashboard

In order to make the system more transparent, the dashboard offers a visual breakdown of individual projects. This allows users to see what they have done, in terms of activities, but also anticipate the benefit of future activities. This graph is broken down from Subjective to Objective, Outcome to Process.



My Projects

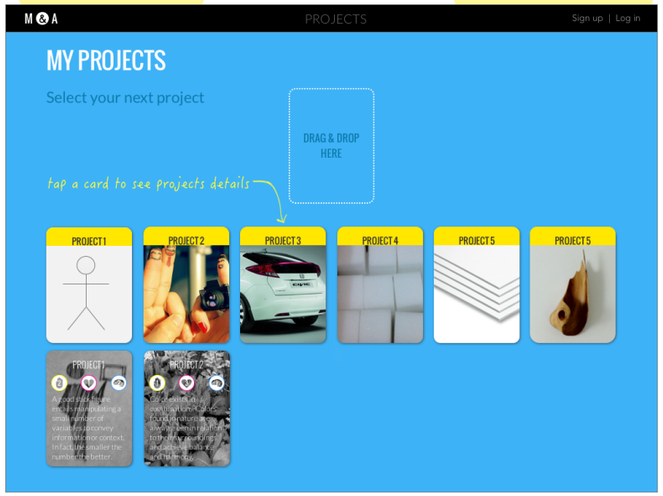
The My Projects section is made up of 3 elements. First all there is the ability to add a new project. Users simply drag and drop the next project they wish to partake in. This goes in line with the notion of engagement as "choice & commitment"

Secondly, this app consists of 6 projects in total. All 6 project activities are presented as cards. With a tap, users can preview the activity and its breakdown, much like the initial assessment cards.

The last section shows up below the row of projects as black and white cards. These are finished projects. They show a breakdown of hands heart head and also the user's final reflection as they were finishing the project.

Which projects have I done?

What should I work on next?

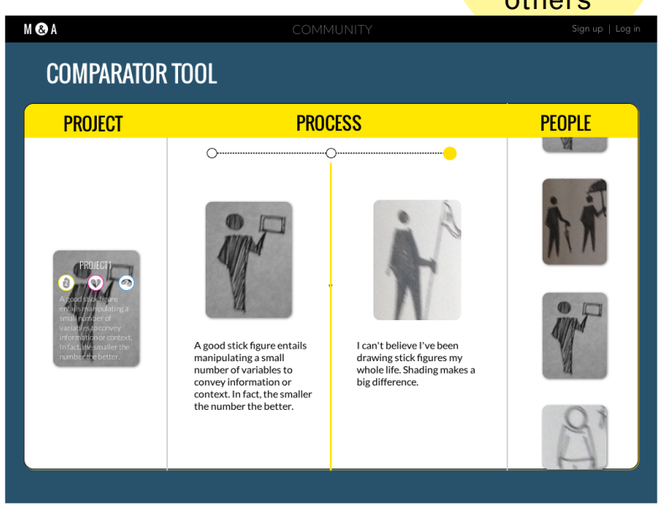


Comparator Tool

The comparator tool allows users to browse and compare what others have done with the same prompts. Only projects the user has completed can be viewed and compared with others'. This is in order to keep the user experience to be based on personal discovery.

The comparator tool is called that because you can compare different stages, so processes. By comparing your process another, users can see how ideas can evolve in different ways.

Compare your project evolution to others'



Project details

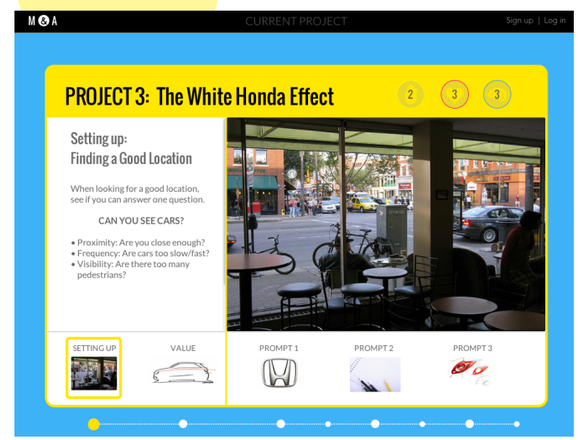
There are 6 projects in total whose content fall into this framework.

Content Framework

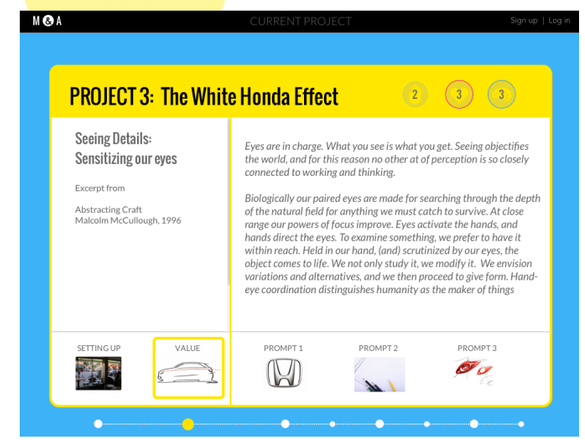
1 Difficulty - Scaffolding of activities
2 Tools - Familiar to unfamiliar, general to particular
3 Instruction sequence - Scaling up in complexity
4 Instruction language - Begin with value proposition
5 Reflection - Articulation of intellectual and emotional challenges

Project Title	Activities (Attributes)	Value Of Activity
1 No More Stick Figures	1 Draw (Symbolic Representation)	1 Explore With Making As Visual Recording
2 Presenting The World In Color	2 Photo (See)	2 Begin To See In Details
3 The White Honda Effect	**3 Honda (Decode)**	**3 Explore With Making As Visual Exploring**
4 Foam Your Hand	4 Foam (Subtractive 3D Making)	4 Explore Intent
5 Tools As Inspiration	5 Foam Core (Additive Modeling)	5 Appreciate Materiality
6 Navigate Materials	6 Wood (Tools And Material)	6 Be Inspired By Tools

What do I need?



Why should I do this?

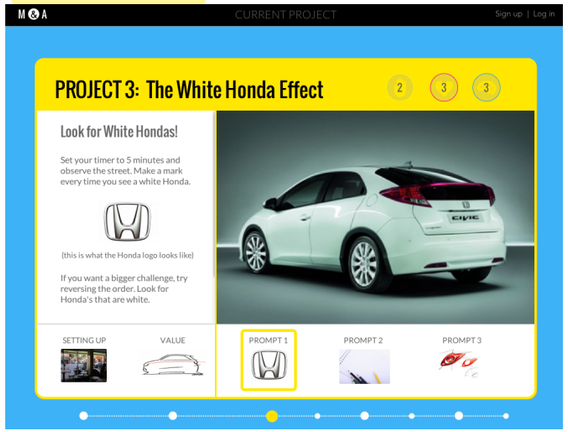


Project Instructions 1, 2 : Creating a safe environment and Communicating value

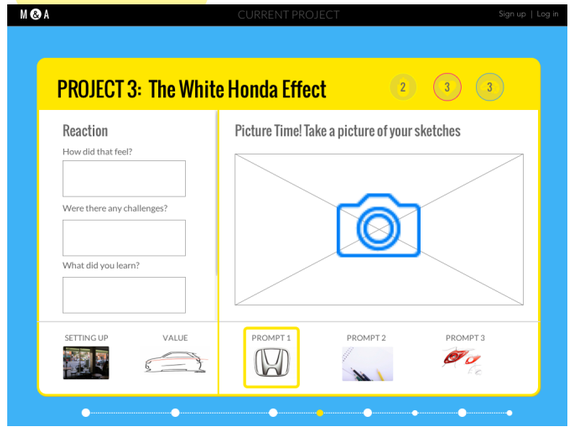
The first two stages in each project instruction page are meant to set the tone. The first prompt tells the user what to look for in setting up a safe environment primed for success, aka does it have all the necessary elements to complete the project. In this example of the "White Honda Effect" the details help users identify an optimal space for viewing passing cars.

The second instruction communicates the value of the project, what the user will gain from partaking in the activity. In this case, users would be asked to read an excerpt from Malcolm McCullough's "Abstracting craft" regarding the importance of eyes. Using credible sources helps keep an objective tone to the communication of information and value of the activity .

What do I do?



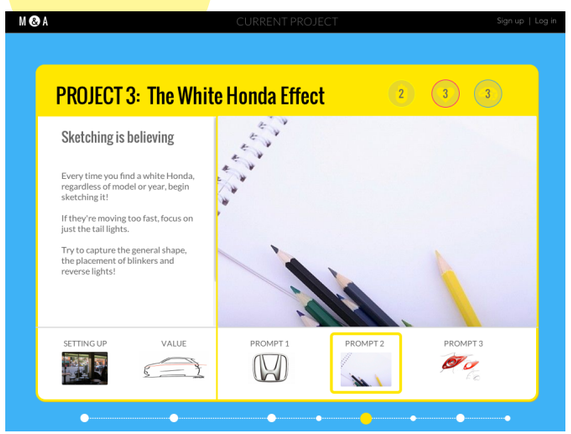
What did I learn?



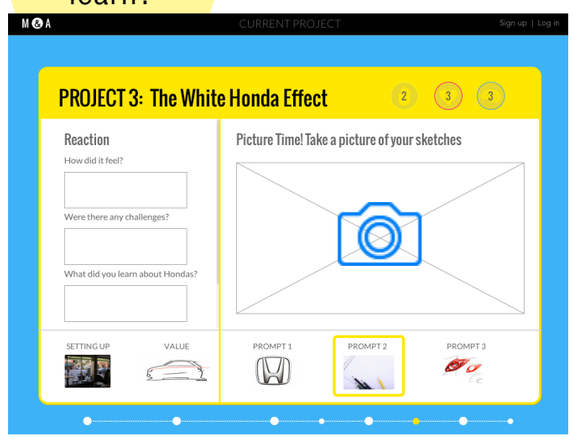
Project Instructions

The instructions of the project start here. With the White Honda Project, users are asked to be on the lookout for white Hondas. This primes them in looking for a particular detail, white, and pay attention to the stylings of Hondas. Users are asked to sit and observe, begin to train their eyes. In this example, the users are asked to take pictures or sketch Hondas. Afterwards they are asked to articulate how they felt, any difficulties they encountered, and what they learned from the experience.

What do I do?

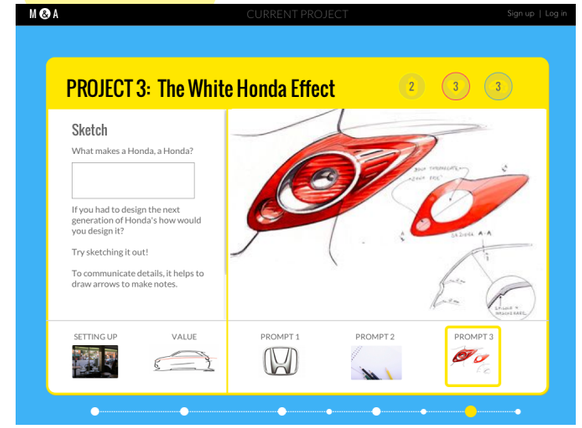


What did I learn?



In this stage, there is a translation from seeing to now making. The user is now asked to use their hands to start sketching cars. This activity is based on sketching as recording and translating what we see into what we make. In this example, users are asked to draw taillights of a Honda and similarly afterwards users are asked to take a picture of their progress and articulate how they felt, any difficulties, and what they learned.

What do I do?



What did I learn?

In the last stage, users are asked to go from sketching as recording to sketching as exploration. They are given a short tutorial whether it be step by step instructions or a video, that inform users of different techniques they can use and be inspired by. In this example, users would be asked to design the next generation of Honda taillights. The tutorial would inform users of the use of red markers. This activity is based on recording details and translating what we see into what we make. Similarly afterwards users are asked to take a picture of their progress and articulate how they felt, any difficulties, and what they learned. This time from the entire project.

This activity is structured to train the eyes to see details, the mind to identify patterns, the hands the sketch for the purpose of recording and exploring and would add 2 hand points, 3 heart points, 3 head points. The reason the heart points are so high for this particular exercise is because it asks the users to begin to create and externalize their ideas.

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