# Virtual Design Improvisation

## Enhancing Computer-based Designing through Designer/Virtual Agent Interaction

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**Thank you**

Denise, for believing in me and never saying “good enough”
My cohort, for your incredible work, respect and kindness
My parents, for your continuous love and support
Emily, for your patience

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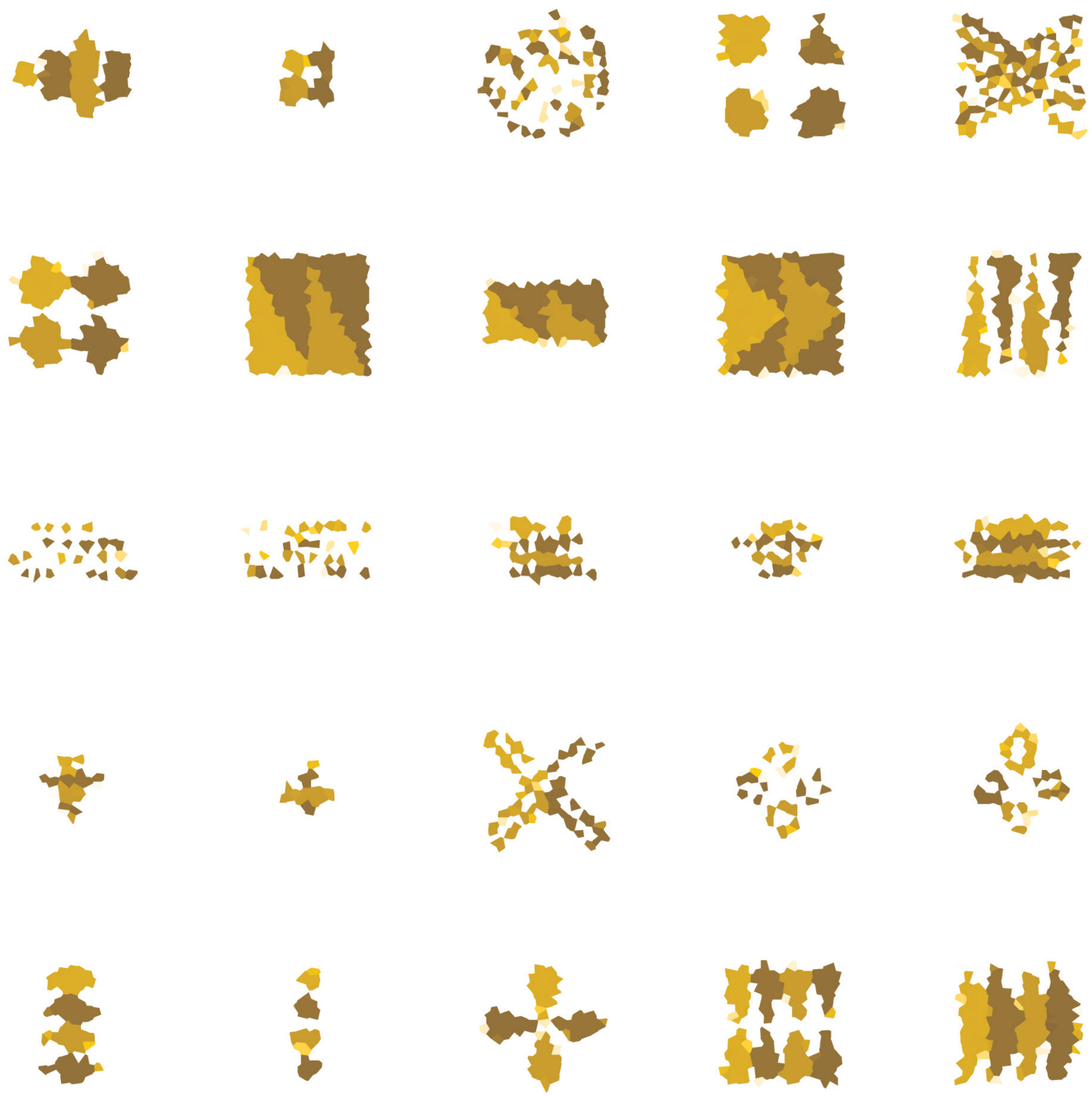


FORWARD

# WHY IMPROVISATION?



In 2016, when I first applied to be part of the Masters of Graphic Design program at NC State University, I met with the Director of Graduate Programs Denise Gonzales Crisp. We talked about program expectations and my personal goals in pursuing a graduate degree in graphic design. When the conversation turned to reviewing my work, I was nervous. I felt as though my design experience was relatively limited considering my age. I graduated from art school more than six years prior and since then had spent the majority of my time playing music in bands, working as a screen printer and taking occasional freelance illustration and graphic design jobs. During our conversation, to compensate for my limited design portfolio, I attempted to explain the connections between my illustrations and graphic design. Surprisingly, Denise offered a different perspective. “Your music is more akin to design than your illustration,” she said. I smiled and nodded in agreement. Of course, I had no idea what she was referring to. At the time, the question “why is design like music?” was almost as nonsensical to me as “why is a raven like a writing desk?”

Some clarification came from my first graduate studio course at NC State in the Fall of 2017 with Professor Gonzales Crisp. Students were asked to redefine the culture of graphic design through visual and conceptual artifacts, “things” that would demonstrate a shift in our own understanding of graphic design and propose alternative visions for design’s future. Throughout the semester I felt like a fish out of water. I kept asking myself: how am I supposed to participate in a conversation without experience or knowledge of the domain? It was an exercise in extended suspension of disbelief; not only did I feel ill-equipped to contribute but the class was largely impromptu, assignments being continuously added to and altered with little time to acclimate. At the end of the semester, I felt as though I had taken part in a long-form zen koan in which I was tested on my ability to "trust the process." While I may not have understood what I was doing in the moment, in time I have come to better understand and appreciate the teaching method and the implications it had on students' creative output, especially my own.

Professor Gonzales Crisp's research concerns the implementation of improvisational methods into design pedagogy (Abdullah & Gonzales Crisp, 2018; Abdullah & Gonzales Crisp, 2019). The Fall 2017 studio adopted an improvisational structure as a method for coping with uncertainty, encouraging cross-pollination of ideas between students to generate unforeseeable outcomes. Framing the studio experience as an improvisational performance revealed a deeper relationship between music and design. Although I do not have formal training or play in a traditional jazz ensemble, "jamming" is an integral part of my musical repertoire. This process, like jazz or improvisational theater, operates on shared understanding between participants. The "rules" are to accept experimentation and let a conceptual direction unfold intuitively, knowing that actively engaging in the process will yield an outcome or reveal a connection that otherwise would not have presented itself.

Why is improvisation pertinent to design practice? What is its value? Consider two qualities of an ideal designer. First, when faced with an ambiguous question, a "wicked" problem as Horst Rittel and Melvin Webber describe (1973), *the designer must be curious.* When designing, the designer must seek out a variety of paths and is rarely satisfied with the status quo or a predictable solution. We see this through designers' tendency to develop multiple possible solutions to a single prompt. Iterative behavior, of pushing past initial concepts, is a paramount competency for the seasoned designer. Designers do not iterate because early ideas are by nature bad or fail to satisfy brief requirements. Iteration is a practice based on the belief that an even better, more creative or surprising idea is just around the corner, on the other side of inevitability.

Second, in order to discover the relevancy of her design, *the designer must remain open.* Here, openness doesn't refer to being agreeable or open-minded per se. Rather it means releasing one's conceptual trajectory to the response from others. In the context of the Fall 2017 Studio, students' project directions would take abrupt turns following



group critiques as ideas would converge. At one point, students were forced to literally switch projects, taking on research questions that another student had generated based on their own interests. Donald Schön's *The Reflective Practitioner* (1983) refers to this kind of responsiveness as "situated cognition," describing design's reciprocal back-and-forth between intuition or "knowing-in-action" and contemplation or "reflection-in-action" when confronted with feedback from an outside source (Mccall, 2012). In the case of Schön, he is referring to the relationship between a professorand student, a dynamic that reflects a more traditional understanding of the academy and design education. In contrast, Professor Gonzales Crisp intentionally created a learning environment in the fall 2017 studio where students would be responsive and responsible to each other rather than to an "all-knowing" instructor.

In another way, attention and openness to others can be thought of as a kind of deep listening, trust of another, the process and the here and now, or, as Schön puts it, "seeing-as" (Schön, 1983). Coincidentally, the term "deep listening," coined by the late experimental electronic musician Pauline Oliveros, is tied to improvisational methodology and ambient music. Oliveros talks about respecting what comes back to you (TEDxIndianapolis, 2015), while Schön marks the shift between knowing and reflecting as the moment when the "situation talks back" (Schön, 1983, p. 131). Openness means listening, reflecting and respecting the encounter with something other than oneself or one's own proclivities.

Not surprisingly, the aforementioned qualities of an ideal designer, curiosity and openness, are the same qualities of an ideal improviser. A musical improviser is only worth her weight if she explores the sonic territory. In jazz improvisation, social structures dictate that soloists are given priority based on experience and proven ability to take creative leaps (Bastien & Hostager, 1988; Kamoche & Cunha, 2001). Those who do not venture out, or "play it safe," run the risk of losing their platform, or in the case of jazz, the opportunity to solo. By the same token, experimentation must be coupled with an awareness of the group. Those musicians who diverge must be able "to blend their competence with that of the other members" (Kamoche & Cunha, 2001, p.747). In many jazz environments, "centering" allows players to gradually expand musical variation once each member familiarizes themselves with the previously explored sonic terrain (Bastien & Hostager, 1988). "Centering" shares many similarities to designers' use of mental models, intersubjectivity, knowledge integration, and design "framing" (Cross, 2010; Hong, Lee & Lee, 2016; Kleinsmann, Deken, Dong & Lauche, 2012; Mcdonnell, 2018; Yuill & Rogers, 2012). Both curiosity and openness are necessary for the musical improviser and designer alike. Both the designer and improviser are social creators, requiring feedback from a variety of sources. Design and improvisation are both exploratory in that an obvious solution is rarely satisfactory. However, the two share differences as well as similarities. Improvisation, while providing procedures for conceptual exploration, is ultimately concerned with the pursuit of a musical idea for its own sake, for the sake of the art. Design, on the other hand, is fundamentally concerned with improving upon a problem or situation. Design entails creative exploration as a means to an end rather than a means to itself.

So why expand the role of improvisation in the design process? Design has plenty of its own ideation strategies, many of which have been tested and finely tuned to yield efficacious results. Some, like brainstorming, mashups or rapid prototyping, even resemble strategies from improvisation (Design Kit, n/d). Why attempt to alter a paradigm that works as is? The answer may concern the proportionate quality of ideas generated via different strategies.

Design ideation methods, especially those from human-centered design (HCD), seek to determine the appropriateness of an idea (Giacomin, 2014). However, few of these methods prioritize novelty over efficacy. Relying too heavily on existing user experience methods may lead designers to produce designs that "work" but are ultimately lacking in inspiration or, dare I say, magic. In his book *Design Thinking* (2011), Nigel Cross references renowned product designer Philippe Starck's "Juicy Salif" lemon squeezer, created for Alessi. Starck's solution is visually absurd but captivating, looking somewhat like a miniscule version of the alien crafts from H. G. Wells's *War of the Worlds*. While a more use-focused solution may have gotten the job done, it is Starck's strange take that provides both function, form and a unique kind of enchantment (as David Rose might refer to it). Designers are positioned to blend novelty and efficacy, less they

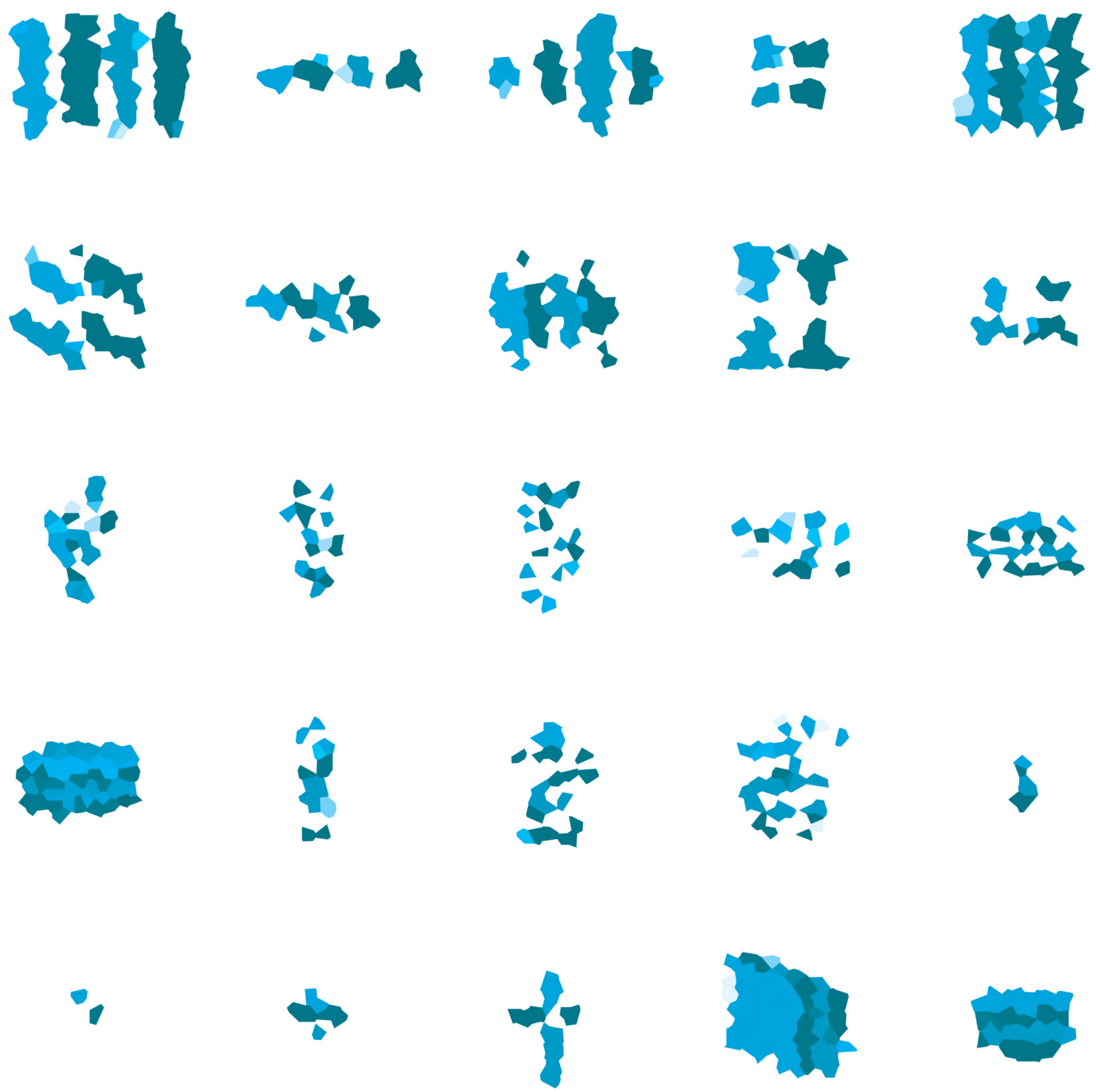


become aesthetically concerned versions of their developer and engineer counterparts. They pursue the problem and the solution concurrently (Cross, 2010; Cross, 2011). To a certain degree, designers must creatively "guess" in order to receive feedback, reflect and adjust accordingly. The end goal is to create something both surprising and appropriate. Established design ideation methods cover the latter; improvisation is engaged with the former (Healey, Leach & Bryan-Kinns, 2005).

Designers can incorporate improvisation to alter some of the common missteps associated with designerly behavior and thinking. Fixation, or the "blind adherence to a set of ideas or concepts limiting the output of conceptual design" (Jansson & Smith, 1991, p. 3), is something that all designers struggle with, especially novices (Cross, 2010). While Cross explains that fixation can be both negative and positive — such as being fixated on pursuing "relevant first principles" — the negative manifestation can become detrimental to developing surprising design outcomes. Negative design fixation can lead to a designer regurgitating tired clichés and overused tropes, mimicking what has worked before in place of surveilling the territory prior to committing to a conceptual or formal path. Conversely, improvisational thinking has been shown to increase creativity by encouraging positive evaluation of "deviant ideas" (Kleinmintz, Goldstein, Abecasis & Shamay-Tsoory, 2014), which may be key to overcoming negative design fixation. To be clear, relying on the status quo serves a purpose; for designers without large R&D budgets or time to experiment, resorting to established schemas serves the bottom line (think the use of rounded corners in contemporary user interface, or bold "Hi, my name is…" landing pages on young tech professionals' personal websites). However, for those who are seeking design potentialities to emerging situations or contexts, what worked before may not work for what has yet to come.

The trickiness with an improvisational approach to ideation is determining where or when such methods should or can be implemented. Staying curious and flexible is relatively feasible at the beginning stages of the design process. However, once designers have significantly developed an idea, fixation becomes that much more difficult to break (Tseng, Moss, Cagan & Kotovsky, 2008; Crilly, 2015). In both a cognitive and pragmatic sense, as a project develops, resources and hard work cement a concept in place (Crilly, 2015). Additionally, the kind of social network needed to effectively model an improvisational performance poses complications. Designers will often work in interdisciplinary teams or groups of different stakeholders where ideas can be traded back and forth. Yet, many designers have no choice but to work independently to generate initial concepts. Some researchers have proposed developing "design heuristics," rules of thumb or creative provocations to stimulate new modes of ideation after creative "exhaustion" has set in (Gray, Mckilligan, Daly, Seifert & Gonzales, 2017). Design heuristics may function well in a highly controlled situation where designers are aware of their own creative deficiencies when they arise. However, a system that could monitor a designer's progression and intervene at the appropriate time would be better equipped to handle a variety of contexts as it would allow the designer to work intuitively until her intuition expires.

Since my conversation with Professor Gonzales Crisp in 2016, I have been preoccupied — fixated you might say — with solving the riddle: why is music like design? Despite my fascination, the reality may be that the two, in fact, are not related. However, there are connections to be made, notably the connection between musical improvisation and design process. Improvisation relates to design through mutual value of curiosity and openness. While only a handful of researchers have studied this (Kleinmintz et al., 2014; Sowden, Clements, Redlich & Lewis, 2015), improvisational competence can enhance divergent thinking and may be able to compensate for common difficulties in the design process such as negative fixation, attachment to early concepts and creative stagnation. Identifying effective opportunities to introduce these methods is essential to expanding the cross-application of improvisation in design.



DEFINING THE PROBLEM

## ABSTRACT



Building on improvisational design pedagogy currently taught at the College of Design at North Carolina State University, this research investigates how a responsive software interface might introduce "just-in-time" messages, creative prompts and exploratory exercises to upper-level design students to enhance their computer-mediated workflow during a multi-week, research-based design project. The proposed interface seeks to enrich a student's design process by intervening during moments of creative stagnation and design fixation. Computer-based design tools such as Adobe Illustrator or InDesign, while enabling efficient production and visual complexity, may stifle a student designer's ability to generate a diversity of ideas and exacerbate the potential for hyperfocusing along one conceptual pathway. An opportunity exists for embedding a responsive interface in a student's software ecosystem that challenges them during computer-based making. The system borrows creative strategy from musical improvisation, a process of thinking and acting on your feet in response to new and shifting phenomena, often yielding chance results when faced with sudden provocation. Improvisational competence can augment divergent thinking and may be able to compensate for common difficulties in the design process such as fixation and attachment to early concepts. In order to encourage the student's improvisational proficiency, the responsive software would exhibit interactive behaviors based on four key elements of musical improvisation: (1) timing, (2) adaptation, (3) association, and (4) articulation. The software's behavior would be tailored to the individual student, their working habits, and stage of development within an upper-level undergraduate Graphic Design course taught at the College of Design at North Carolina State University.

In a pleasant, animated video short, complete with upbeat ukulele strumming and carefree background whistles, IDEO's Design Kit website breaks down a condensed version of the Human-Centered Design (HCD) process. "Human-Centered Design is a creative approach to problem solving," the narrator reports, "it's a process that consists of three phases: inspiration, ideation, and implementation" (Design Kit, n/d). Elsewhere on the site, categories are conveniently color-coded, dissected into individual methods to apply within each phase. One thing is clear from IDEO's documentation: HCD encompasses a vast array of tools, procedures, and methods for identifying a design problem, collecting relevant information, generating potential solutions, applying them to real-world contexts, and learning from their response.

IDEO is just one source of many that has concrete methods for problem solving. Nigel Cross's research looks into the individual cognition and behavior of designers, a taxonomy of expert and novice designer processes. Complementing IDEO's trifecta of inspiration, ideation, and implementation, Cross categorizes design process into problem formulation, solution generation and process strategy, each category containing sub-elements and procedures (Cross, 2010). While IDEO provides strategies to practice within each phase, Cross's work digs deeper into the cognitive processes and behaviors of expert designers. He identifies designers' habit of generating the solution and framing the problem concurrently (Cross, 2010, p. 74). This, as Cross notes, extends Rittel and Webber's (1973) assertion that designers deal with "wicked problems," problems that, unlike scientific inquiry, are not predicated on straightforward questions nor predetermined paths towards viable solutions (Cross, 2010, p. 7). It follows that HCD seeks to address wicked problems with repeatable strategies that can be followed not only by expert designers but by novices as well.

However, an element of HCD methodology that remains somewhat elusive is the generation of ideas that designers apply towards problem framing. As part of a taxonomy of design process, Cross identifies issues that explicitly relate to the generation of ideas. These issues include sketching, generation of alternatives and modal shifts as generally positive features of designerly behavior and cognition. Additionally, Cross notes



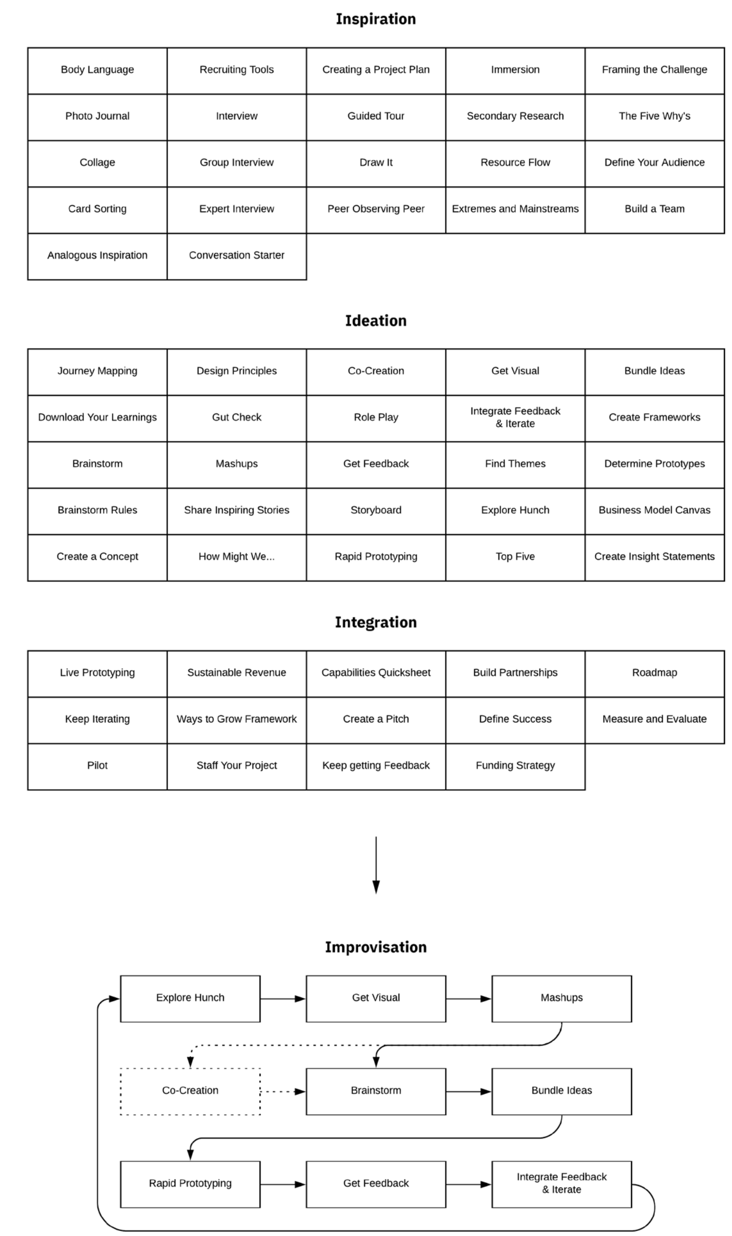



**fig. 1.2.1** IDEO's Methods for Human-Centered Design as related to improvisation

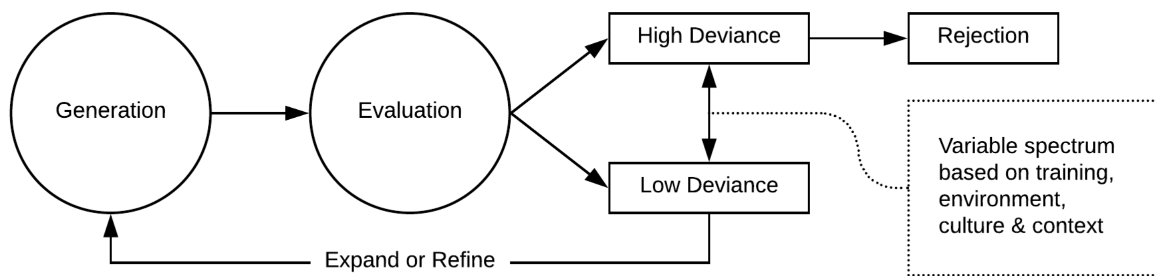



**fig. 1.2.2** "Twofold Model" of Creativity

design fixation and attachment to concepts as potential pitfalls for novice and expert designers alike (Cross, 2010). Design thinking methodologies like IDEO's attempt to target some of these issues by encouraging activities like rapid prototyping, visualizations, mash-ups and brainstorming. On their website, IDEO suggests brainstorming follow certain guidelines for maximizing output, including deferring judgement, quantity over quality and building off the ideas of others (http://www.designkit.org/, n/d). Interestingly, these guidelines are all part and parcel of another field: improvisation (fig. 1.2.1).

While HCD represents a soup-to-nuts approach to creative problem-solving, improvisation prioritizes the generation of ideas (Healey, Leach & Bryan-Kinns, 2005). As a broad term, improvisation can be described as the process of thinking and acting in the moment in response to new and shifting phenomenon, often times linked to chance results when faced with sudden provocation (Kamoche & Cunha, 2001). In this way, improvisation is an excellent model for coping with some of the issues that may arise during ideation. In a study conducted by researchers at the University of Haifa, Israel, musicians with improvisation training, musicians with traditional training and non-musicians were asked to perform a number of non-music-related tasks to determine their level of divergent thinking (Kleinmintz, Goldstein, Abecasis & Shamay-Tsoory, 2014). The study results showed that musicians with improvisation training scored higher overall in both fluency and originality of ideas than the other two participant groups. The researchers concluded that previous improvisation training allows subjects to evaluate generated ideas with lower deviance (inappropriateness), thus allowing them to produce a wider range and novelty of ideas.

Kleinmintz et al. base their research on a "Twofold Model" of creativity, a framework that identifies two modes: the generation of ideas and the evaluation of ideas (fig. 1.2.2). In this model, a combination of someone's prior training, their environment, culture and social context, or, as renowned psychologist Mihaly Csikszentmihalyi describes it, their domain and field (Borgo, 2005), influences the evaluative spectrum. Csikszentmihalyi and fellow creativity researcher Keith Sawyer have argued that creative emergence necessitates a marriage of generation and evaluation (Sawyer, 2000; Sawyer, 2008; Borgo, 2005). This is especially evident in jazz improvisation ensembles, where adaptation and execution of ideas occur almost simultaneously as creative process and product merge within the performance (Sawyer, 2000). The idea is compatible with Cross's identification of designers' concurrent formulation of problem and solution (Cross, 2010).

Improvisation adds a model for incorporating deviance and adaptation as integral components to stimulating novelty and moving an idea forward, which may be key to mitigating design fixation. The reciprocal back-and-forth that improvisation is built on entails that an individual must respond to changing phenomena, input from other participants, and resist the urge to be overly persistent or defensive when contributing ideas. Researchers have shown a relationship between improvisational competency and the ability to see opportunities in seemingly unrelated concepts (Kleinmintz et al., 2014), sometimes referred to as a designer's level of "opportunism" (Cross, 2010). If a designer wishes to mitigate their fixated behavior when designing, improvisation offers a robust toolset for doing so.

# PROBLEM STATEMENT



The Human-Centered Design (HCD) paradigm provides a wide-ranging framework for researching, ideating, prototyping and testing designs to improve their efficacy (Giacomin, 2014). IDEO, leading practitioners of HCD, have codified the framework, categorizing and detailing methods that any designer can ostensibly employ in their own practice (Design Kit, n/d). However, ideation as a creative mental process remains the least straightforward for young designers, as self-reported by undergraduate students across multiple studies (Pan, Kuo & Strobel, 2013; Chen, 2016). In addition to difficulty with ideation, novice designers can be susceptible to some of the adverse facets of designerly cognition, such as fixation and attachment to early concepts (Cross, 2010). Fixation refers to "a blind adherence to a set of ideas or concepts limiting the output of conceptual design" (Jansson & Smith, 1991, p. 3). Fixation can indicate attachment to design artifacts but can also refer to fixating on one line of creative reasoning or conceptual direction.

In contrast, improvisation as a creative approach prioritizes generating novel outcomes and moving an idea forward (Healey, Leach & Bryan-Kinns, 2005). Improvisation is not a new concept in the design field. Some of IDEO's current ideation methods resemble procedures from musical improvisation. Others propose redefining Design Thinking as a process framework prioritizing making, testing, learning from feedback, openness, and curiosity (Carlgren, Rauth & Elmquist, 2016), a framework that bears a striking resemblance to improvisational strategy (Miner, Bassof & Moorman, 2001). In addition, professors of the College of Design at North Carolina State University are currently implementing improvisation in the classroom, practicing collaborative making, modified critique methods and "play" as critical components of design pedagogy (Abdullah & Gonzales Crisp, 2018; Ham, 2013).

To extend the benefits of improvisational design education, improvisation could be embedded into design software. As is, the computer-mediated design tools students use to achieve formal results, while enabling efficient form making and visual complexity, may stifle their ability to generate a diversity of ideas and exacerbate the potential for hyperfocusing along one conceptual pathway (Pan et al., 2013; Robertson & Radcliffe, 2009). By improvising during computer-based ideation, students can enhance their creative process with tools that complement designerly cognition and behavior.

As an example, Adobe's Creative Suite allows for unparalleled precision and efficiency but stops short of addressing fixation and attachment to concepts, the negative issues Nigel Cross identifies in his research on designerly cognition (Cross, 2010). In my own experience, design software can be both inspiring and time-saving but can easily extend the temptation to perfect a limited set of ideas over developing a variety of solutions. Pan, Kuo & Strobel's study (2013) compares undergraduate design students' preference for physical tools (i.e. sketching) to computer-based tools in relation to their perceived difficulty at various stages of the design process. Overall, students in the study perceived concept generation to be the most difficult stage of the design process, commensurate with findings from other studies (Chen, 2016). However, those who engaged in paper-based note-taking and sketching rated lower in perceived difficulty during ideation. The findings are in line with similar studies and research that identify a relation between reification of ideas (i.e. making forms) and both ease of generation and variety of outcomes (Sawyer, 2013; Winger Sei-Wo Tseng, 2018; Youmans, 2011). Interestingly, more than half of participants in Pan, et al.'s study preferred to work with computer tools over physical ones, claiming that sketching was time-consuming and by forming their ideas using the computer in the first place, eliminated a step that otherwise would lengthen their design process (Pan et al., 2013). The researchers did not evaluate the design outcomes from the study but recorded self-assessments of student work. Those students using computer tools noted that they had a tendency to hyperfocus on the details of individual designs rather than developing multiple concepts.

There appears to be somewhat of a paradox here. While a majority of students reported that using the computer allowed them to quickly and easily apply complex variation to their ideas, improving their ability to visualize alternate results, doing so resulted in fewer overall outcomes compared to students who sketched their ideas by hand. Why actively choose to use a tool that makes the process more difficult or less productive? Robertson and Radcliffe's (2009) study of the effects of computer-aided design (CAD) software provides further explanation. Similar to Pan, et al.'s study, Robertson and Radcliffe found that CAD software enhanced participants' visualization and communication abilities, but simultaneously exacerbated circumscribed thinking, bounded ideation and premature design fixation. In the context of a student designer, the enhanced visualization capabilities that software affords may ultimately be the dominant factor when deciding to choose one ideation mode over another, regardless of any corresponding hindrances the software might cause.

In addition to some of the negative effects of computer-based designing, upper level design students, while having acquired a body of knowledge, experience, and stylistic preferences throughout their educational career, tend to default to visual and conceptual approaches that have proved useful, and successful, in past projects. During their final year, design students' independent work is often entangled with concerns for finding employment following graduation. In this context, they may be less inclined to challenge themselves to seek out divergent conceptual pathways for their designs, even with faculty mentorship and motivation. However, as students, they maintain a degree of openness to learning new skills, especially those that strengthen their chances of finding employment.

An opportunity exists for implementing a responsive protocol system in design software that challenges students during multiple phases of the making process. Design software that learns, reacts and provokes the user, instead of passively receiving instructions, may stimulate students' divergent design cognition and encourage a breadth over depth approach when designing on the computer. Computer-generated provocation of this kind is especially pertinent when the student is working alone, without direct feedback from instructors, peers or other stakeholders. Such interventions might assume different evaluative and generative behaviors within the software, depending on the student designer, their particular working habits, and stage of development within their project.

## ASSUMPTIONS & LIMITATIONS



Throughout their academic career, students are exposed to a number of traditional, experimental, analog and digital methods for generating design solutions. As indicated in established design trends of the near future (AIGA, Designer of 2025: Introduction) and corroborated in studies by Pan et al. (2013) and Chen (2016), most students—familiar with computer-mediated tools—prefer to conduct the majority of their work within a digital environment. This project assumes that students are willing to adopt alternate methods of design ideation if they are seamlessly integrated into existing and familiar software interfaces. Modifications or additions to the software system may need to reference existing schemas of use in order to facilitate easier transition to an alternate workflow. Instructor and potential employer encouragement may also be critical for students to willingly adopt alternate technologies and procedures; if students' expected competencies include conversational, computer-based improvisation with a virtual design agent, they are more likely to learn and adopt them during their educational career.

On the technical end, this project assumes that virtual design agents function using a combination of context-based machine learning algorithms (such as image recognition, speech analysis, sentiment analysis, speech-to-text, text-to-speech, etc.) and boolean-type "if/then" arguments, operating behind-the-scenes. This project assumes that the programs have already been "trained" on and follow different improvisational feedback methods prior to the consumer-side introduction of such features. This project assumes that, like most software, there will be hiccups along the way toward more stable versions. While the design student will not need to train the software to work, the scenario assumes that the student will need to consistently work and "converse" with the computer in order to contextualize and enhance the appropriateness of virtual agents' feedback throughout the process.

While this research may be pertinent to designers at all levels, in and out of design education, this investigation will look primarily at upper-level undergraduate design students and their approach to computer-mediated idea generation during an independently-driven, multi-week design project. I am not focusing on incorporating improvisation into design pedagogy. Instead, I am choosing to investigate how to integrate improvisational strategies into the digital-realm. Here the students can interact with the system and their preferred design software concurrently. My project does not propose introducing improvisation techniques into preliminary, non-computer-mediated stages of the design process, though doing so may prove equally useful to students seeking to generate unexpected results. The study will be modeled after the structure of a senior capstone project at the College of Design at North Carolina State University. Although some of the ideas proposed in this study may hint at altering design curriculum, my proposed interventions work in concert with the existing classroom structure.



# DEFINITION OF TERMS

**Attachment to Concepts**
"Designers become readily attached to single, early solution concepts and are reluctant to abandon them in the face of difficulties in developing these concepts into satisfactory solutions" (Cross, 2010, p. 92).

**Concept Space**
"[T]he elements [Concept Space] contains are ideas, relationships, or other abstractions which may later become the basis for elements in configuration space. [...] changes to conceptual designs or configurations are motivated by these abstractions or concepts" (Jansson & Smith, 1991, p. 3).

**Configuration Space**
"Configuration space is an imaginary space which contains physically-realizable configurations, or more specifically, the mental representations of configurations such as diagrams and sketches and combinations of physical elements which comprise these physical objects" (Jansson & Smith, 1991, p. 3).

**Design Agent**
"[A] system that can modify its expressive behavior as the context changes and can cooperate with other design agents" (Ishizaki, 2003, pg. 34).

**Design Fixation**
"[A] blind adherence to a set of ideas or concepts limiting the output of conceptual design" (Jansson & Smith, 1991, p. 3).

**Divergent Design Cognition**
The mental process of generating multiple, often unexpected or personally innovative design concepts.

**Generation of Alternatives**
"A wide range of alternative solution concepts" (Cross, 2010, p. 92).

**Ideation**
The "Solution Generation" process, where designers articulate different conceptual pathways to apply towards a given design intervention (Cross, 2010).

**Knowledge-based Fixation**
"[A] failure of a designer to consider other tangible physical elements in his or her configuration space" (Youmans & Arciszewski, 2014, p. 134).

**Problem Framing**
The process of "structuring and formulating the problem [...] directing the search for solution conjectures" (Cross, 2010, p. 91)

**Relevant First Principles**
"[I]dentifying requirements, or desired functions, and arguing from these to appropriate forms or structures" (Cross, 2010, p. 55).

# RESEARCH QUESTIONS



## MAIN

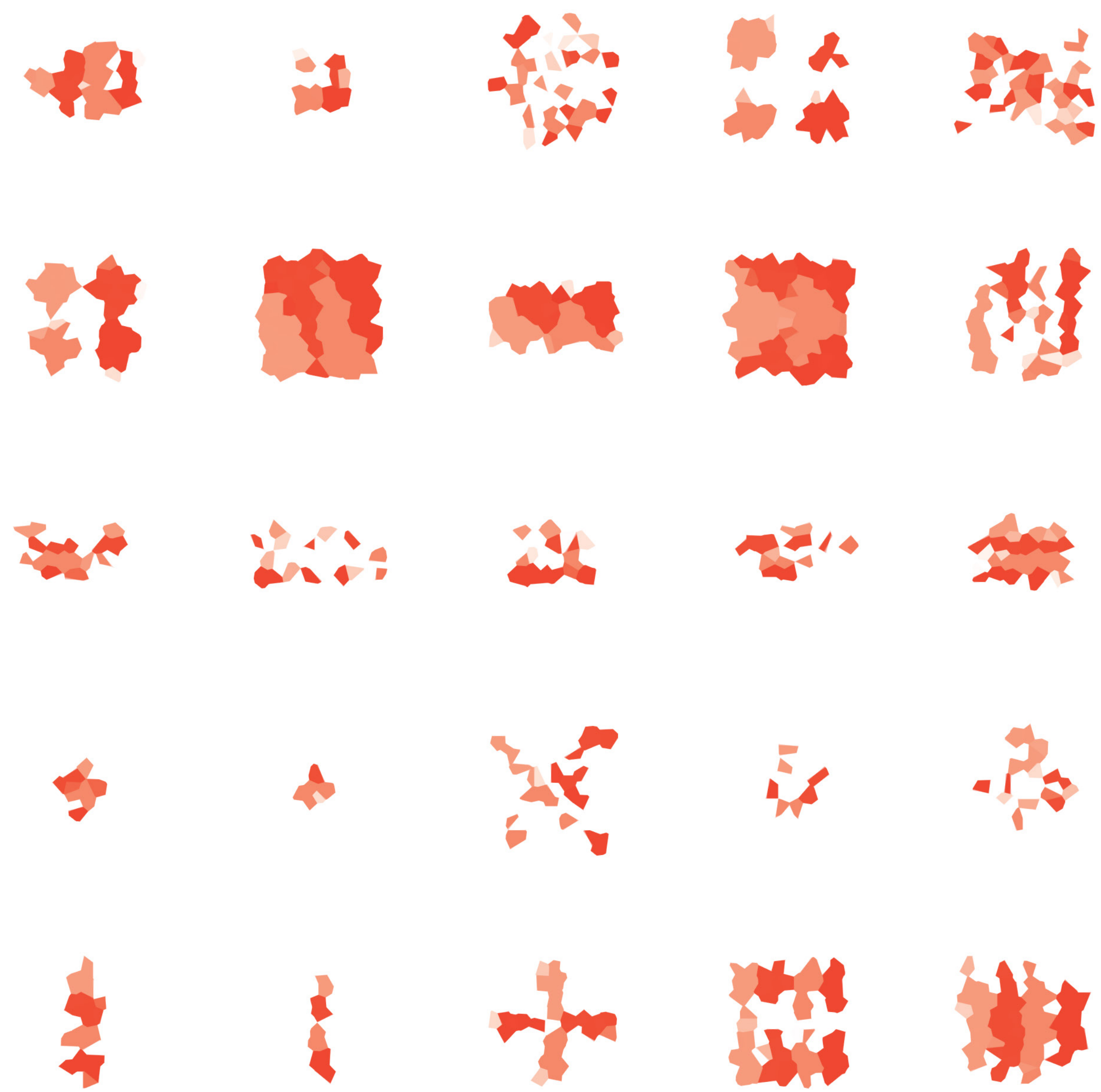
How might the design of a conversational virtual agent employ improvisational methods to mitigate negative design fixation and creative stagnation in upper-level undergraduate graphic design students during recurring computer-based ideation stages of an independent, multi-week design project?

## SUB QUESTIONS

**Adaptation**
How might the virtual agent introduce anomalous feedback during visual ideation to challenge the student's adaptive competency when using visual design software?

**Association**
How might the virtual agent generate atypical associations in response to user input to stimulate the student's opportunistic behavior when designing on the computer?

**Articulation**
How might the virtual agent introduce conversational prompts to encourage the student to articulate their design project problem frame?



METHODOLOGY



## DESIGN FIXATION

**THEMES**

Design fixation affects novices and experts in different ways; novices often become fixated on existing solutions, while experts can become fixated on an initial problem “frame” or design direction (Cross, 2010; Crilly, 2015

Design fixation can broken down into subcategories, each with different origins and potential remedies (Youmans & Arciszewski, 2014).

A distinction must be made between fixation due to domain-knowledge and fixation due to design precedents (Jansson & Smith, 1991; Cross, 2010; Youmans & Arciszewski, 2014; Crilly, 2015).

Design precedents can encourage fixation. Fixation may be mitigated by abstaining from reference material during early stages of design ideation or by referencing partial or ambiguous sources (Jansson & Smith, 1991; Tseng, Moss, Cagan & Kotovsky, 2008; Cross, 2010; Youmans & Arciszewski, 2014; Cheng, Mugge & Schoormans, 2014; Crilly, 2015; Koh & Lessio, 2018).

Reifying ideas (making) and receiving feedback on those physicalizations can discourage fixation (Crilly, 2015; Youmans & Arciszewski, 2014).

Designers often narrow the “potentiality” of a design direction as a project develops (Zhang, Xie & Nourian, 2018; Crilly, 2015).

Brainstorming as a team doesn’t necessarily equate to greater diversity of ideas, and can, under certain circumstances, actually exacerbate fixation (Crilly, 2015; Youmans & Arciszewski, 2014) .

With training and conscious reflection, designers may be able to enhance their ability to recognize and mitigate (some of) their own fixation (Zhang, Xie & Nourian, 2018; Crilly, 2015).

**Jansson & Smith (1991)**
The researchers advocate for the measurable effects of design fixation, proposing a distinction between mental conceptual and configuration spaces when designers develop ideas. The researchers explain that the ideation process requires a back-and-forth between these two spaces to move a project and the conceptual design process along. The researchers conducted multiple studies, observing design students' overall tendency to produce similar (mimetic) design solutions when presented with existing examples of a design solution. The researchers note the relationship between prior domain knowledge and design efficacy, suggesting that fixation may need to be further specified to account for the kinds of information necessary to tackle complex design problems. The researchers conclude that the way the design process begins and continues to unfold over the lifespan of the process may have significant consequences on the type and level of fixated behavior.

**Tseng, Moss, Cagan & Kotovsky (2008)**
The researchers conducted an experiment of 71 undergraduate engineering students at Carnegie Mellon University, testing their ability to "assimilate and apply newly acquired information when ideating solutions to a design problem" (p. 203). From their study, the researchers reached a number of conclusions: (1) distantly related information is more readily accepted when design goals are open, (2) obviously similar information to a design prompt has a higher degree of impact on subsequent ideation than distantly related information and (3) designers who are given existing solutions prior to ideation are more likely to produce designs that resemble those solutions (evidence of design fixation) than designers who weren't given the references at all. The researchers challenge the notion that "taking a break" from the design problem can dissuade long-term fixation based on initial associations to existing design solutions. Instead, they propose that expanding goal orientation (openness through problem reframing) may allow designers to incorporate more distantly related information and create more novel solutions, especially after designers make initial attempts.



**Cross (2010)**
Cross looks at the design process and cognition (among other elements of design). Cross describes designerly methods of working, namely "framing" and "fixation." He notes differences in behaviors between non-designers, novice and expert designers when faced with ill-defined problems. Cross describes novice designers as being susceptible to fixation prompted by existing solutions and/or an inability to produce an array of possible solutions (iterations). Expert designers, on the other hand, are more likely to become attached to early concepts based on a strong ability to articulate a coherent problem "frame." Cross considers this a type of fixation, different from the kinds of fixation that novice designers often experience in that articulating the problem frame allows experts to formulate more diverse and efficacious design solutions.

**Youmans (2011)**
Youmans conducted a study of 120 design students from the University of Illinois at Chicago (UIC) and amateur psychology students from UIC's psychology department, testing their ability to develop new design concepts based on assigned reference material, individually and in small groups. Youmans found that group interaction was not related to mitigating design fixation. "Assembly Bonus" (the effect of having multiple minds working on a problem, reducing individual cognitive load and allowing for more opportunities to notice fixation within the group) did not appear to factor into the experiment. Groups were unfamiliar with each other, which may have led to design fixation in order to preserve group cohesiveness. The study demonstrated that physical prototyping (termed "full design process") was helpful in combating design fixation. Youmans makes a distinction between sketching and prototyping, although he notes that "virtual" prototyping may produce similar effects to physical prototyping.

**Youmans & Arciszewski (2014)**
The researchers propose the distinction of fixation into, "unconscious adherence to the influence of prior designs, conscious blocks to change, and intentional resistance to new ideas" (p. 126). The researchers compare

each of these fixation types against an orthogonal axis of conceptual and knowledge-based fixation. The researchers claim that designers can experience unconscious fixation even when explicitly being told not to fixate. This may be related to the subconscious, associative nature of memory. Designers may exhibit conscious blocks because of their domain experience, working within constraints in order to enhance productivity. Similarly, intentional resistance to new ideas may occur because of a "prevailing attitude that a previously successful solution is preferable to that of a novel solution" (p. 132-133). Here, finding an operable solution will "work;" a design solution does not need to be revolutionary (either publically or personally). The researchers propose a number of potential ways to mitigate fixation, including surrounding oneself with diverse perspectives that come from working in multi-disciplinary teams, working in shorter bursts with intermittent breaks, consciously attending to the types of knowledge being used to solve a problem (first order knowledge vs. second order, third, etc.) and breaking problems down into smaller components and reframing design strategies to address these components.

**Cheng, Mugge & Schoormans (2014)**
The researchers conducted a study of industrial design graduate students tasked with redesigning the style of an existing product, either an electric mixer, dust buster, printer or hairdryer. Some participants were randomly assigned full photographic reference material, while other participants were given partial references (i.e. cross sections of images) with rich visual information. The findings from the study revealed that participants who were given partial visual references produced designs that were more original overall than the designs created by participants who were given full visual references (assessed both by professional judges and through self-assessment). Designers who used partial reference material also self-reported a higher level of self-satisfaction with their designs. The researchers speculate that this is due to the "incompleteness" of information, stimulating the designers to actively combine visual ideas to produce a complete whole, thus instilling a higher level of self achievement. While the study seems to suggest that ambiguity is useful for mitigating fixation, the researchers clarify that the "partiality" or the ambiguity of a source must be carefully balanced; too ambiguous and the reference runs the risk of being useless or distracting. Further, the level of ambiguity may need to be tailored to the individual designer, due to their relative familiarity with the source material.



**Crilly (2015)**
Crilly looks at cause and effect of design fixation and expert strategies to mitigate it. Crilly compiles an extensive review of current literature on design fixation, citing previous experimental studies on the origins of design fixation and some preventative measures. Crilly argues for a qualitative approach to researching design fixation in the context of design practice, in contrast to many existing studies on fixation, conducted within controlled environments. From his interviews with designers in the field, Crilly notes that design precedents and constraints encourage design fixation, while feedback and conscious design strategy (methods) can mitigate or discourage fixation. Interestingly, Crilly notes that openness, as the broad antithesis to fixation, often "consumes resources" in a professional setting, and may be impractical under certain circumstances or moments in a design life cycle. Thus, the balance between openness and persistence becomes a challenge that designers must face in the real world. Crilly notes that conscious awareness of one's own fixation, which many of the interviewees claimed to observe, may be the result of years of experience and practice. This may account for the conflicting reports from other studies that maintain that some level of fixated behavior operates below a level of awareness (Youmans & Arciszewski, 2014; Koh & Lessio, 2018), and that with training, a designer can enhance awareness of fixation. Crilly provides four conclusions from his research:

- **(1)** fixation may come not only from design precedents but from the design brief or project scope itself.
- **(2)** fixation may be mitigated through physical prototyping and critical feedback.
- **(3)** many real world design projects can't or don't allow for exploratory "breadth" in concept development due to resource cost.
- **(4)** expert designers draw on their rich past experience when consciously balancing between openness and persistence.

**Koh & Lessio (2018)**
The researchers conducted a study of 106 second-year undergraduate engineering students, looking at their tendency to fixate on design elements from previous patents when tasked with designing a new concept for an electric kettle within a sprint-style timeframe. Students from the filter group were provided existing patents, while students from the control were given no reference material. The findings reveal that reviewing patent agreements prior to the design exercise increases the risk of both design fixation (adherence to a limited set of ideas) and distraction (failing to attend to the entire scope of the brief in lieu of tackling a particular issue) even when explicitly instructed not to. In addition to their study, the researchers conducted a literature review of current creativity enhancing methods such as SCAMPER, TRIZ, ASIT, the Duncker Diagram, the Kepner–Tregoe (KT) method, morphological charts, mind maps and referencing abstract cues for inspiration. The researchers propose that methods for creative problem framing encourage more viable design solutions, while stimuli and synthesis tools encourage greater quantity and breadth of design solutions.

**Zhang, Xie & Nourian (2018)**
The researchers conducted a study of high-school students during a design project, finding that over half of subjects became “fixated at the end of the project” (p. 838). The researchers advocate for “interventions and instructional activities to mitigate fixation” in young designers as fixation prevents students from fully exploring “the conceptual space” (p. 838). The researchers propose that students reflect on their design process in order to understand the value of iterative design and to encourage them to develop a wide array of ideas.



## IMPROVISATION (MUSIC)

**THEMES**

Improvisation deals with risk-taking within contextual boundaries, i.e. not chaos (Bastien & Hostager, 1988; Healey, Leach & Bryan-Kinns, 2005; Alperson, 2010).

Improvisation entails a material and temporal convergence of thinking and executing (Miner, Bassoff & Moorman, 2001).

Improvisation implies some level of intuition and domain competency, which may be related to improvisation’s unspoken technical and social structures (Sawyer, 2000; Kamoche & Cunha, 2001; Healey, Leach & Bryan-Kinns, 2005.)

Improvisational performers must implicitly trust and be attuned to each other to balance creative leaps with mutual understanding of musical vocabulary (Bastien & Hostager, 1988; Magni, Proserpio, Hoegl & Provera, 2009).

**Bastien & Hostager (1988)**
The researchers describe improvisation as a unique brand of collaboration, which requires participants to be especially attuned to each others’ voice and input in order to maintain momentum and cohesive direction. During the performance, each member must be constantly alert, shifting their playing and building off each other’s ideas, while proactively engaged with ideas of their own. Technical structure is defined through compositional frameworks, song structures and the use of licks or “musical grammar.” In their study of improvisational behavior among professional jazz musicians, the researchers refer to the phenomenon of “centering” as a technical strategy that aids in the development of unique outcomes. They conducted an experiment, bringing together four master jazz musicians for an improvised concert, none of whom had rehearsed together or even met each other before the performance. From song to song, the authors observed that the musicians’ musical vocabulary and habits became more familiar and integrated with each other, eventually leading to more

elaborate variation. This strategy, whether applied consciously or not, is used to recalibrate the musicians' shared vocabulary and rapport, their center, providing the groundwork to explore emergent possibilities.

**Sawyer (2000)**
Referencing art criticism works by John Dewey and R. G. Collingwood, Sawyer draws a distinction between product creativity — as experienced in aesthetic artifacts via many, individual delayed receptions — and improvisational creativity — as experienced through live performance via collective immediate reception.

**Miner, Bassoff & Moorman (2001)**
The researchers provide a convenient framework for improvisation, as it might be employed in administrative and organizational structures. The article outlines four key features of improvisation—including material and temporal convergence of design and execution, novelty and deliberateness—and relates those features to seven comparative constructs that include intuition, creativity, bricolage, adaptation, innovation, learning and compression.

**Healey, Leach & Bryan-Kinns (2005)**
In their study of improvisational interactions between jazz musicians, the researchers observed group social structures, noting a combination of body orientation and physical gestures to signal shifts in performance leadership, in this case through soloing or the creation of novel transformations on the theme.

**Sawyer (2007)**
Keith Sawyer highlights common themes found in "effective creative teams" (p. 14). These themes closely resemble the behaviors found in musical groups. Sawyer relates group creativity to Mihaly Csikszentmihalyi's idea of "flow" or a "particular state of heightened consciousness (p. 42)." Sawyer, a student of Csikszentmihalyi, adapts this idea towards his own concept of "group flow," and provides guidelines for establishing group flow within creative teams:



- **The Group's Goal**: a common end shared between team members within the group.
- **Close Listening**: team members are highly attentive to what others are doing and saying.
- **Complete Concentration**: team members focus solely on the task or activity at hand.
- **Being in Control**: the team is autonomous from senior management.
- **Blending Egos**: team members give up personal gain for the needs of the group.
- **Equal Participation**: each team member performs equally in the group.
- **Familiarity**: team members are familiar and comfortable with each other's work style and habits.
- **Communication**: team members maintain constant communication with each other.
- **Moving It Forward**: team members are always pushing ideas
- **The Potential for Failure**: team members are aware of the risk of failure in creative endeavors (p. 44-56).

**Magni, Proserpio, Hoegl & Provera (2009)**
In their study of information system developer teams, the researchers looked at how different industries employ improvisational techniques into their workflow. The researchers established metrics and measured individual's improvisational abilities as well as overall team output. In their analysis, the researchers found that behavioral integration and cohesion are directly tied to an individual's ability to respond with solutions to emerging uncertainty. Both of these factors help promote a more seamless flow of information, resources, abilities and openness within the team, corresponding to increased potential for creativity. Additionally, the researchers note that creativity, while interrelated to improvisation, is only one component of the equation. Improvisation is unique in that it necessitates speed and agility in the face of uncertainty. Improvisation must be quick to react to changing stimuli.

**Alperson (2010)**
Alperson provides a map of key elements to musical improvisation, "spontaneity and freedom, skills, and the social dimension" (p. 279). Of particular importance is his clarification of the difference between improvisational performance and improvised outcome. Alperson notes that the performative element of improvisation, improvising, sets the stage for a particular kind of "free play" and exploration. He makes another critical point, that improvisation exists "as spontaneous achievement within the constraints of the possible" (p. 274), implicitly dealing with risk-taking within contextual boundaries.

**Kleinmintz, Goldstein, Mayseless, Abecasis & Shamay-Tsoory (2014)**
Researchers conducted a study of musicians with improvisation training, musicians with traditional training and non-musicians. Participants performed an Alternative Uses Test (AUT), asking them to imagine alternative uses for a number of everyday household items, an Evaluation Task and Subset of Torrance Tests. The study results showed that musicians with improvisation training scored higher overall in both fluency and originality than the other two participant categories on all tests. The researchers concluded that improvisation training teaches subjects to evaluate ideas with lower deviance (inappropriateness), thus allowing them to produce a wider range and novelty of ideas. Researchers also provide a "Twofold Model" of creativity, a framework showing the progression of idea generation and evaluation.

**Sowden, Clements, Redlich & Lewis (2015)**
The researchers conducted a series of studies looking at the effects of improvisational dance on subsequent creativity tasks in children (ages 8-10). "In both experiments, we found that children who took part in the improvisation interventions showed better divergent thinking and creativity after the intervention. Our findings suggest that simple, arts-based improvisation interventions could have domain-general benefits for creative cognition processes" (p. 128).



## IMPROVISATION (DESIGN)

**THEMES**

Some instructors at the College of Design at North Carolina State University employ improvisational techniques in design pedagogy. Instructors implement these techniques via group critiques and experimental ideation exercises (Abdullah & Gonzales Crisp, 2018; Abdullah & Gonzales Crisp, 2019).

**Ishizaki (2003)**
See entry under *Design Software*.

**Abdullah & Gonzales Crisp (2018)**
Abdullah and Crisp offer methods for implementing improvisational techniques into design teaching in the undergraduate classroom. They outline three exercises to apply and their benefits to lateral thinking, co-creation and jump-starting the creative process. As advocates for explicit implementation of improvisation in design, Abdullah and Crisp represent a vanguard of designers operating from a rich tradition of experimental, programmatic and conditional design, music and art practice.

**Abdullah & Gonzales Crisp (2019)**
Gonzales Crisp outlines the methodology, experience and outcomes from implementing an improvisational structure to her fall 2017 studio course at North Carolina State University.

## DESIGN STUDENTS

**THEMES**

Many undergraduate design students prefer to use design software to generate and manipulate visual ideas directly on the computer (Pan, Kuo & Strobel, 2013).

A majority of undergraduate design students in multiple studies self-reported that idea generation can be one of the most challenging parts of the design process (Chen, 2016; Pan, Kuo & Strobel, 2013).

**Chen (2016)**
Chen conducted open-type surveys of "189 undergraduate industrial design students from three universities," determining that "the most difficult design tasks included concept generation, design presentation and design research" (p. 461).

**Pan, Kuo & Strobel (2013)**
Researchers conducted observational studies and interviews of undergraduate graphic design students. Findings from the studies showed that students perceived ideation as the most difficult stage of the design process. Students who engaged with paper-based note-taking and sketching rated lower perceived difficulty during the ideation stages of the process. Students who preferred to use physical tools (sketching) revealed that it allowed them to remember their ideas and offered a way to externalize and examine their thoughts quickly. Over half of respondents who preferred computer tools over paper-based tools felt that sketching was time-consuming and, by forming their ideas using the computer in the first place, eliminated a step that otherwise would lengthen their design process. Students who preferred computers in the ideation phase noted that they could easily apply (complex) variation to their ideas quickly, thus improving their ability to see alternate results. In addition to the benefits of computer usage in the ideation phase, students noted drawbacks, including a tendency to hyperfocus on details of individual designs over developing multiple concepts.



## CREATIVITY

**THEMES**

Ambiguous visual references and project goals can prompt designers to "resolve" ambiguity through generation of visual and conceptual possibilities (Tseng, Moss, Cagan & Kotovsky, 2008; Tseng, 2018).

Designers are able to explore more possibilities when project goals are open (Tseng, Moss, Cagan & Kotovsky, 2008).

Designers can use creative provocations (known as design heuristics) to stimulate new ideas after creative exhaustion has set in (Gray, Mckilligan, Daly, Seifert & Gonzalez, 2017).

**Tseng, Moss, Cagan & Kotovsky (2008)**
See entry under *Design Fixation*.

**Gray, Mckilligan, Daly, Seifert & Gonzalez (2017)**
The researchers propose introducing "design heuristics" (creative provocations) to design students after they have exhausted their initial concept generation process. The researchers found that with the aid of heuristics students were not only able to generate additional concepts after creative exhaustion had set in but that their concepts were more novel, specific and relevant to the design brief.

**Tseng (2018)**
The researcher looks at ambiguity as a catalyst for ideation, conducting experimental studies of novice (freshman) and experienced (upper level graduate) designers as they cope with ambiguous images and subsequent idea generation. The researcher concludes that ambiguity triggers cognitive uncertainty and a search to "resolve" via the generation of ideas, using the ambiguous forms to represent functional elements. In the studies, expert designers were able to respond to increasing levels of ambiguity and able to generate more ideas overall. This suggests a level and kind of uncertainty resolution in expert designers that both allows them to work towards a solution and explore more options.

## DESIGN SOFTWARE

THEMES

Embedding external feedback systems into design software may enhance the users' problem-solving abilities when using the computer to design (Kochhar, 1994; Mccall, 2012.)

Some researchers report a connection between computer-based design tools (software) and premature design fixation (Robertson & Radcliffe, 2009).

**Kochhar (1994)**
Kochhar provides a detailed framework, functionality and prototypical example of Cooperative Computer-aided Design (CCAD) programs. As Kochhar explains "the goal of CCAD is to support exploratory design, while keeping the user central to the design activity" (p. 54). With a CCAD program, a designer works with the computer program to develop design ideas by inputting desired design outcomes, receiving generative iterations in response to those inputs and selecting a particular version for manual refinement. The designer can then reinitialize the system to generate new iterations in response to user revision, repeating the process infinitely if desired. Kochhar describes the CCAD system as aiding the designer in "exploring design alternatives when they have no fixed final design in mind, but only some idea of its properties" (p. 56).

**Ishizaki (2003)**
Ishizaki proposes the idea of "design agents," modular design sub-systems that respond to changes in the digital environment, information content and user preference. These systems can "modify [their] expressive behavior as the context changes and can cooperate with other design agents" (p. 34). These agents act as mediator between content and content receiver. Ishizaki's book was written in 2003, prior to the advent of Web 2.0, responsive web design, artificial intelligence and aggregation curation platforms such as Facebook, Twitter, Pinterest, Apple News, etc. Many of these modern technologies perform the same functions Ishizaki foretold in his writings.

**Kim & Baylor (2006)**
Kim and Baylor provide a framework for developing Pedagogical Agents as Learning Companions (PALs) in software learning environments. They draw upon Distributed Cognition, Social Interaction and Social Cognition theories to determine seven characteristics to be considered when creating AI learning agents: Competency, Interaction Type, Gender, Affect, Ethnicity, Multiplicity and Feedback Type. The framework identifies variables within each of these characteristics and the potential outcomes from these variables.

**Robertson & Radcliffe (2009)**
The researchers conducted a survey of designers using CAD to visualize their design ideas. The researchers noted four factors that impact creative problem solving ability including: (1) Enhanced Visualization and Communication, (2) Circumscribed Thinking, (3) Bounded Ideation and (4) Premature Design Fixation. While (1) allowed for better communication between different parties/stakeholders involved in the design process, the researchers note that the remaining three factors often negatively impact the designer's creative problem solving ability. The researchers propose that software designers must consider these phenomena when creating future design tools.

**Mccall (2012)**
Mccall breaks down the successful and non-successful features of different CAD software that utilize feedback systems to improve design creativity and promote the efficacious development of concepts. Mccall's thesis is predicated on the idea that evaluation and ideation are intertwined. He references critical design theory by Rittel and Schön, championing Schön's concept of the "designer as situated cognition" instead of Rittel's concept of the "designer as planner" (p. 22). Using Schön's conceptual framework, Mccall describes three types of evaluative feedback, discussion, implementation and use, each offering different methods for disturbing the designer's actions and realigning their rationale. Mccall concludes that future design software will need to integrate these kinds of feedback systems in order to improve designers' creativity and design outcomes.

## DESIGN PROCESS

Expert designers demonstrate advanced ability to be “comfortable” with uncertainty and shifting requirements (Cross, 2010; Carlgren, Rauth & Elmquist, 2016).

Some design educators advocate for ways that novice (student) designers can scaffold experimentation in their design process (Ham, 2013).

**THEMES**

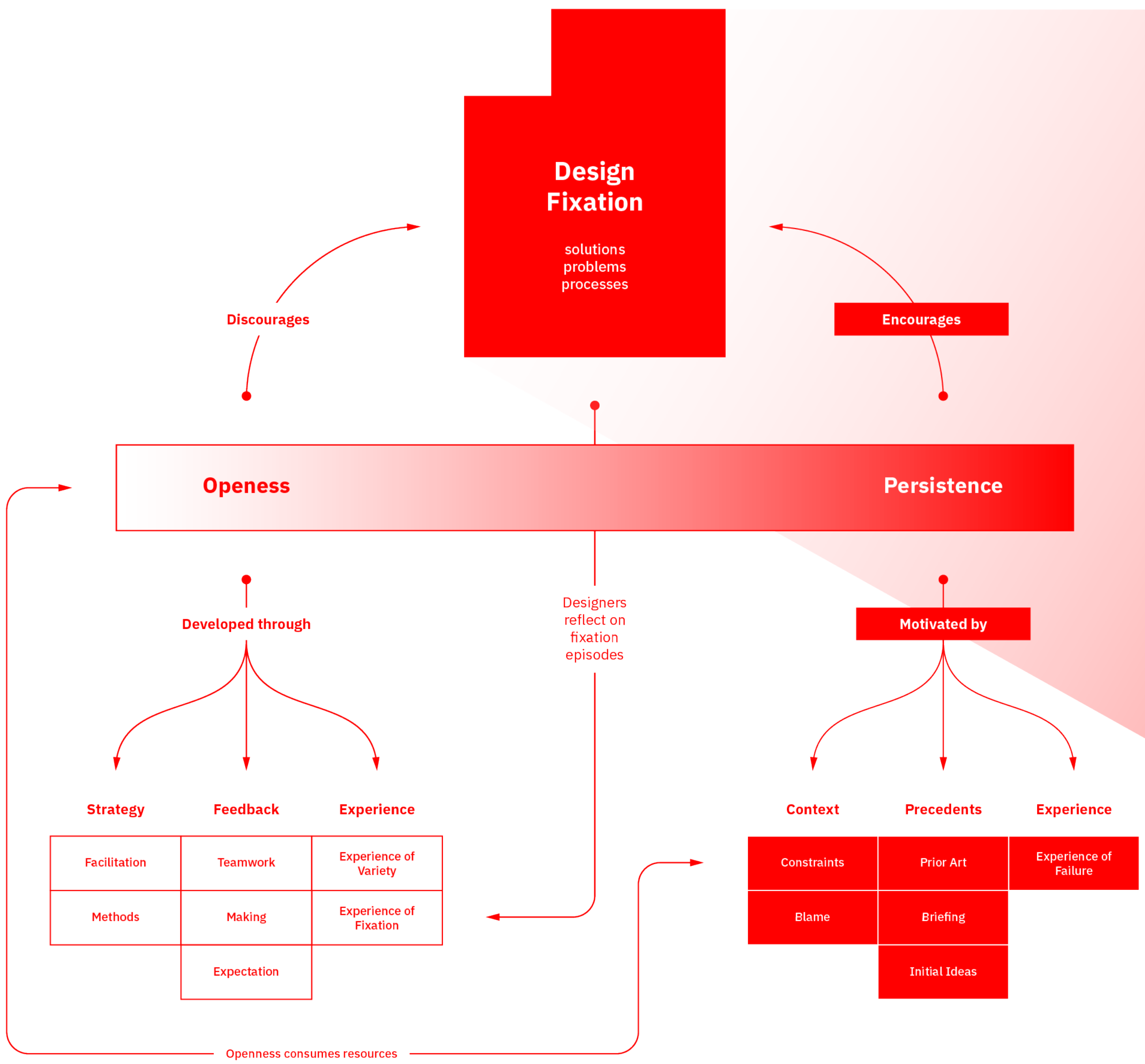
**Cross (2010)**
Cross’ in-depth research of professional design practitioners, proposes a theoretical framework for design cognition. Cross describes designerly methods of working, namely ‘framing’ and ‘fixation.’ Cross notes the behavioral differences between non-designers, novice and expert designers when faced with ill-defined problems.

**Giacomin (2014)**
Giacomin provides a description of Human Centered Design (HCD) paradigm and lays out a pyramid model/framework of complexity for HCD interventions. He provides common methods for practicing HCD, categorized for different types of inquiry.

**Ham (2013)**
Ham advocates for the “formal description” (p. 596) of creative methods of inquiry in design education, through the adoption of “shape grammars” — generative systems and programmatic rules of play— as a bridge between intuitive forms of exploration and reflective articulation.

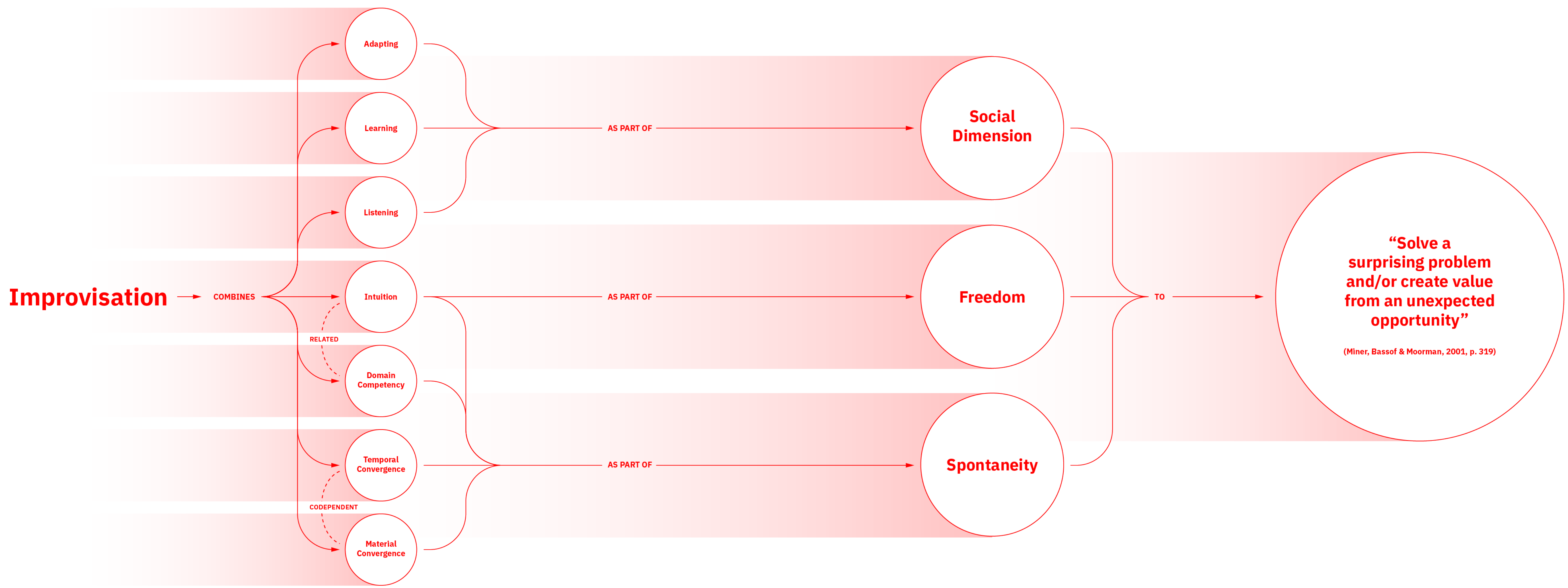
**Carlgren, Rauth & Elmquist (2016)**
The researchers propose a revised framework for Design Thinking based on contextual interviews with design practitioners in the field. The framework includes five main themes:

- **(User focus)** Priority empathizing with, relating designs to and involving users during multiple stages of the design process.
- **(Problem framing)** Comfort with ambiguity, unconstrained thinking and the unexpected. Willingness to shift the scale (scope) of problem and solution spaces to achieve the best design outcome.
- **(Visualization)** Making as a form of learning, communicating and testing ideas.
- **(Experimentation)** Comfort with iterations, multiplicity of ideas and making mistakes. Testing ideas early and often so as to receive feedback (as a form of learning).
- **(Diversity)** Valuing difference as a method for understanding the problem from as many perspectives as possible. Collaborating with fields and disciplines outside of one’s own.




| | Conceptual Fixation | Knowledge-Based Fixation |
|---|---|---|
| **Unconscious Adherence** | **Example** Luchins' (1942) "einstellung effect (i.e., the use of the same algorithm to solve new problems)<br>**Remedies** Timely warnings to consider all options (Luchins, 1942) | **Example** Copying the features (even negative features) of an example (e.g. Jannson & Smith, 1991)<br>**Remedies** The inclusion of physical prototyping materials during the conceptual design process (Youmans, 2010); for novice designers, possibly the use of visual analogy (Casakin & Goldschmidt, 1999) |
| **Conscious Blocking** | **Example** Preservation during the Wisconsin Card Sorting Task (Grant & Berg, 1948)<br>**Remedies** Short breaks or "incubation" (Smith & Linsey, 2011); possibly design training methods (e.g., TRIZ; Altshuller, 1994) or computer assisted design (Dong & Sarkar, 2011) | **Example** Difficulty thinking of new uses for existing object to solve problems (Kleinger et al., 2005)<br>**Remedies** Short breaks or "incubation" (Smith & Linsey, 2011); possibly design training methods (e.g., TRIZ; Altshuller, 1994) or computer assisted design (Dong & Sarkar, 2011); for novice designers, possibly the use of visual analogy (Casakin & Goldschmidt, 1999) |
| **Intentional Resistance** | **Example** Thomas Edison's insistance that high power transmission use alternating current<br>**Remedies** No known remedy, possibly systems of cognitive-information feedback (Youmans & Stone, 2005) | **Example** A professional who fails to consider knowledge from outside of his/her own area of specialization<br>**Remedies** No known remedy, possibly interdisciplinary cooperation, creativity exercises, or changes in beliefs (Gordon, 1961) |

Hybrid fixation framework based on existing frameworks by Youmans & Arciszewski (2014) *Types of Design Fixation and Possible Remedies*, and Crilly (2014) *Factors influencing design fixation in professional practice.*




Hybrid improvisation framework based on existing frameworks by Miner, Bassof & Moorman (2001) *Discriminant Validity among Improvisation and Related Constructs*, and Alperson (2010) *A Topography of Improvisation*.

## VIRTUAL ASSISTANTS

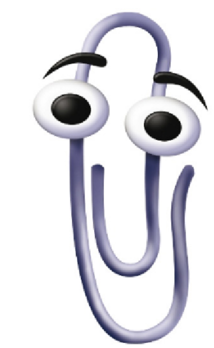
**Clippy**

Clippy began as part of the failed “Bob” OS for Windows, a system that used the visual and interactive metaphor of rooms in a house instead of a desktop (Rossen, 2017). While the rest of the OS was thrown out, Clippy remained as part of Word. The much maligned virtual assistant failed to resonate with users for a number of reasons. Clippy continued to provide feedback suggestions on basic functions of the software even after users demonstrated their mastery of key commands and handling of the software. As a result, users deemed Clippy’s assistance useless beyond basic tasks for the beginning user. In addition to being functionally nonadaptive, many female users reported that Clippy’s “leering eyes” made them feel uncomfortable.

**Amazon Echo, Google Home, Apple Homepod**

The explosion of smart home devices such as Amazon’s Echo, Google’s Home and Apple’s Homepod have taken the once futuristic premise of a personal robotic assistant and made it a relatively affordable reality. Heather Woods, professor of Rhetoric and Technology in the Department of Communication Studies at Kansas State University relates the automation that virtual home assistants provide to the kind of task offloading that was once only afforded to the upper classes, through hired (or sometimes forced) labor (Woods, 2018). Along with the convenience and expanded user accessibility that virtual assistants allow, Woods notes a number of problematic issues that arise from their proliferation. Perhaps most controversial are invasions of privacy and non-transparent data collection that come from a system that is “always listening” to the user at any given point. Recent scandals involving monolithic tech companies like Facebook abusing and exploiting user data for their own benefit, makes it difficult not to think that virtual assistants unwantedly collect information on their users without express permission. Woods also points out the difficulties with feminine anthropomorphisation of virtual assistants like Siri, Alexa or Cortana, noting that the feminine embodiment of virtual assistants perpetuates a stereotype of “pink collar” work: cleaning, organizing,





Clippy


Amazon Echo

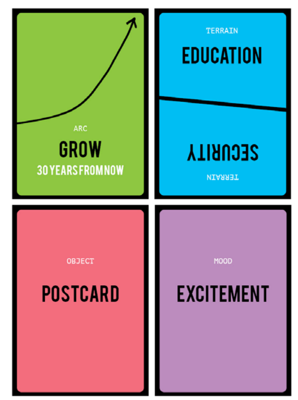
scheduling and cooking. Despite these critical issues, virtual assistants are increasingly popular and finding their way into people’s homes, as our reliance on them continue to grow.

## HEURISTICS

**Oblique Strategies**

Brian Eno and Peter Schmidt’s seminal Oblique Strategies is a card deck of enigmatic, even poetic provocations, intended to assist the artist in her creative process. The deck has its origins in the text-based “basic working principles” (Taylor, 1997) that Eno and Schmidt kept around their respective recording and painting studios. As an additional “tool” (or module) of the studio-as-instrument, Strategies behaves as constraints to stimulate alternative forms of cognition. The deck of cards targets the user’s ability to think laterally, that is to approach a problem tangentially instead of head-on, or as Eno describes it to create “[systems] the intention of which was to foil the critic [...] and encourage the child” (Eno & Amirkhanian, 1980, min. 15:08). While the card deck produces excellent procedures for encouraging divergent and lateral thinking, these


Oblique Strategies




The Thing from the Future

procedures are, in the end, self-imposed. If a user does not have the ability to be meta-cognizant of her creative process, she may not activate these strategies at appropriate times. Another shortcoming is that the cards are perhaps too ambiguous (Cheng, Mugge & Schoormans, 2014), and may induce more confusion than inspiration depending on the user.

**Designercize**

A fairly simple web-based program, Designercize provides designers with semi-randomized design challenges to provoke and inspire. The interface is modeled after 1980s style video games, offering instructions for use, "difficulty" settings, design prompt reload and exercise duration adjustments. The principle of the application is straightforward: combine unexpected concepts to produce a design brief in hopes of staving off creative blocks. The limitations here are that the brief is self-contained and cannot adjust over time, nor can it respond to user content. However, the included timing element encourages the design "player" to work quickly, perhaps reducing the self-imposed compulsion to produce beautiful artifacts and concentrate instead on developing novel and appropriate design concepts.



**The Thing from the Future**

As designer and creator Stuart Candy describes, The Thing from the Future is an "imagination game for envisioning alternative tomorrows" (Candy, 2018). During his guest lecture in the Spring of 2019 at North Carolina State University, Candy asked rhetorically "how can we scaffold our understanding so that we don't rely on our past associations?" The Thing from the Future attempts to do just that. The game uses cards of different suits, corresponding to different contexts, situations and objects from an imaginary future, and asks participants to articulate design possibilities based on the unique combination of elements. Much like Oblique Strategies and Designercize, The Thing from the Future forces the designer to consider potential futures relating to random prompts, challenging their normal creative process.

## AI-ASSISTED SOFTWARE

**Magenta**

Magenta is a division of Google's artificial intelligence research program that involves applying machine learning to creative tools. Magenta houses a number of projects including Magenta Studio, Music VAE and NSynth. Magenta is also connected to Google's Quick Draw software, which uses user generated drawing data to inform image recognition and image generation algorithms. Like most machine learning-based programs, Magenta's software modules require large amounts of data to drive them. For instance, the NSynth program takes many instances of existing sound waveforms (of a flute, clarinet, guitar, cat meowing, dog barking, etc.) and extrapolates a representational model of the sound. These representational models can then be combined to create new, hybrid sounds, such as a cross between a vibraphone and a cow. The applications of a program like this may seem limited, but the idea behind the software is what's important. By combining unusual sources, the software is able to generate unfamiliar sounds, potentially exciting the user's inspiration.

**Dreamcatcher**
Autodesk's Dreamcatcher is a generative computer-aided design program for creating design objects. As a currently-used program in industry, Dreamcatcher perhaps comes closest to a working version of Kochhar's predictions on Cooperative Computer-aided Design programs (1994). In Dreamcatcher, the designer inputs specific use-cases and necessary requirements for an industrial form. The program then generates a multitude of design possibilities based on these requirements, from which the designer chooses the most appropriate or interesting possibility (or possibilities). With Dreamcatcher, efficiency and profitability are the largest influence; the ability to generate many possibilities without significant time devoted to human designing means that more time can be devoted to testing, learning and ultimately getting the product out the door and into the hands of consumers. In this way, Dreamcatcher is not so much a cooperative design tool that enhances a designer's ability to design. Instead it is a system of choosing or curating design decisions. This may be highly pragmatic in an industry setting, in which many designers work, but stops short of enriching an individual designer's creative process.

**Orb Composer**
The relatively new Orb Composer uses artificial intelligence to automatically compose music according to Gerstner-esque morphological components. The user chooses, edits and rearranges these components to create a musical composition. The software is still in its infancy; the user's ability to "converse" with the AI as described in Kocchar's paper (1994) on CCAD is limited, and output appears to be somewhat uniform. While a user can quickly achieve musical results by articulating structure, tempo, mood and instrumentation, it's debatable whether or not this kind of interaction actually encourages divergent thinking.



## GD401 SENIOR CAPSTONE PROJECT

I conducted a number of observational studies for this project, including multi-week observations of senior students during classroom critiques and exercises in the GD401 Capstone course at North Carolina State University's College of Design in fall, 2018. This course spanned seven weeks, representing a mini version of a complete design research project, driven by students' personal interests. The majority of class time was spent with students reviewing and critiquing each others' work in different group sizes, from one-on-one sessions with the instructor and teaching assistant, to small group critiques, to larger presentations with the entire class. In addition to the feedback that students received from each other and instructors, guests from local design and technology companies visited the class to offer outside perspectives on at least two occasions.

The Capstone course was held twice per week for 7 weeks, a total of 13 classes overall with one class taken off for Thanksgiving holiday. As a limitation to the study, I was only present for half (six) of the total number of classes. These classes were primarily devoted to critiquing student work, whereas the classes I did not observe involved students working independently on weekly deliverables.

**Study Features**
I began the study with a pilot structure, using the AEIOU method.

| | | |
|---|---|---|
| Activities | Environment | Interactions |
| Objects | Users | Notes |

**After the pilot study, I made minor adjustments to account for the behaviors I was noticing. Since both the environment (studio) and users (students, instructor and teaching assistant) were static, I eliminated both categories after the first round of observations, replacing them with Motivations and Struggles. I included the category Quotes, after finding myself recording snippets of conversations during the initial study.**

| | | |
|---|---|---|
| Activities | Interactions | Objects |
| Motivations | Struggles | Quotes |
| Notes | | |

**Findings**

A number of interesting trends and takeaways emerged from the observational studies. Below, some of the more interesting revelations are presented along with their corresponding week and study feature. These represent a small portion of the total observations made during the studies, those that were relevant to my project space.

## WEEK 1

| Observation | Feature |
|---|---|
| Students are generally willing to receive feedback on their websites → writing/typing up comments from peers and instructor | Interaction |
| When sharing and reviewing students' initial research questions, peer feedback isn't "landing" with the reviewee | Interaction |
| Informal conversations were noted to produce interesting ideas → improvisation? | Interaction |

## WEEK 2

| Observation | Feature |
|---|---|
| Conversations are highly collaborative/improvisational → one idea triggers another | Interaction |
| Ideas are thrown out, only certain ideas are recorded by the students → implies a kind of evaluation of ideas (i.e. the student decides a suggestion isn't good or appropriate for their topic) | Interaction |
| Students want to shape their projects around predetermined design outcomes → "I want to do something with data mapping" → desires fuel conceptual direction | Motivation/Quote |
| "I can't see past my own perception to see what [the users] want" | Quote |



## WEEK 3

| Observation | Feature |
|---|---|
| Students aren't writing any comments down! → may signify that the critique isn't landing or being accepted | Interaction |
| Critique follows a conversational flow → Student presentations spark a back-and-forth conversation, driven by each student's personal experiences. | Interaction |
| One student doesn't want to pivot directions at this stage → they feel like they're "in too deep." This suggests mid-stage fixation. | Interaction |
| Students are still trying to break off a lot of different elements, elements that are distinct from one another | Struggle |
| Instead of mapping out difficulties in scenario, students are quick to map out a proposed solution | Struggle |
| Trying to narrow the topic to something manageable | Struggle |
| Some students have a complicated vision of the project and this seems to prevent them from receiving other students' feedback. | Notes |

## WEEK 4

| Observation | Feature |
|---|---|
| Students' small groups are "self-dividing," according to seating → may imply that feedback is contained within comfortable/familiar groups → critique based on cognitive and social similarity | Interaction |

| Observation | Feature |
|---|---|
| One student makes formal and conceptual changes to their design on-the-spot in response to critique feedback → good responsiveness! | **Interaction** |

**WEEK 5**

Thanksgiving break, no observations made.

**WEEK 6**

| Observation | Feature |
|---|---|
| Students' comments are concept-based for one student whose project is clearly defined and whose visuals support the concept → sign of development → essentially done. | **Interaction** |
| Students prioritize branding elements | **Motivation** |
| Student wants to add elements that don't necessarily relate to the particular context to see how it would look → visualization to understand functionality → form and function marriage | **Motivation** |
| Students have developed a lot of components but struggle to tie them together | **Struggle** |
| One student has function and interactions thought out well but struggles w/ branding → different struggles for different students | **Struggle** |

**WEEK 7**

| Observation | Feature |
|---|---|
| Instructor evaluates students based on their ability to link research to project visuals and interaction decisions | **Interaction** |
| Guest reviewer sometimes tries to throw off the presenter with "how is this different than...?" Students recover by articulating their study limitations. | **Interaction** |
| Some students are slightly defensive of their projects and the feedback given at this final stage. Very few students record reviewer feedback. | **Motivation** |
| Critique flow: Compliment & Encouragement → Clarification → Where They've Missed the Mark → Opportunities | **Notes** |



# SURVEY

In addition to the observational study of the GD401 Senior Capstone course, I conducted an anonymous survey. Of the students requested only 11 offered to provide responses, representing approximately half of the class.

**THEMES**

A majority of students felt that establishing an initial concept was the most difficult part of the project

Most students had between 2-5 other classes and part-time jobs while working on their Capstone project

Many of the students felt that instructor-driven research deliverables were not helpful and needlessly imposed upon them (with user interviews being the general exception)

Most students rated the feedback they received from the teacher's assistant as the most helpful, supportive and inspiring

Almost all students used moodboards, Pinterest, Google Images or similar reference aggregators for inspiration not just at the beginning but at multiple stages of the process

Many students would return to their mood boards as a way to anchor their project or when they needed inspiration

Almost all students reported they didn't have enough time to complete the project or that they felt the process was rushed

Below are the questions as they appeared on the survey and the most common responses.

| Question | Most Common Response(s) |
|---|---|
| How did you begin the capstone project? What's the first thing you did? | 1. Selecting a topic from multiple interests<br>2. Creating a moodboard |
| What other responsibilities (school, work, personal, etc.) did you have during the project? | 2-3 other classes and part-time work |
| How much time were you able to devote to the capstone project outside of class in a given week? | 5-10 hours |
| Where did you conduct the majority of your work? | Home |
| Which software program/s did you use to develop your visual ideas? | Illustrator |
| Why did you choose to use certain program/s over others? | Familiarity & ease of use |
| Did you use (visual or research) templates in your design process? If so, how did these templates assist you in your design process? | No, only instructional templates (guides) that the teacher provided when creating research question, empathy map, as-is scenario and user journey map. |
| Did you use visual resources (from content aggregators such as Pinterest or Google Images) for inspiration in your design process? If so, were they useful and why? | Pinterest → mood board<br>For inspiration & establishing aesthetic |
| Did you have any "a-ha" moments duringthe project? If so, where and when did these moments occur? | 1. No<br>2. During an unrelated activity<br>3. Talking with TA<br>4. Combing through references<br>5. Interviewing people |
| Were you more productive working alone or surrounded by others? Why? | Alone, because it's less distracting but I would occasionally bounce ideas off others |
| In what setting did you feel you received the best feedback on your work? | One-on-one with TA |
| What was most useful about receiving feedback in this way? | TA's feedback was constructive, helpful and supportive. Valuable critique gets lost in large group discussions. |
| Did you receive feedback on your work outside of class? | Yes |



| Question | Most Common Response(s) |
|---|---|
| If so, from who/whom? | Peers |
| Did you ever actively seek feedback on your work in progress outside of class? | Yes |
| If so, which elements of your design did you request feedback on? | 1. Concept<br>2. Visual Design<br>3. Originality |
| Which part (if any) of the capstone project did you get stuck? | 1. Identifying a topic of interest<br>2. Creating as-is scenario, identifying user pain points, identifying which elements to prototype and which were non-essential (all tied) |
| Were you able to overcome getting stuck? If so, how? | 1. Being forced to turn something in due to time constraint<br>2. Taking a break or doing a different activity |
| How did you know that you were stuck? | 1. Staring at a blank screen<br>2. Repeated activity |
| What strategies (if any) do you use regularly to overcome creative blocks? | 1. Take a break<br>2. Work on something different<br>3. Reference research<br>4. Seek out feedback<br>5. Look for inspiration<br>6. Quick iterations |
| If you had to do the project over again, what would you change (if anything) about the way you conducted your work? (This is not a question about the content of the work, but the process of doing the work) | 1. Spend less time satisfying instructor-driven research deliverables<br>2. More time in general<br>3. Make earlier<br>4. Spend more time refining hi-fi designs<br>5. Testing and redesigning |

# USER PERSONAS & SCENARIO



## BACKGROUND

At the College of Design at North Carolina State University, students' first year experience entails "immersive, hands-on design studios and method courses focused on the processes of design thinking" (First Year Experience, n.d.). As first year students entering college for the first time, students are met with care and encouragement from their educational environment and are confronted with worldview-altering lessons and feedback from professors and peers. This can be both a nurturing and shocking transition for students. Additionally, many students are testing out a diverse array of computer programs for the first time. Introducing significant changes in computer-mediated workflow may be lost among a deluge of change in the students' lives and educational experiences.

By the time NC State University undergraduate design students reach their junior and senior years, they have accrued knowledge through myriad assignments, including collaborations with local companies on sponsored projects to address industry-relevant design challenges. Upper-level students have developed their own methods for coping with a variety of design issues presented to them by their instructors. Whereas newly admitted students are busy absorbing their new environment, living away from their parents, learning to cope with new information and acquiring an array of technical skills, upper-level students have begun to operationalize approaches to researching and formalizing design ideas. Toward the end of their academic career, many students have secured or are in the process of applying to various design positions. In other words, by the time upper-level students reach the end of their academic career, their priorities are divided between educational and professional pursuits. Increased cognitive load and less time to devote to class projects may have detrimental effects on the diversity and originality of ideas employed in their final project.

During their college careers, students become accustomed to having assignments provided to them. Following a predictable path, teachers describe their plan of work through the syllabus, students identify pertinent assignments and (usually) complete these within the given timeframe. In this sense, students' motives are to succeed in their educational training. As noted by one design professor at North Carolina State University, the exciting part of teaching is creating assignments that force students to challenge assumptions, keeping them in a heightened state of inquiry. Ideally, students internalize this kind of inquisitive behavior and incorporate it into their methodological repertoire. However, students' professional transition requires them to tackle design challenges without the explicit aid, direction and feedback from mentors whose goals include keeping students from becoming too comfortable when designing. Having quick access to a personalized system whose goal is to creatively challenge the designer in situations where their priorities are elsewhere may be key to maintaining inquiry beyond the academy.

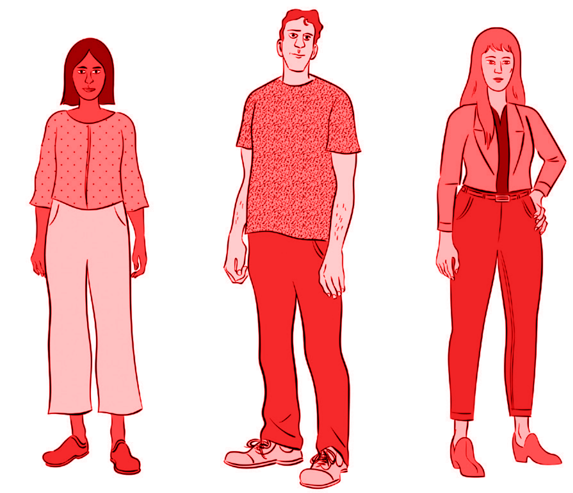
## PERSONAS

**Esma**
**Attitude**: Optimistic, persistent, determined
**Fixation Leve**l: High
Esma is a 21-year-old undergraduate graphic design student at North Carolina State University's College of Design. Esma loves drawing autobiographical mini-comics, listening to music (her guilty pleasure is anthemic pop female vocalists), vintage clothing and keeping up-to-date with the latest trends in web design. She is in her final year and is preoccupied with next steps after school. At her parents' behest, Esma is trying to find an entry-level design position at one of the local tech companies in the area, knowing that they often hire recent graduates and hoping the position will provide her with an income to pay back some of her substantial college loans. Although generally excited to be working on the Capstone project, Esma feels nervous and overwhelmed. In order to graduate on time, she is taking 3 additional classes on top of her studio class and works part-time at the local coffee shop two days a week. To fit everything in, Esma decides on her project direction early: an online journal for mini-comics and zines by immigrant authors. Esma begins to collect visual resources for a mood board before the first week of class.

**Otis**
**Attitude**: Sarcastic, insecure, uncertain
**Fixation Level**: Medium
Otis is a 22-year-old undergraduate graphic design student at North Carolina State University's College of Design. Otis is smart and excels in his academic courses, but sometimes struggles to complete studio assignments. He is often on the fence about what project direction to go in and the Capstone project is no exception. Otis is frustrated going into the process, having previously thought the class would have an entire semester to devote to the independent project. He feels that seven weeks is too short a time to fully explore ideas and create something worthy of putting in his portfolio. When it comes time to decide on a project direction, Otis is uncertain what topic to choose. He knows he is interested in environmental issues, but doesn't know how to shape his interests into a project direction that would satisfy the research requirements for the class or how to set the scope to fit within the limited timeframe. Otis comes to the first week of class underprepared and, as a result, doesn't feel compelled to share anything with the rest of his peers.

**Maggie**
**Attitude**: Resourceful, orderly, pragmatic
**Fixation Level**: n/a
Maggie is a 39-year-old adjunct professor, teaching in the Graphic Design Department at North Carolina State University's College of Design. Maggie spent the majority of her 20s and 30s developing her freelance design practice, getting her Master's degree (also from NC State) and working as a UX designer for SAS in Cary, NC. She was offered an adjunct position teaching the senior undergraduate studio course. Maggie was selected by the department to teach the senior studio course based on her outstanding work in the field and her connections to leading tech companies and professional design peers. She maintains a goal-oriented approach to the design process and encourages her students to do the same.





(left to right)
Esma, Otis & Maggie

## SCENARIO

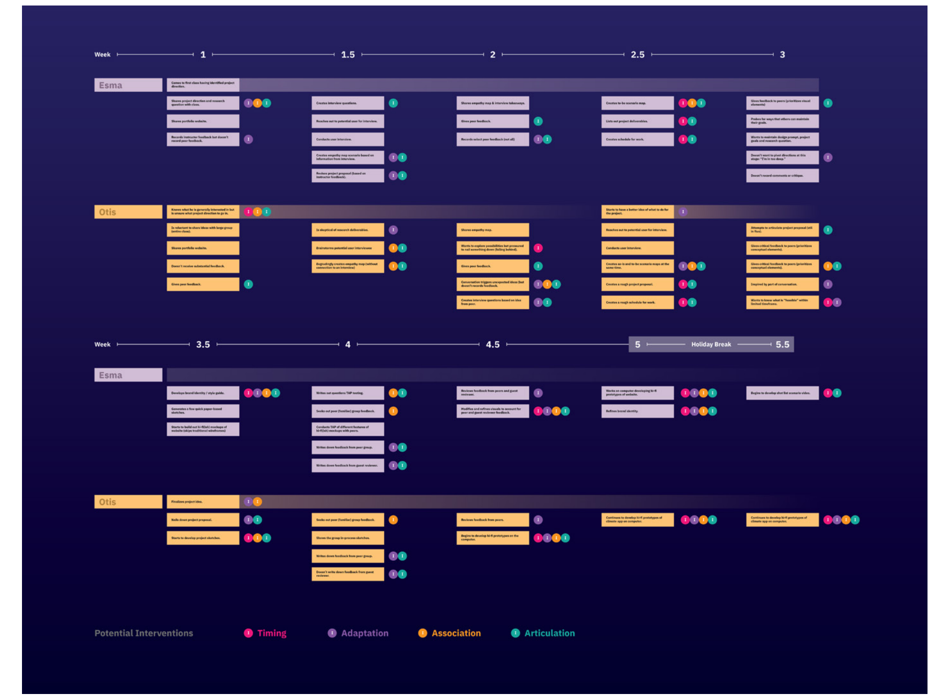
Having just completed a multi-week research project in collaboration with IBM, Esma, Otis and their fellow classmates are coming into the process creatively spent. The premise of embarking on another condensed project in the remaining weeks of the semester is daunting. On the first day, Maggie suggests that the students interact with LEE, the virtual design agent over the course of the Capstone project. In addition to the usual classroom activities, Maggie asks the students to converse with LEE for at least one hour every week about their project. The students are skeptical about the additional requirement on top of their already packed schedules. Maggie reminds students that employers are looking for graduates with experience working with conversational virtual agents as part of their normal design workflow. Some students begrudgingly oblige, while others are curious about the premise of working within a new paradigm. To give the students more incentive to work with LEE, Maggie proposes that their final grade for the class include a "level of virtual agent interaction," in place of producing extensive case study materials.

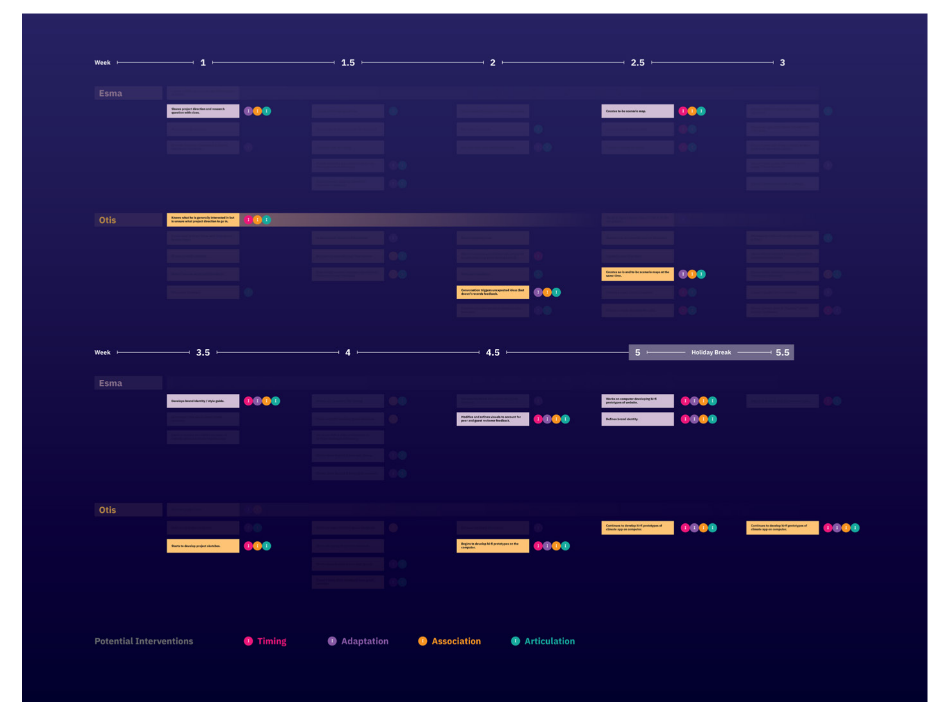
# USER JOURNEY MAP

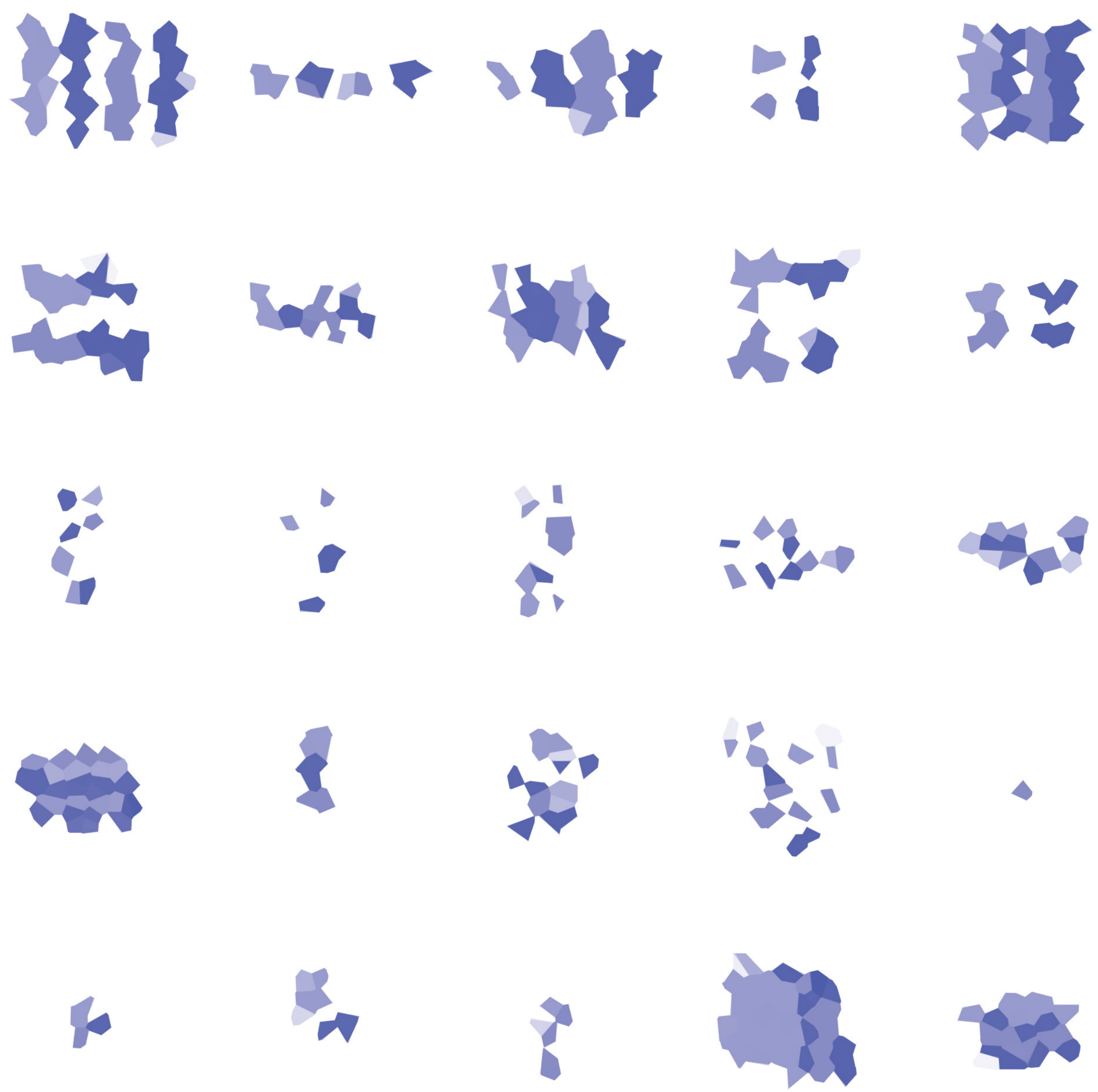


Using my observations as a model, I plotted both personas' journey over the course of a multi-week design project, marking moments of fixation along the way to ground subsequent studies. The journey map stops one week before the project presentation period in consideration of the observable "point of no return," where students were too busy concentrating on making final adjustments to their projects to be receptive to outside feedback. I marked moments of fixation with different colored dots indicating which improvisational strategies (**timing**, **adaptation**, **association** and **articulation**) the virtual agent could employ in response to the student's behavior. Moments with a confluence of appropriate strategies (three or more) narrowed the scope of the investigation, revealing a number of intervention opportunities.

| | |
|---|---|
| **Onboarding / Familiarizing**<br>Establishing VA/designer relationship<br>Creating VA "memory" | **Project Scoping**<br>Articulating expectations<br>Challenging assumptions |
| **Idea Generation**<br>Locating and engaging interests<br>Expanding on existing knowledge<br>Encouraging opportunism | **Revisiting Project Scope**<br>Rearticulating expectations<br>Expanding associations<br>Encouraging opportunism |
| **Fixation Interruption**<br>Observing obsessive design behavior<br>Encouraging "stepping back"<br>Proposing timed iteration | **Coping with Feeback**<br>Introducing unexpected references<br>Incorporating instructor, TA and student feedback |





DESIGN EXPLORATIONS

## 3.1 CO-DOODLING

Early studies of virtual agent that generates and modifies user-created forms in real time, within the user's software canvas.

**Scenario**

Samantha has just finished work on a multi-week "sponsored project" and she is creatively exhausted. Her next assignment is the self-guided senior capstone project, the culmination of her educational experience. She knows she wants to explore something surrounding her passion for music, but she doesn't know where to begin. After scouring Pinterest, Dribbble and Pitchfork for inspiration, Samantha pull up Illustrator to start working out some initial concepts, terrified of the black canvas. Before beginning, she is prompted with an unfamiliar setup alert.

The setup wizard gathers contextual information about Samantha's project, gauges initial progress, project urgency and desired collaboration behavior (fig. 3.1.1). The software proposes an ideation method to get the process started and then proposes an alternative based on the user's preference (fig. 3.1.1).

After the setup phase, Samantha returns to the familiar Illustrator environment, with some subtle differences (fig. 3.1.2). She notices the small avatar on the toolbar. While the avatar speaks to her, Samantha notices that some of her tools are inaccessible. The software avatar begins to place generative forms on the canvas (fig. 3.1.3). Samantha, slightly confused, selects the rectangle tool and begins to draw frames around the generative forms. As she adds to the canvas, the avatar responds by altering its visual approach (fig. 3.1.4). Samantha realizes that the avatar both learns from and proposes alternatives to her visual strategy (fig. 3.1.5). The differences are slight at first but then grow in dissimilarity over time.

**FINDINGS**

Although this study revealed starting points for conversation-based human-computer interaction, the major takeaway was that the form making exercises implied in the illustrations were divorced from consideration of the student's project context, and as such, didn't represent the complexity of a senior-level research project.


fig. 3.1.1

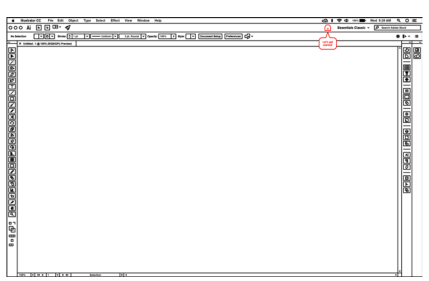


fig. 3.1.2

fig. 3.1.3

fig. 3.1.4

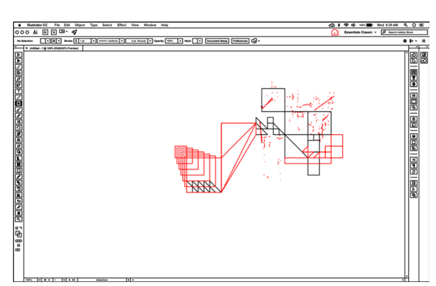


fig. 3.1.5



## 3.2 DESIGN SOFTWARE TOOLS

**Random Style Tool** (fig. 3.2.1)
Different formal changes for different content types (i.e. typeface vs. paragraph orientation). Click, hold and drag with the tool to scan through alternate versions of selected content.

**Alternates Browser** (fig. 3.2.2)
Click notification to reveal 'alternates' view. Scroll left and right to choose alternate style possibilities.

**Shuffle Tool** (fig. 3.2.3)
Selecting content with the shuffle tool and pressing return (enter) automatically rearranges the content within the defined space.

**Synthesis Tool** (fig. 3.2.4)
The synthesis tool would create an amalgamation of selected forms on the artboard.

**Version Shifting** (fig. 3.2.5)
Three finger touch, left to right moves backwards and forwards through project versions.

**FINDINGS**

Similarly to the "Co-doodling" study, these studies continued to address formal concerns, and did not properly speak to the complexity of issues that seniors deal with during their Capstone project. Interesting takeaways included the idea of easily synthesizing multiple ideas together and gestural control of versioning, which prompted the question: what other ways are there to show versioning of projects and how might this be used to break fixated behavior? However, the virtual agent component was conspicuously missing from the studies.

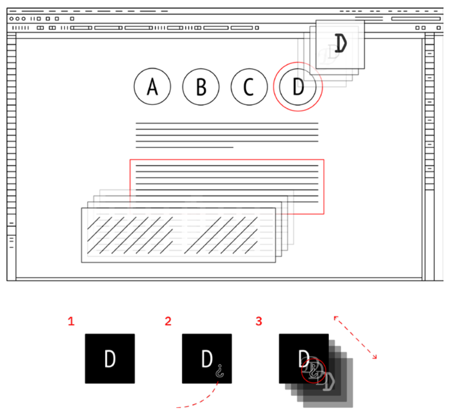


fig. 3.2.1

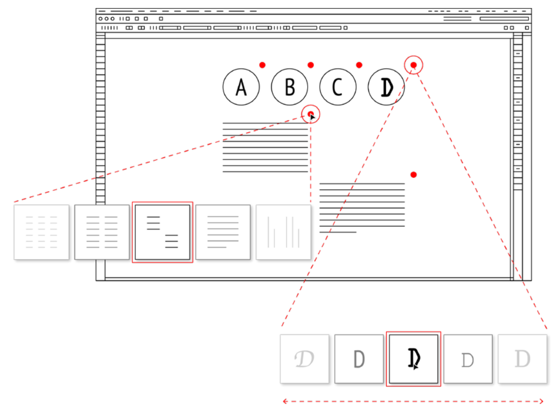


fig. 3.2.2

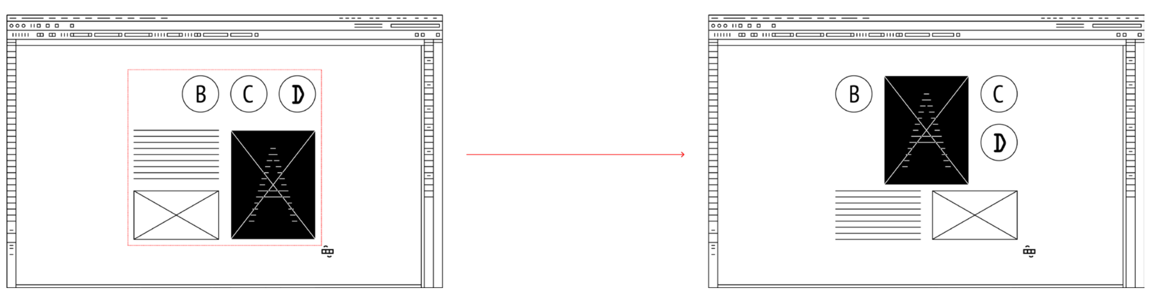


fig. 3.2.3

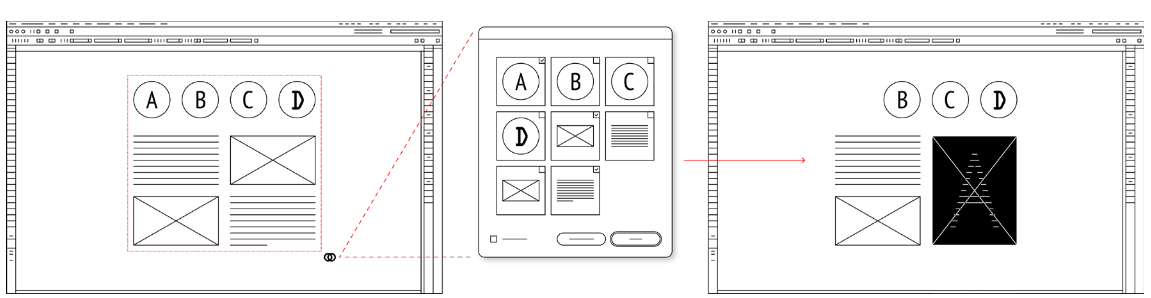


fig. 3.2.4

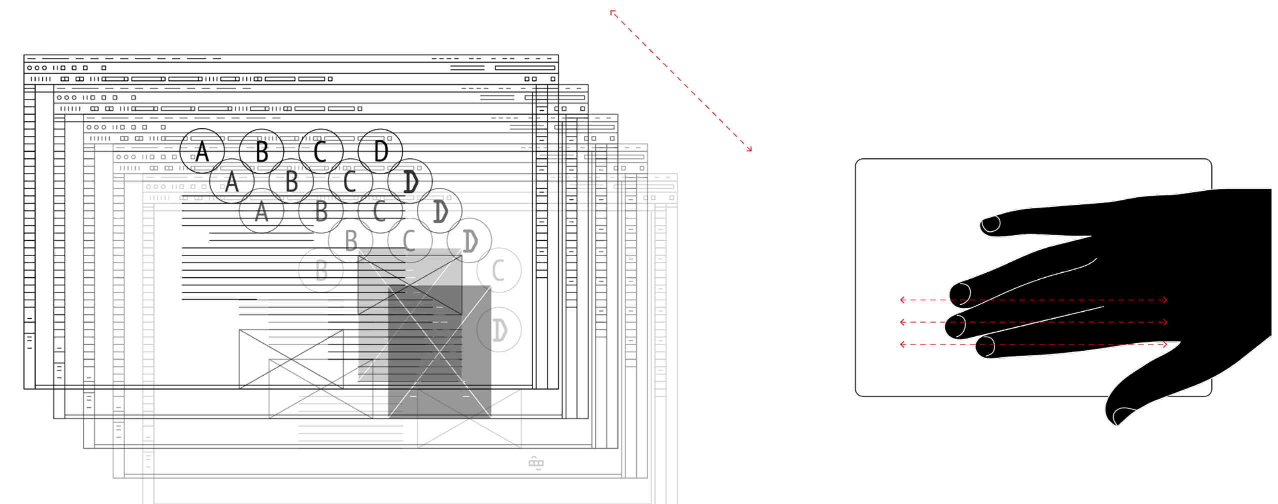


fig. 3.2.5

## 3.3 "CHANGING HANDS" WORKSHOP

An exploratory workshop with fellow graduate students simulated how a virtual agent might (mis)interpret a designer's work in progress through text-based and visual feedback. The software would observe and analyze the student's computer visualizations in progress, and offer interpretational feedback in the form of descriptive and generative responses. This could be facilitated by a virtual agent through image-recognition and generation (similar to Google's Deep Dream Generator). A major insight for subsequent versions of the software interface came from the final phase of the workshop where students projected possible directions for individual design investigations. For many of the workshop participants, identifying opportunities, even in seemingly unrelated ideas allowed them to see their project in a new light. Opportunism is a key competency of expert designers (Cross, 2010) and improvisers alike.

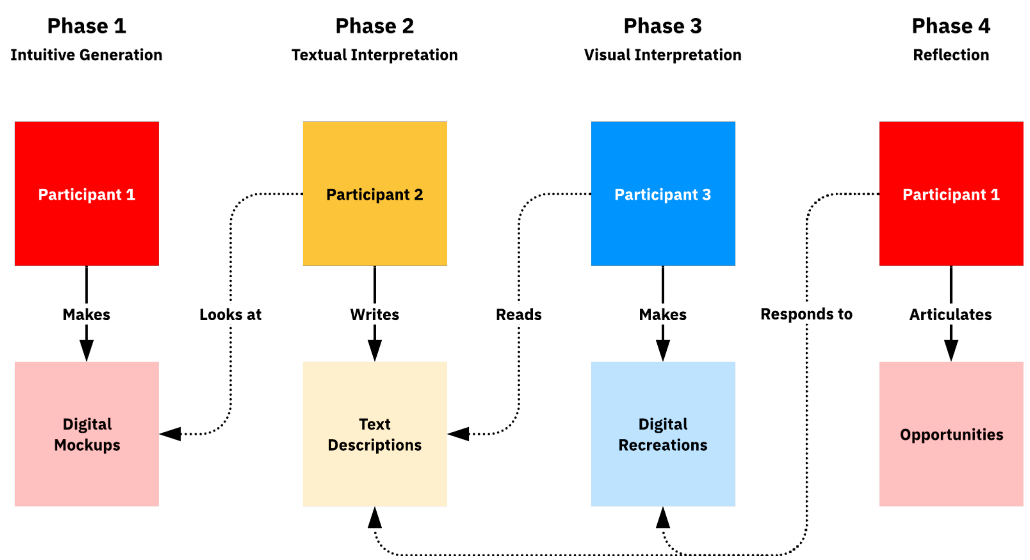



fig. 3.3.1

**Workshop Description**

In his book The Reflective Practitioner (1983), Donald Schön describes design as "situated cognition," a process where designers are faced with unexpected feedback from various stakeholders, impacting the trajectory of the designer's mode of creation. In Improvisational Design (2003), Suguru Ishizaki describes a framework of virtual design agents, modular design sub-systems that respond to changes in the digital environment, information content and user preference. The "Changing Hands" workshop explores collaborating with and responding to other design agents — in this case, other designers — using a combination of intuitive and reflective making strategies. The workshop forces participants to adapt to changing contexts and interpretations of their work as iterations shift hands throughout the process.

In **Phase 1** of "Changing Hands," students are asked to create three visualizations without expository text showing a range of states, moments or narratives from the current condition of their final project. In **Phase 2**, students switch projects, and provide text-based descriptions



of their partner's visualizations. In **Phase 3**, projects switch hands again to a new set of students. These students create visualizations based solely on the written descriptions from the previous phase. Finally, in **Phase 4**, each student returns to their own project and articulates how to utilize or account for (mis)interpretations of their work (fig. 3.3.1).

The intent of the workshop was to simulate the experience of a student designer interacting with a software design agent during computer-mediated making process. In the early stages of design ideation, the software agent would observe and analyze the student's visualizations in progress within the design program. The agent would then offer interpretational feedback in the form of descriptive and generative responses, prompting the designer to reconsider and adapt to the computer's interpretation of their work. The experience of receiving feedback of a design in progress allows the student to identify and articulate issues and opportunities early on. This may result in the student's enhanced ability to shift directions in response to or accounting for the software agent's feedback, as well as, ideally, being able to step outside their normal making strategies to see their work from alternate perspectives.

**FINDINGS**

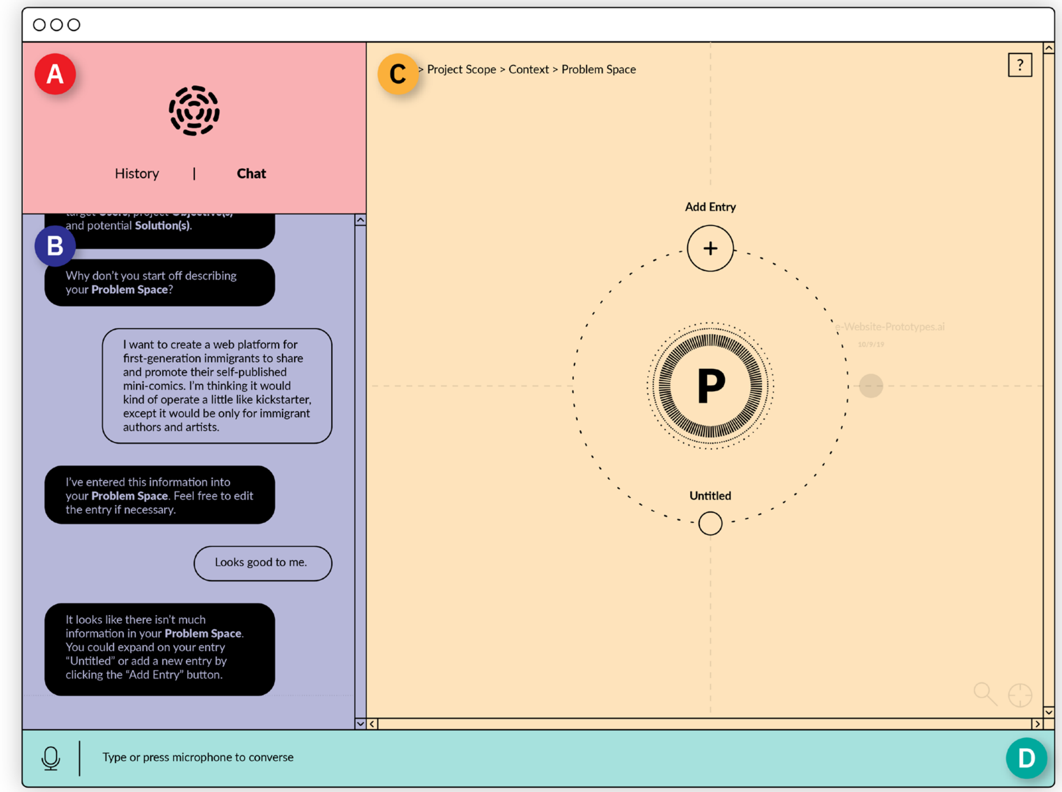
Although the workshop was conducted in a pseudo-scientific manner, some interesting patterns emerged from the process. Overall, students noted a moderate to high level of opportunism, or their ability to see new opportunities from others' interpretations of their work, at the end of the workshop. Other findings included a slight average decrease in visual ambiguity (increased visual specificity) from Phase 1 to Phase 3 and an increase in propositional interpretations (new ideas) from Phase 2 to Phase 3. During the workshop, a number of student participants noted that they were more motivated to complete their own visualizations than visualizations for other students' projects. This is partly to be expected. Practically however, this may mean extending the time for Phase 1 up to a day or two and limiting the kind and scale of responses in Phases 2 and 3. Since the workshop participants were all part of the same studio course, their awareness of each others' projects may have had significant impact on the type and quality of their responses.

The majority of the visual and interaction studies were based on my two personas, Otis and Esma. Having identified the most opportune moments to intervene along their respective user journeys, I began to build out interactions that would occur during three key stages of both personas' design process: **idea generation**, **project scoping** and **visual refinement**.

## 3.4 GENERATING IDEAS (1)

Initial explorations of the interface featured two main windows: a chat window, where the software agent and the design student would converse via text or mic input, and a multi-mode window, where the software would switch between visual mappings of the designer's conceptual direction over time, a timeline of different conversations between the student and LEE, and creative exercises to stimulate new perspectives and greater project complexity (fig. 3.4.1). In early prototypes, the student converses with LEE via the chat window on the left side of the interface. In this study, LEE would run through multiple rounds of word associations, asking the designer to choose topics of interest, then asking them to articulate how different combinations could develop as design projects. In this scenario, Otis begins the process using ambiguous terms. However, by repeating the process, using keywords that the designer generated in previous rounds, the designer would eventually begin to reveal a richer design investigation.

**Scenario**
Otis logs onto the LEE interface for the first time and is met with a few introductory questions, asking him about the status of his project (fig. 3.4.2). After Otis expresses that he doesn't have a clear sense of how to progress, LEE generates a timed exercise to help Otis come up with ideas based on his interests (figs. 3.4.3 + 3.4.4). LEE asks Otis to articulate potential design directions that might come out of combining his interests (fig. 3.4.5). When Otis tries to skip ahead with time to spare, LEE pushes back and challenges Otis to generate another design possibility (fig. 3.4.6). LEE generates a second round of word associations, based on the responses from the previous round (fig. 3.4.7). Whereas the first round of word associations were abstract and vague, Otis's responses in the second round begin to develop greater specificity and complexity. Again, LEE asks Otis to articulate a design possibility based on the new word combination (fig. 3.4.8). This time, Otis generates a much more complex idea, one that involves areas of his own interest. When LEE asks Otis if he has learned anything from the exercise, Otis is surprised that he was able to come up with something so unexpected (fig. 3.4.9).




A Virtual agent  B Chat window  C Multifunction window  D Text & voice input

fig. 3.4.1

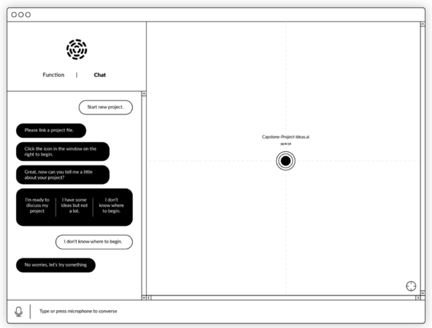


fig. 3.4.2

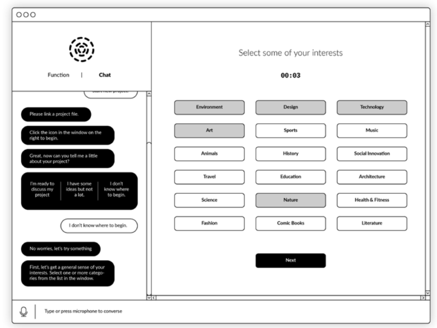


fig. 3.4.3

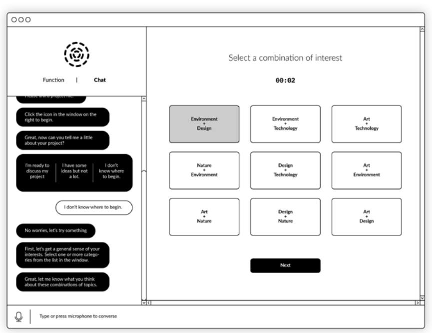


fig. 3.4.4

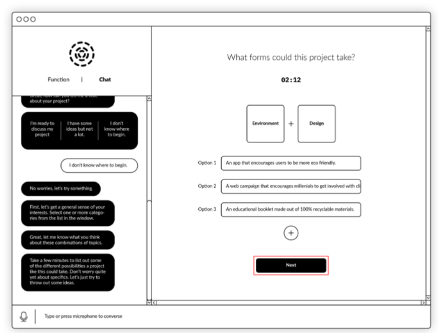


fig. 3.4.5

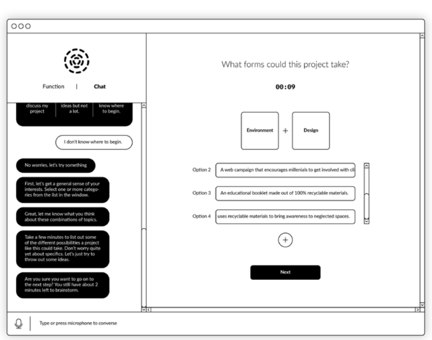


fig. 3.4.6

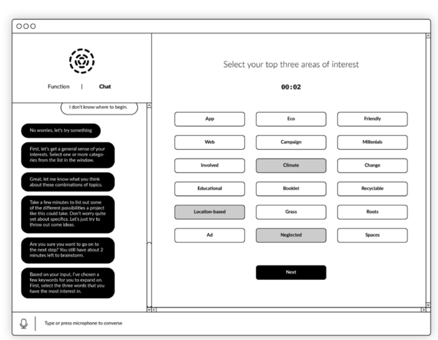


fig. 3.4.7



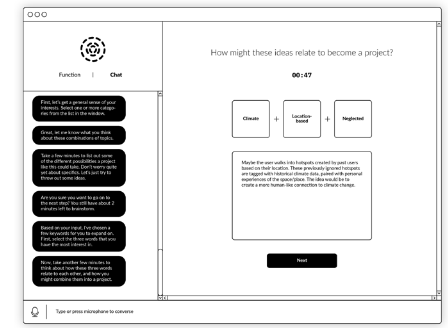


fig. 3.4.8

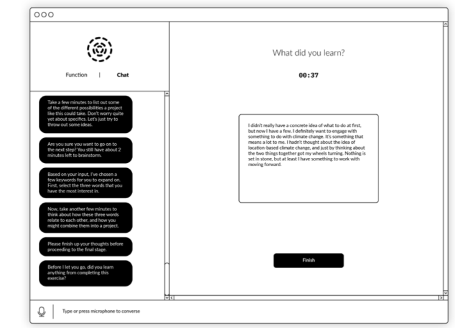


fig. 3.4.9

**FINDINGS**

This study challenged me to work through some of the functionality of the interface, how LEE would stimulate the designer to generate ideas. As I developed the scenario, I played the role of Otis to see what I could come up with on the fly; I did not know what Otis was planning on making for his final project at the start of the study, just like the persona! By going through the process of identifying interests from the character's profile, and articulating possibilities based on those interests, I began to craft an idea that Otis could follow for his capstone project. In this way, the study had characteristics of a wireframe, storyboard and bodystorming. Although this study was pivotal in laying the functional groundwork of the interface, Professor Gonzales Crisp noted the rigidity of the interface, and encouraged me to explore different ways that the AI could establish a relationship with the user instead of the questionnaire format that I had been using. She also encouraged me to explore different ways of showing the progress of the project over time.

## 3.5 ELABORATING ON THE PROJECT

In contrast to Otis, Esma knows exactly what she wants to do for her project going into the process. The difference in approach prompts different responses from LEE. In this study, I explored how LEE would challenge Esma early on in the process to expand the scope of her project, introducing articles from the web and asking her to account for new information. Like with Otis, LEE uses the designer's words to prompt exercises that ask the designer to articulate their position. Here, LEE confronts Esma's interests with anomalous feedback, which prompts her to dig deeper into her investigation.

**Scenario**
LEE asks Esma to describe her project's problem space (fig. 3.5.1). When Esma provides a nondescript response, the virtual agent pushes back and proposes that she try an exercise to help her elaborate (fig. 3.5.2). Based on her initial response, the virtual agent combs the web for related articles, asking Esma to intuitively choose an article that speaks to her (fig. 3.5.3). When she selects an article, the virtual agent pulls out interesting quotes to speed the process along, and asks Esma, again, to intuitively choose a quote to respond to (fig. 3.5.4). The quote from the news article forces Esma to consider real world phenomena related to her project (fig. 3.5.5), and prompts her to shift her project direction to account for this information (fig. 3.5.6).

**FINDINGS**

While the introduction of news articles from the web was successful for exposing the designer to unexpected associations, like with "Generating Ideas," this study relied heavily on a survey-like question and answer format, and did not feel especially "improvisational." Gonzales Crisp again suggested that I explore different ways that LEE might glean information from the user without the interaction becoming too formal.



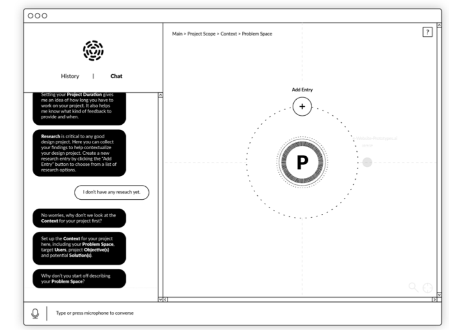


fig. 3.5.1

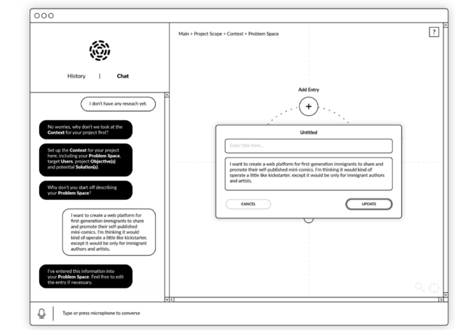


fig. 3.5.2

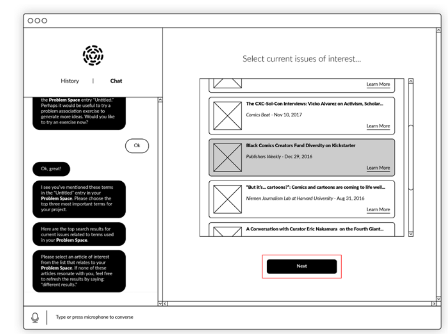


fig. 3.5.3

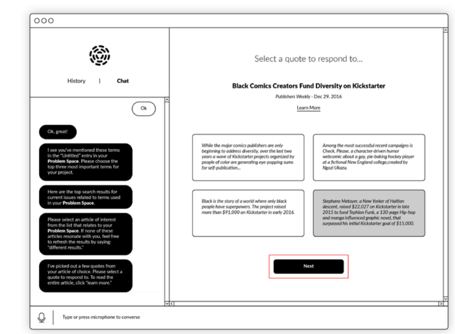


fig. 3.5.4

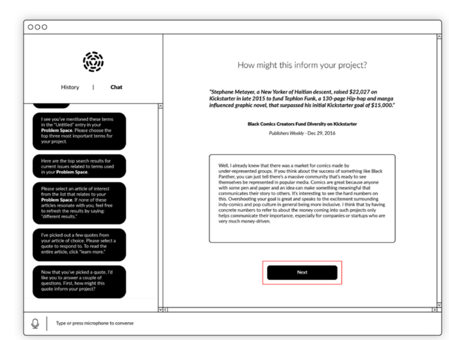


fig. 3.5.5


fig. 3.5.6

## 3.6 SCHEMA EXPLORATION

Eventually, the question “what are the AI and the student building when they interact with each other?” arose during conversations with Professor Gonzales Crisp. Instead of thinking about the question metaphorically, I considered different ways that the human-computer conversation might build visually over time (figs. 3.6.1 - 3.6.4). Later prototypes of the interface included different versions of these visual records. By recording interactions as distinct nodes, the user would have the ability to review conversations and exercises after-the-fact, select, move and connect past interactions to trigger new exercises, providing an augmented conversational experience.

**Schemas** (fig. 3.6.1)
When the student designer interacts with the virtual agent (VA) via conversation and computer-based creative exercises, the VA creates...

**Sporing**
“Spores” of varying size, shape and color, based on

- the number of back-and-forth interactions between the user and VA
- type of interaction (adaptation, association, articulation, timing)
- duration of interaction
- and level of user-reported influence on project direction

The user can return to a spore after-the-fact to reveal conversation history and exercise insights from past interactions.

**Tiling**
“Tiles” of varying color, based on

- type of interaction (adaptation, association, articulation, timing)

and location, based on

- relatedness to past interactions

The user can return to a tile after-the-fact to reveal conversation history and exercise insights from past interactions.



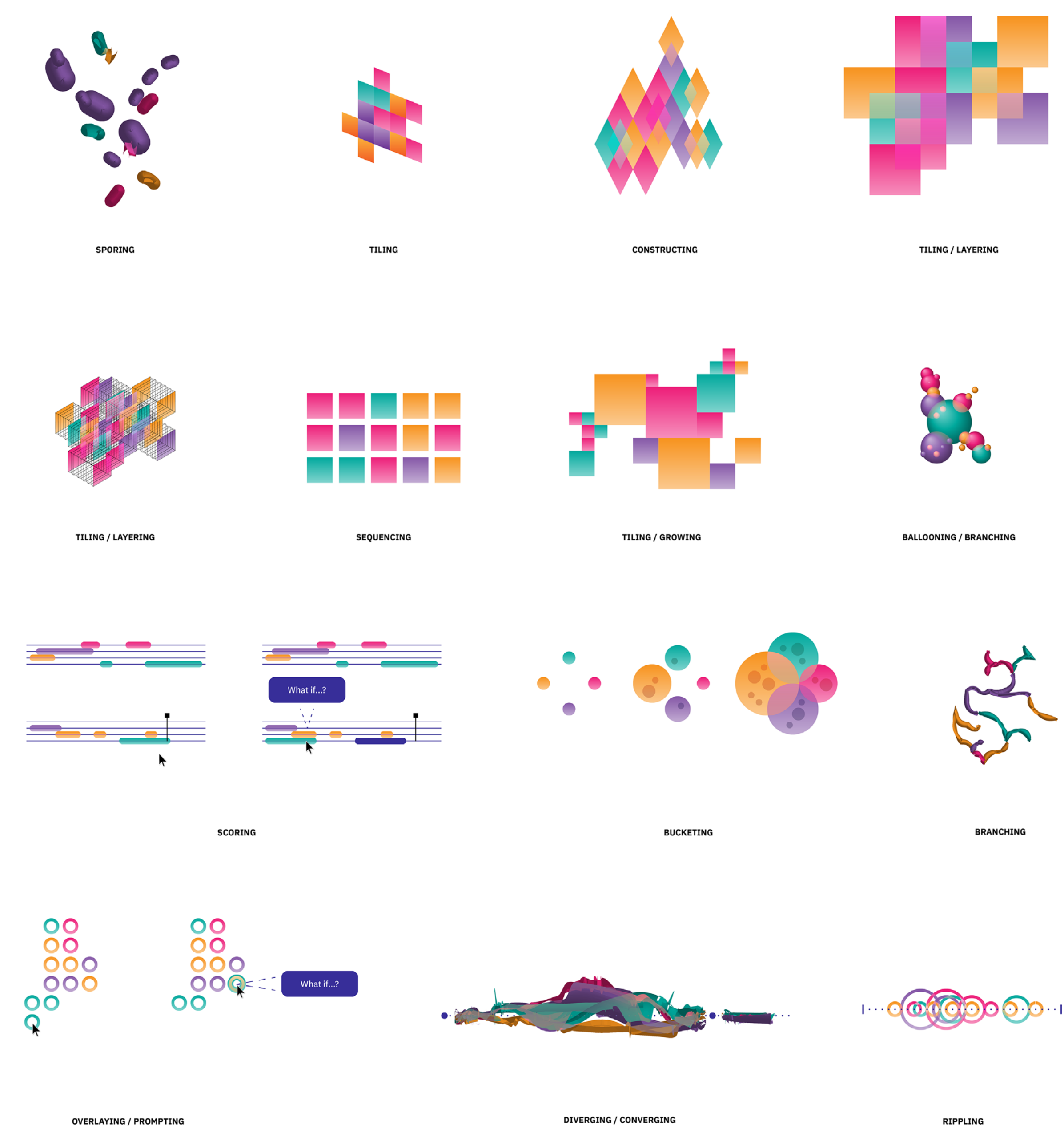



fig. 3.6.1

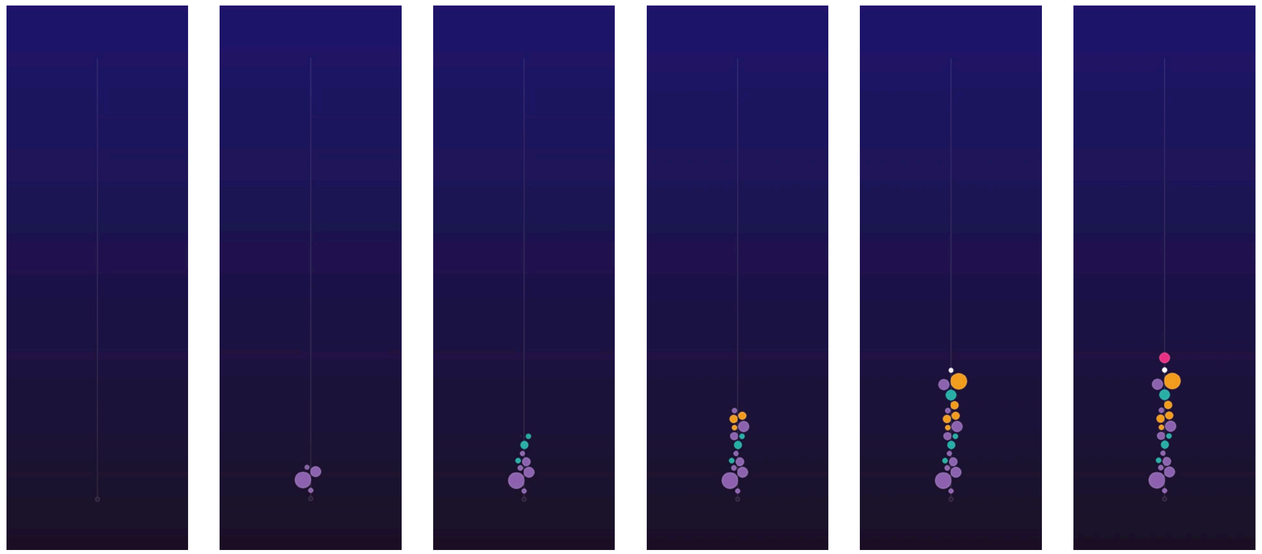


**fig. 3.6.2** “Sequencing”

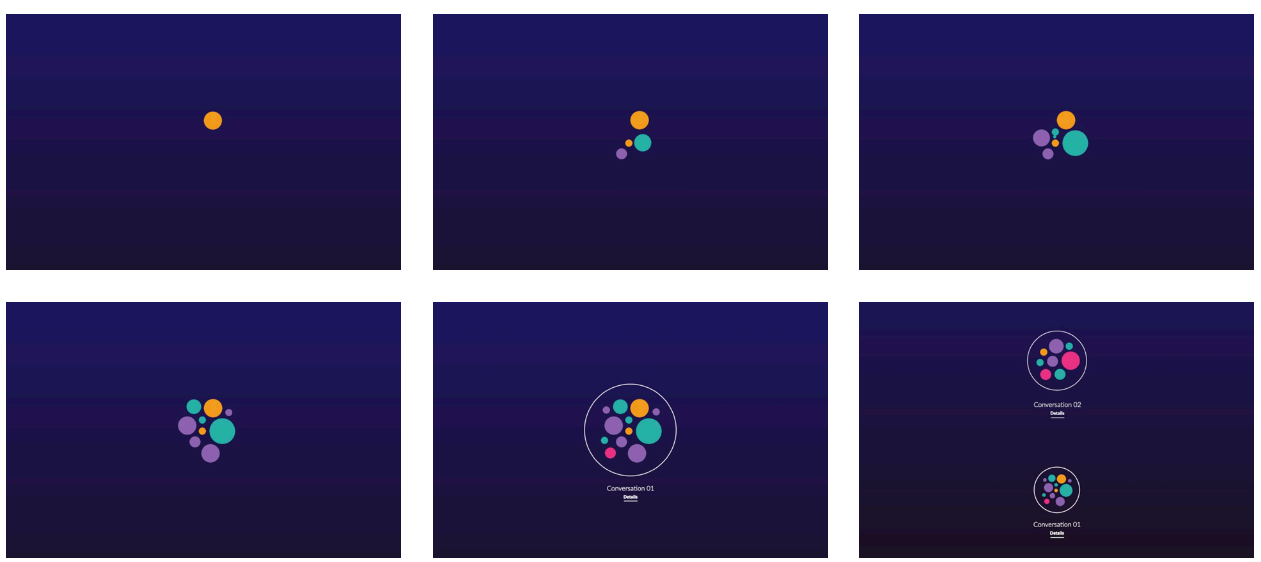


**fig. 3.6.3** “Bucketing”



**Constructing**

A structure of components of varying color based on

- type of interaction (adaptation, association, articulation, timing)

and connectivity, based on

- relatedness to past interactions

The user can return to a component after-the-fact to reveal conversation history and exercise insights from past interactions. The user can select component connection points to learn why the VA chose to link two or more interactions together.

**Tiling/Layering**

A structure of tiles of varying color based on

- type of interaction (adaptation, association, articulation, timing)

and layering, based on

- relatedness to past interactions

The user can return to a tile after-the-fact to reveal conversation history and exercise insights from past interactions. The user can select tile overlays to learn why the VA chose to layer two or more interactions together.

**Sequencing**

A sequence of tile “events” of varying color based on

- type of interaction (adaptation, association, articulation, timing)
- history of events along a timeline

The user can return to an event after-the-fact to reveal conversation history and exercise insights from past interactions.

**Tiling/Growing**

A network of tile “events” of varying color, size and location based on

- type of interaction (adaptation, association, articulation, timing)
- duration of interaction
- level of user-reported influence on project direction
- relatedness to past interactions

The user can select adjacent event connection points to learn why the VA chose to link two or more interactions together.

**Ballooning/Branching**

A network of event "nodes" of varying color, size and location based on

- type of interaction (adaptation, association, articulation, timing)
- duration of interaction
- level of user-reported influence on project direction
- relatedness to past interactions

Conceptual tangents are split along different "branches." The user can return to a node after-the-fact to reveal conversation history and exercise insights from past interactions. The user can select adjacent event connection points to learn why the VA chose to link two or more interactions together.

**Scoring**

A generative musical "score" of interaction events that propagate over the course of the project. The VA places "notes" along a timeline based on

- type of interaction (adaptation, association, articulation, timing)
- duration of interaction

The user can return to a node after-the-fact to reveal conversation history and exercise insights from past interactions. The user can move notes forwards and backwards along the score timeline to reveal new inter-note, "hybrid" insights (chords).

**Bucketing**

Cellular buckets that "fill up" over time based on

- type of interaction (adaptation, association, articulation, timing)
- duration of interaction
- level of user-reported influence on project direction

The user can return to a cell after-the-fact to reveal conversation history and exercise insights from past interactions. The buckets will eventually overlap and collide with each other, visualizing a richer design investigation.

**Branching**

A network of decision paths of varying color and directionality, based on

- type of interaction (adaptation, association, articulation, timing)



- vertical movement towards an actionable objective (determined through user-reported influence on project direction)

The user can return to a branch "split" after-the-fact to learn why the VA chose to split the user's visual and/or conceptual progression.

**Overlaying**

An array of ring "events" of varying color and location based on

- type of interaction (adaptation, association, articulation, timing)
- relatedness to past interactions

The user can return to a ring after-the-fact to reveal conversation history and exercise insights from past interactions. The user can move rings around the array to reveal new "hybrid" insights.

**Diverging/Converging**

A three-dimensional map of interactions along a timeline, showing threads of different color, complexity and proximity, based on

- type of interaction (adaptation, association, articulation, timing)
- duration of interaction
- level of user-reported influence on project direction
- level of divergence from a user-defined theme

The user has the opportunity to create anchors along the timeline to rearticulate the problem frame. Doing so would realign/reorient subsequent levels of divergence and convergence.

**Rippling**

A series of "ripples" of varying color and size along a timeline, based on

- type of interaction (adaptation, association, articulation, timing)
- duration of interaction
- level of user-reported influence on project direction

The user can scan through past interaction ripples by moving the location marker along the timeline.

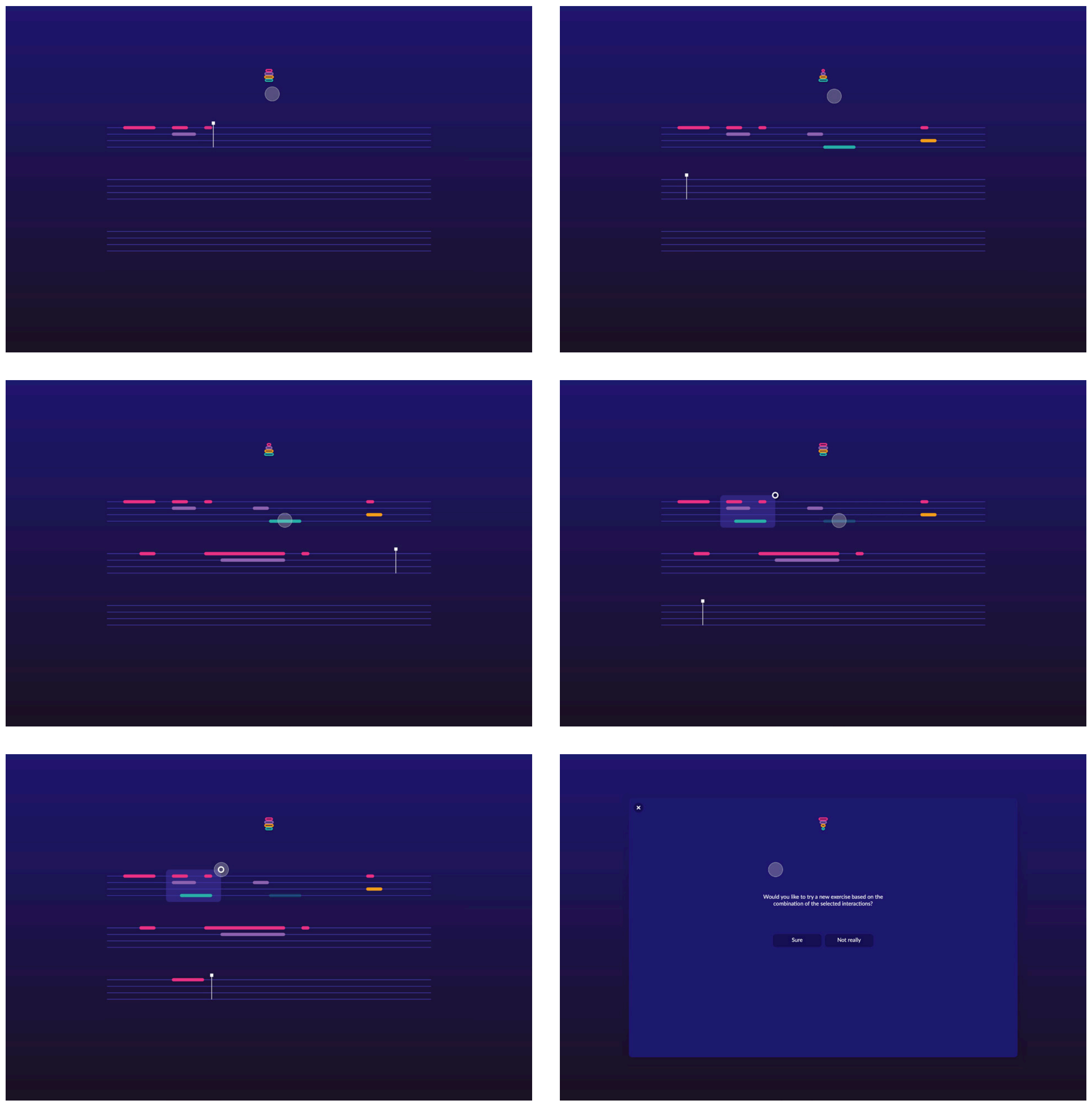



**fig. 3.6.4** "Scoring"



**FINDINGS**

A number of important realizations came out of these studies. The use of visual information to connote project development over time was valuable regardless of approach, but the specifics of each schema revealed deeper insights. Moving past interactions around the visualization to inform new creative prompts, as seen in the "Overlaying/Prompting" and "Scoring" schemas, became a recurring theme. While the "Scoring" schema was eventually abandoned in later versions of the interface, manipulating past interactions to stimulate new ones remained an important theme throughout the remainder of the studies.

## 3.7 GENERATING IDEAS (2)

As I developed the interface, I eventually collapsed the distinction between conversation and improvisational exercises, focusing instead on the improvisational nature of the conversation. I returned to the initial exchange between LEE and Otis, using some of the lessons learned from previous studies.

**Scenario**

LEE greets Otis as he logs in for the first time, provides a brief overview of the system, and asks Otis to provide details about himself (fig 3.7.1). After Otis gives his name, student status and explains how he got into design, LEE requests more background information (fig. 3.7.2). When Otis describes his busy schedule, LEE picks up on his emotional state (fig. 3.7.3), and checks to see if it correctly understands the current state of Otis's project (fig. 3.7.4). After asking some more project-specific questions, LEE requests that Otis think of possible design project ideas based on the combination of what he knows now and what he wishes to learn more about. As Otis stumbles through a few ambiguous responses to the prompt, LEE encourages him to push further, to continue generating ideas (fig. 3.7.4). From Otis's responses, LEE picks out keywords, re-presents them to Otis in graphic format (fig. 3.7.5), asks him to choose the three most important terms from the list, and challenges him to think about how these terms could be combined into one idea (fig. 3.7.6). The forced association prompts Otis to approach his project differently and stimulates an idea that he can pursue further.

**FINDINGS**

This study focused primarily on the ways that the AI might parse through informal conversation to find terms that it could reference as material for subsequent creative exercises. The goal here was to move away from the interface relying too heavily on the user the "choosing," picking options out of a list. Prior feedback suggested that this wasn't a very improvisational mode of interaction. While I believe I was successful in limiting those actions, replacing them with a conversational mode of information retrieval, the language and dynamic between the AI in these studies remained rational and largely didactic. Feedback included reducing the embedded power dynamic of the AI to reflect a more collaborative, peer-to-peer relationship, rather than a teacher/student relationship. This corresponds to previous survey research, where feedback from the teaching assistant was preferred to feedback from the instructor, presumably because of the more collegial dynamic between the student and TA.

## 3.8 INTERRUPTING FIXATION

In this study, I focused on making LEE's language more collegial. Instead of always having the right answers, LEE provides an educated guess about what Esma could be doing instead of her natural inclination to overprocess one element within her design document. In this way, the virtual agent isn't overextending its authority over the designer; this kind of self-assuredness may be off-putting, especially with a non-human entity. Instead, LEE offers a propositional method, which the designer can either accept or reject.

**Scenario**
LEE catches Esma as she fixates on constructing a headline for the landing page of her website (fig. 3.8.1). LEE checks to make sure it's properly assessing Esma's "stuckness" (fig. 3.8.2) by reminding her that she's been



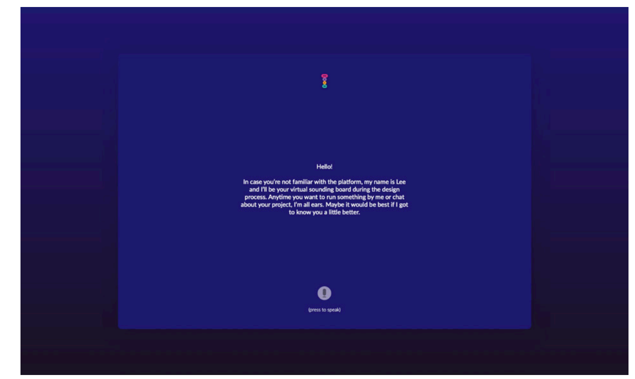


fig. 3.7.1

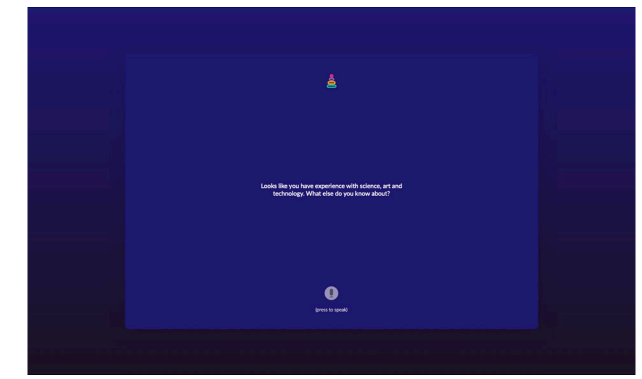


fig. 3.7.2

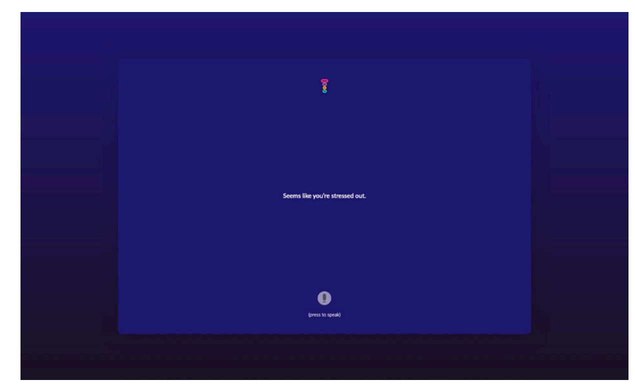


fig. 3.7.3

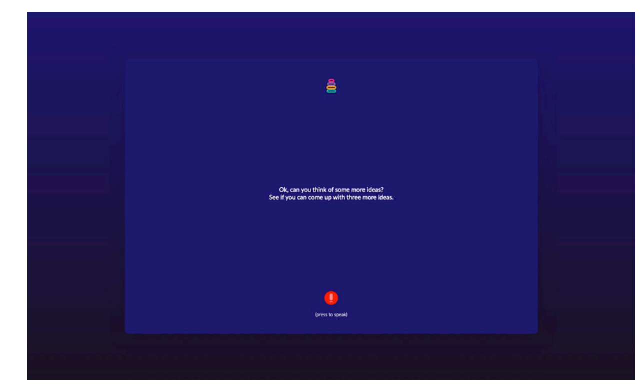


fig. 3.7.4

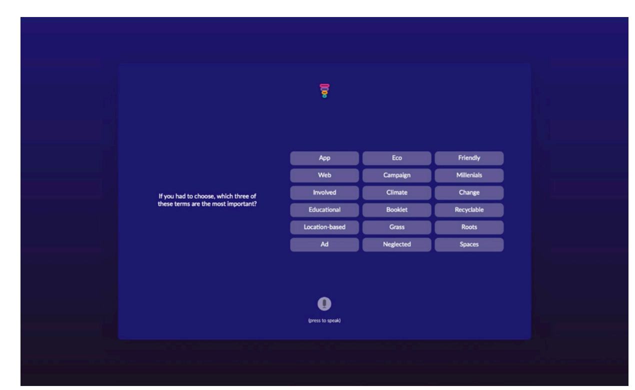


fig. 3.7.5

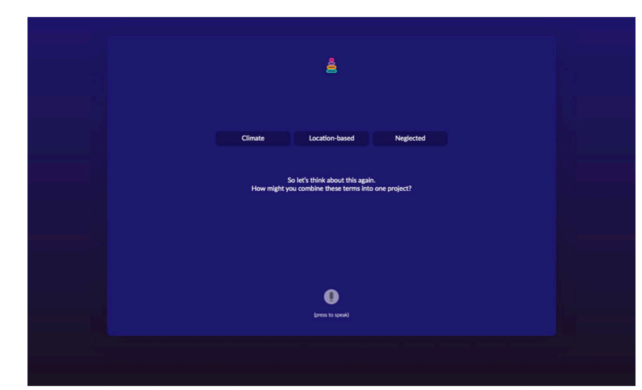


fig. 3.7.6

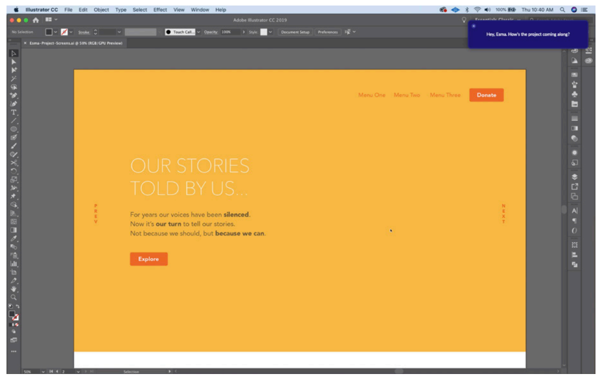



fig. 3.8.1

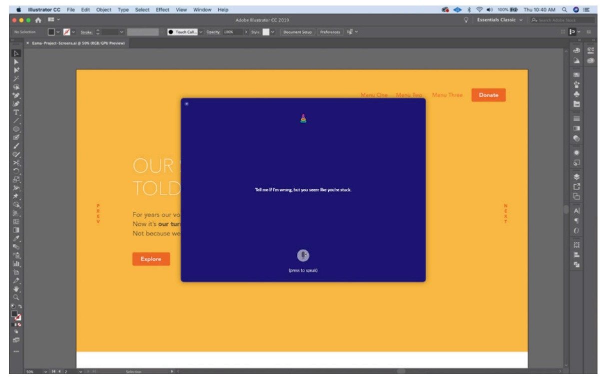


fig. 3.8.2

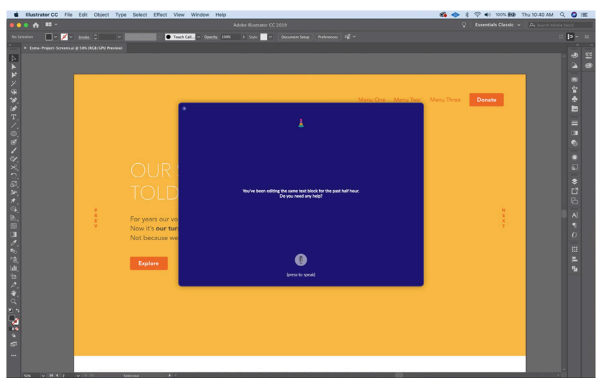


fig. 3.8.3

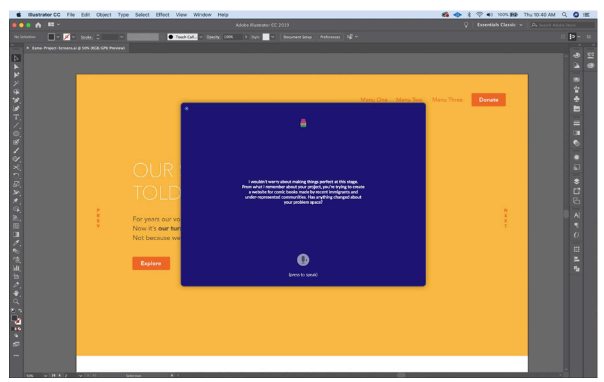


fig. 3.8.4

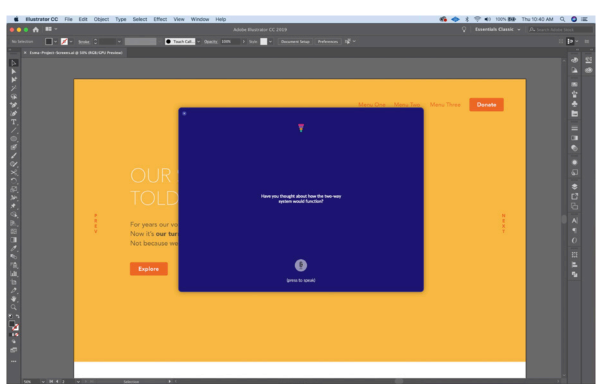


fig. 3.8.5

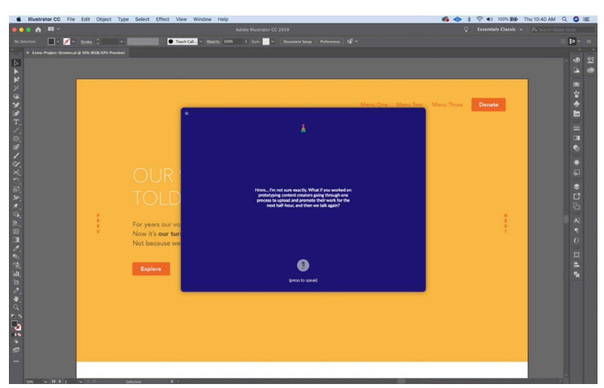


fig. 3.8.6



working on a single element in her design fie for over half an hour (fig. 3.8.3). LEE reminds Esma to step back (fig. 3.8.4) and think about which elements she needs to address in order to communicate her concept to others (fig. 3.8.5). To help relieve some of the pressure of creating a “perfect” design, LEE sets a thirty minute timer and asks Esma to work on prototyping one of the necessary elements within the condensed time frame (fig. 3.8.6).

**FINDINGS**

Feedback from this study seemed to suggest that there could be alternative methods of notifying the designer of a particular point of fixation. Out of this critique came the question: how might the virtual agent notify the designer without making them feel imposed upon or annoyed?

## 3.9 REVIEWING INSIGHTS

While visualizing the conversation between the designer and virtual agent offered an aesthetically pleasing quality to the interface, the visualizations remained unclear as to what they were representing. Some method of labeling was necessary for the designer to be able to use the conversation nodes in her process. These studies offer variations on the theme.

**Trial 1**
I began with a more familiar visual schema based on a timeline. The designer would scroll through the timeline and click on nodes between conversation start and stop points to reveal top level conversation information, and a detailed conversation transcription (figs. 3.9.1 & 3.9.2).

**Trial 2**
Attempting to venture out from the norm, Trial 2 (figs. 3.9.3 & 3.9.4) explored something akin to the “bucketing” schema from Study 3.6. Here, the interface references a map (or molecular composition), with conversations occupying distinct bubbles or dialog nodes. Smaller bubbles within larger conversation bubbles are categorized according to different

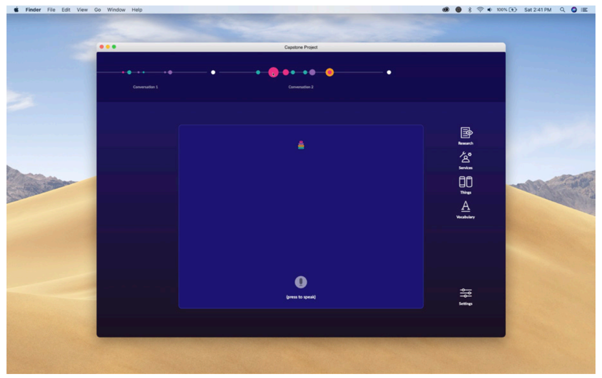


fig. 3.9.1

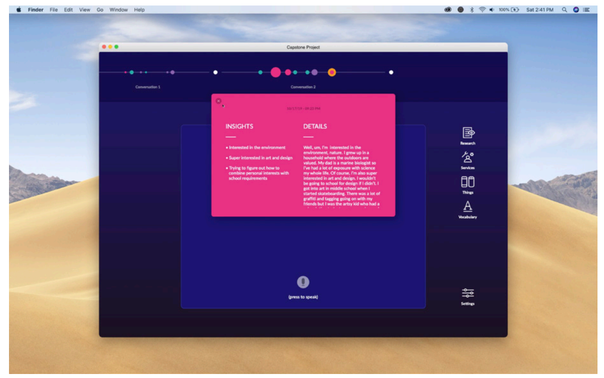


fig. 3.9.2

elements within a student's design project: research, services, artifacts and visual vocabulary, designated by different colors and icons. Like in the previous trial, users would click on an element to reveal top level insights and detailed transcription of the conversation.

**Trial 3**
Exploiting the geographic/molecular metaphor, Trial 3 focused on how the user might "zoom-in" to see the conversation nodes in greater detail (figs. 3.9.5 - 3.9.8).

**FINDINGS**

The important takeaway from this study came from settling on a non-traditional visual schema, and the use of adjustable scale to enhance the user's ability to distinguish detailed insights from larger picture conversations.



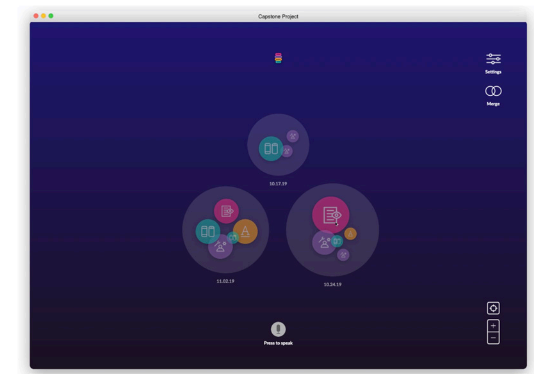


fig. 3.9.3

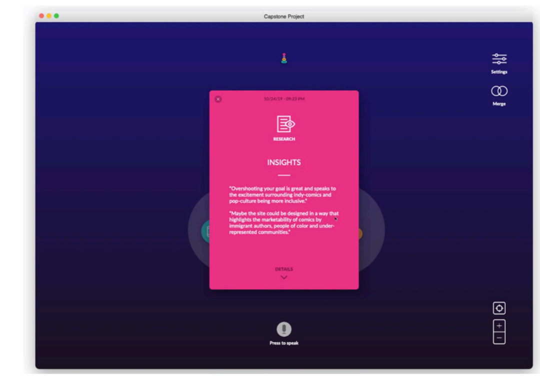


fig. 3.9.4

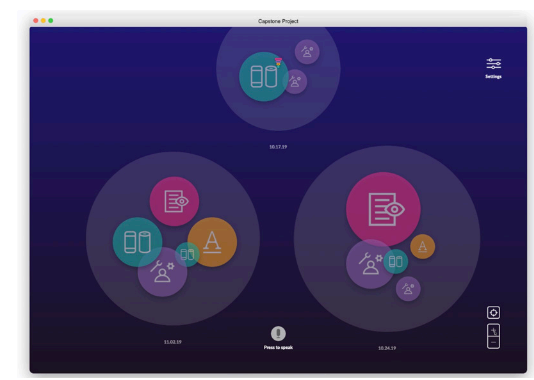


fig. 3.9.5

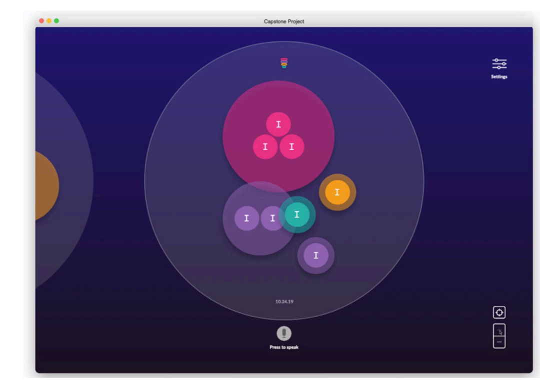


fig. 3.9.6

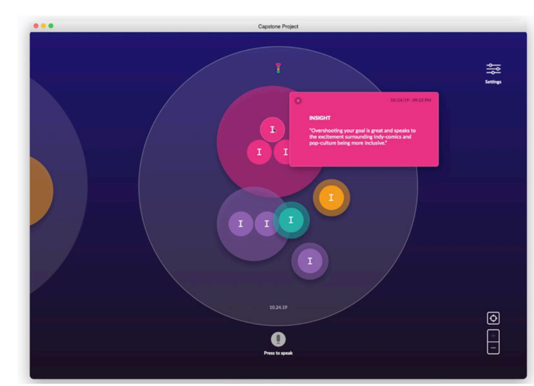


fig. 3.9.7

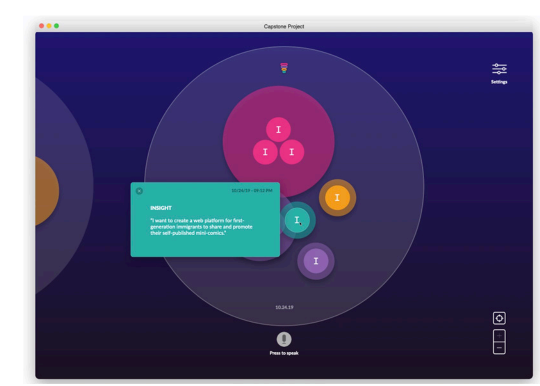


fig. 3.9.8

## 3.10 SYNTHESIZING IDEAS

From discussions with Professor Gonzales-Crisp, it became evident that the visualizations of conversations between the student designer and LEE, the virtual agent needed to function as something more than just a visual record, something to excite the process instead of passively recording it. To speak to this concern, I drew from earlier trials with “synthesis” tools embedded within the design software interface. The following studies play with synthesizing multiple idea nodes from previous conversations between the student and AI.

**Trial 1**

In the first trial, the designer activates the ‘merge’ function (fig. 3.10.2), which brings up a discrete dialog box. The designer chooses conversation nodes one by one (figs. 3.10.3 & 3.10.4), and initializes the merge action (fig. 3.10.5), which prompts LEE to contemplate a potential creative exercise (fig. 3.10.6).

**Trial 2**

The second trial utilized the same stepped functionality as the first trial, this time with a slightly modified visual schema (figs. 3.10.7 - 3.10.12).

**Trial 3**

Here I incorporated the zoom functionality from the “Reviewing Insights” study, which allowed the user to pinpoint specific insight nodes to merge. Instead of breaking the merge function into discrete steps, these studies simplified the process by allowing the user to drag and drop insights over each other to initialize the synthesis of two ideas (figs. 3.10.13 - 3.10.21).

**FINDINGS**

These studies looked at the ways a user might merge or synthesize ideas from previous AI/designer conversations. Although subtle, modifying the system to support a drag and drop approach allowed the process to become more fluid. The intention here was to encourage unpredictable experimentation when the student combines ideas. Removing barriers, no matter how slight, moves the student closer to this goal.



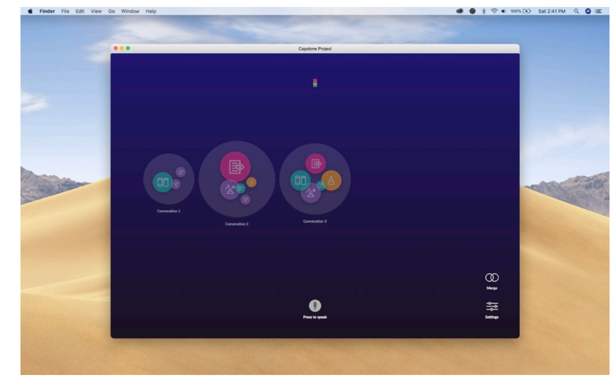


fig. 3.10.1

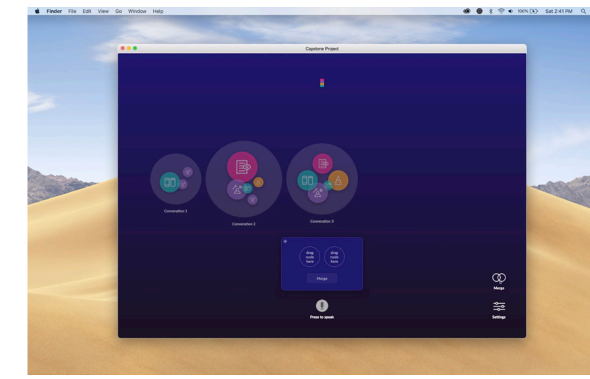


fig. 3.10.2

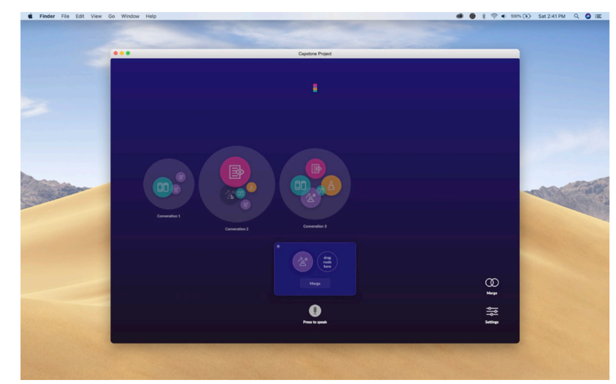


fig. 3.10.3

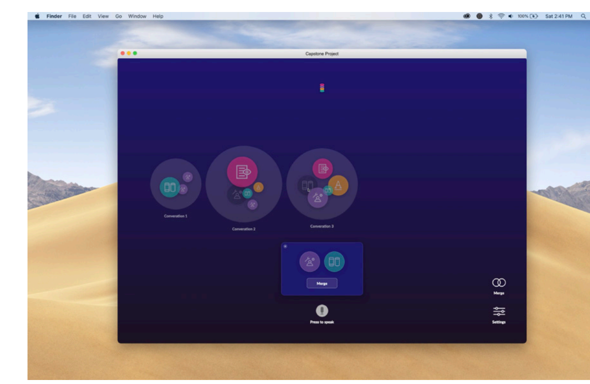


fig. 3.10.4

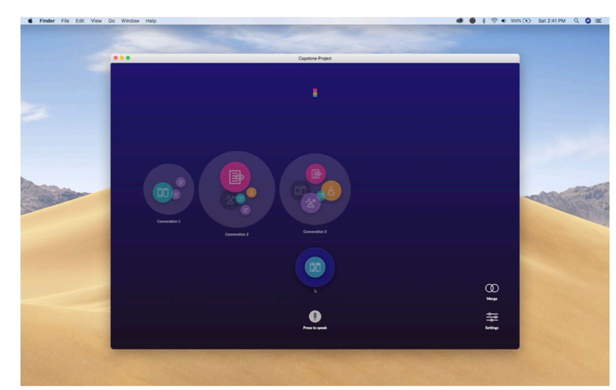


fig. 3.10.5

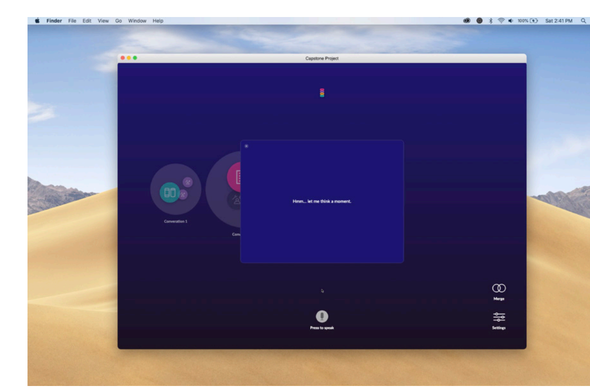


fig. 3.10.6

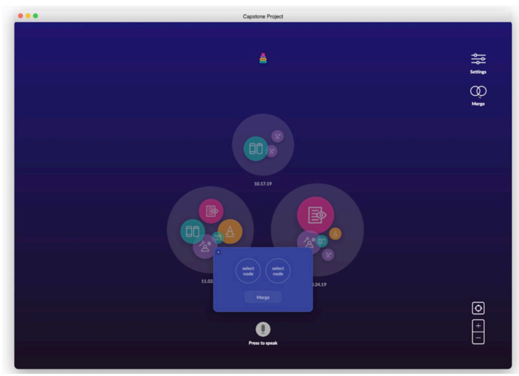


fig. 3.10.7

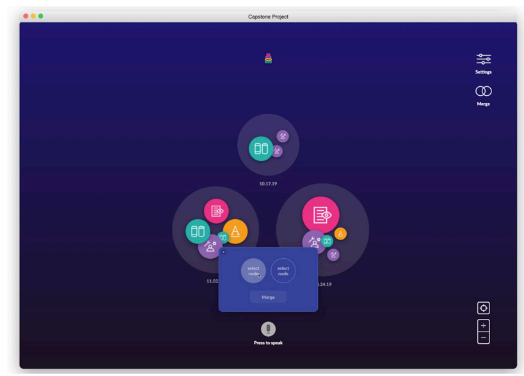


fig. 3.10.8

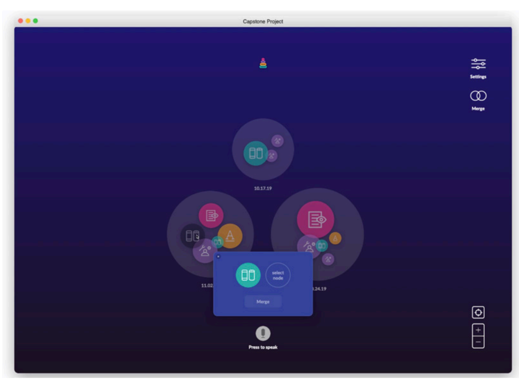


fig. 3.10.9

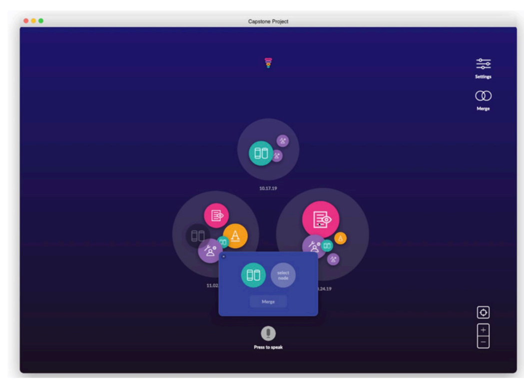


fig. 3.10.10

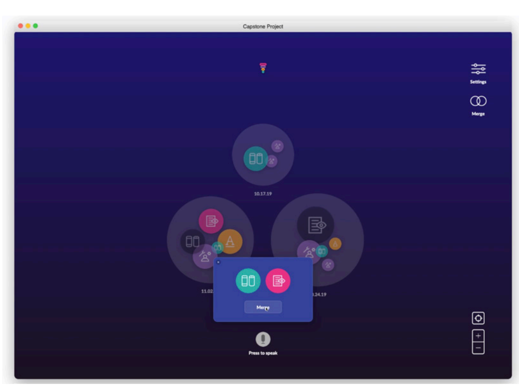


fig. 3.10.11

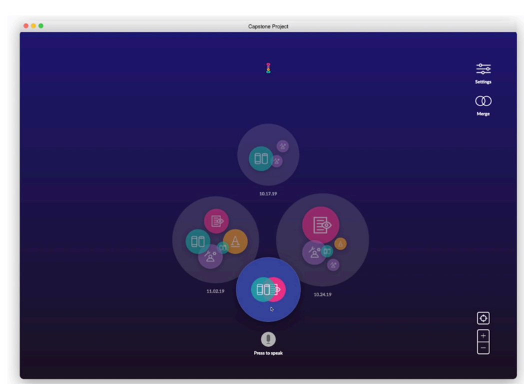


fig. 3.10.12



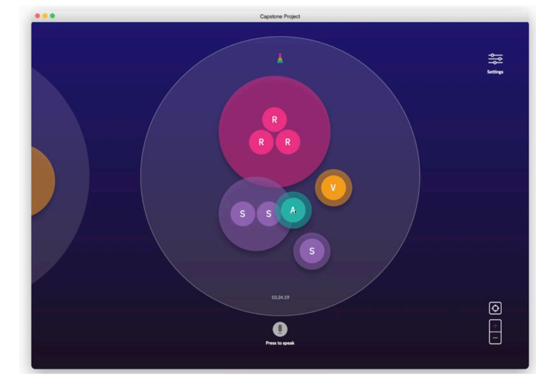


fig. 3.10.13

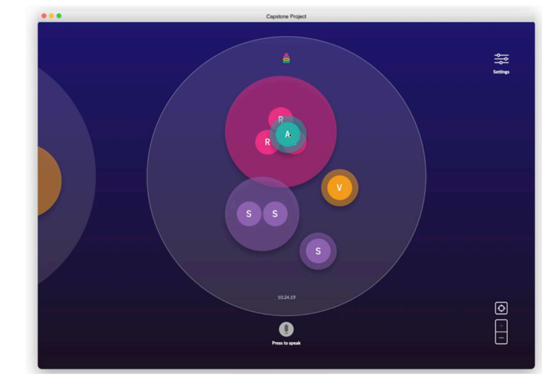
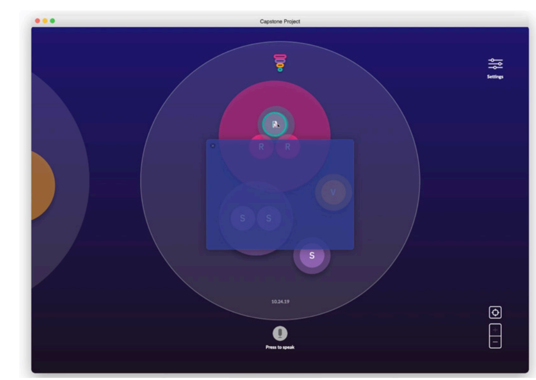


fig. 3.10.14



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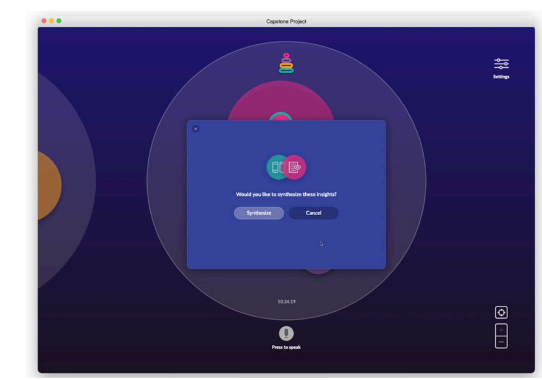

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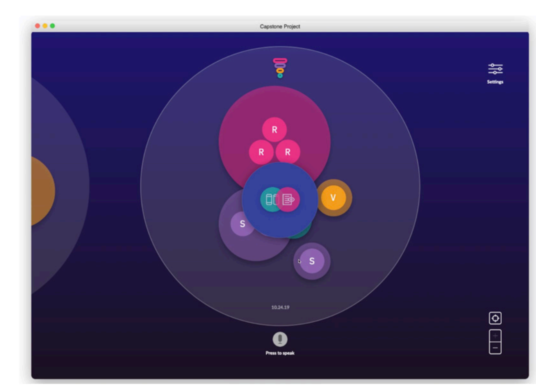


fig. 3.10.17

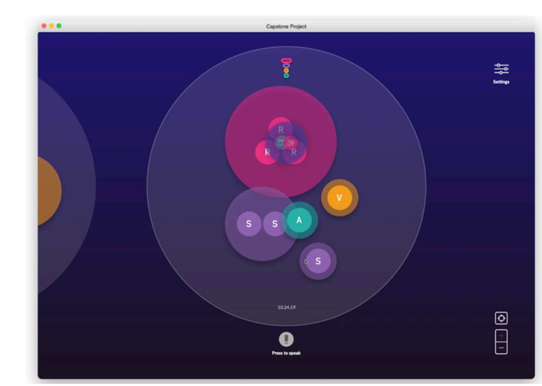
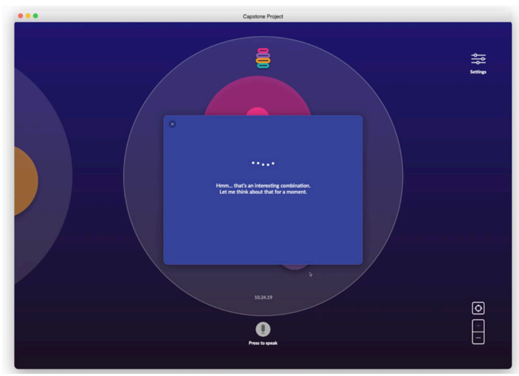


fig. 3.10.18



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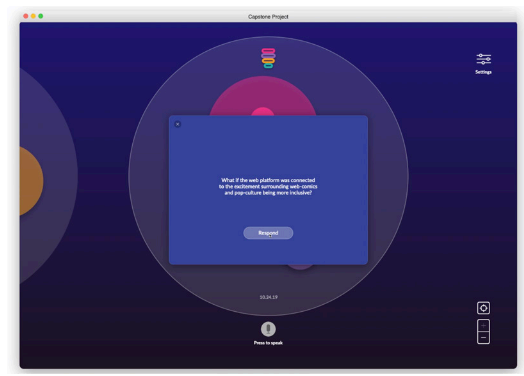


fig. 3.10.20

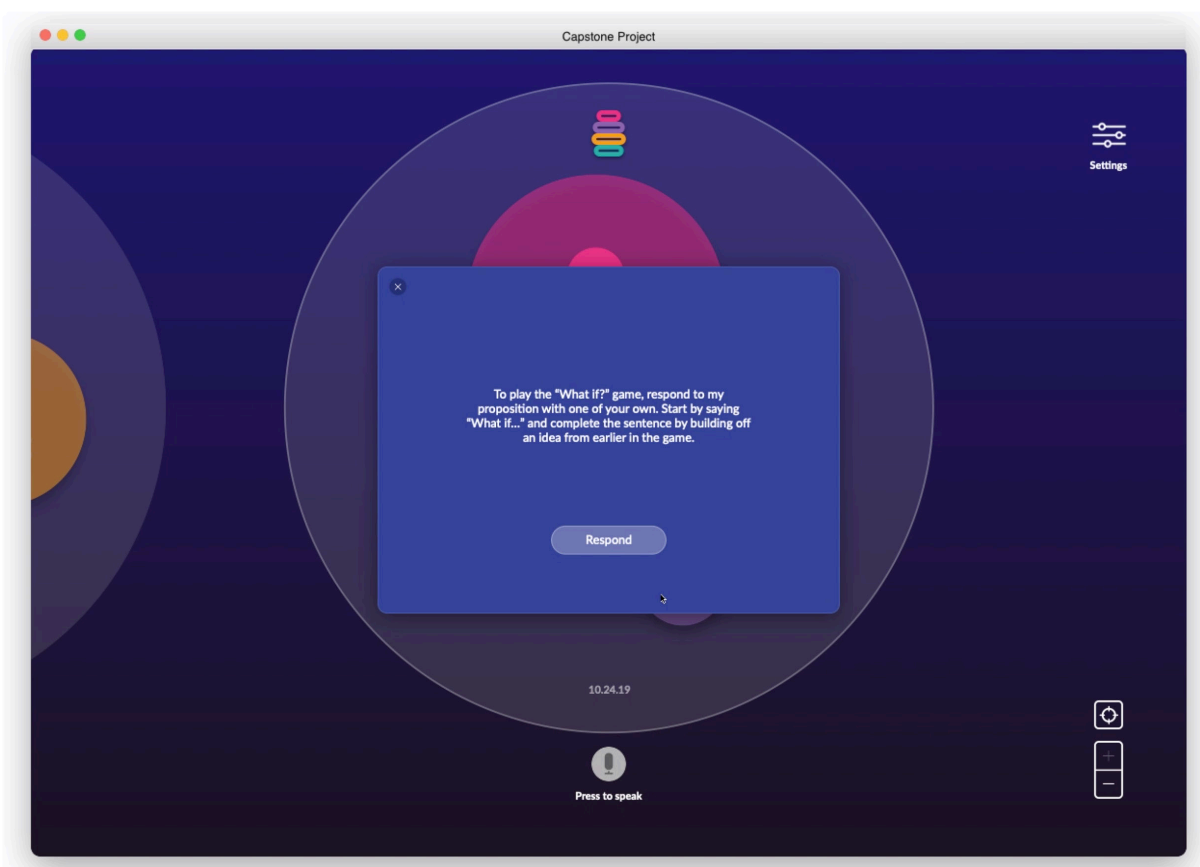



fig. 3.10.21



The final scenario looks exclusively at Esma as she progresses through three stages of her capstone project: initial onboarding with LEE, the virtual agent, early/mid-process experimentation with synthesizing ideas, and mid/late-process fixation interruption during visual refinement.

## 3.11 ONBOARDING

When Esma loads LEE for the first time, she is met with a friendly introduction to the system (fig. 3.11.1). LEE the virtual agent, asks for Esma's name and description of her design project (fig. 3.11.2). As Esma answers some initial questions, LEE pulls up a collection of online articles that reference keywords from Esma's responses (fig. 3.11.3). LEE suggests one article in particular and selects quotes from the article to give Esma an overview of the material (fig. 3.11.4). LEE asks Esma how she might account for the new information and how it might be applied to her project context (fig. 3.11.5). This stimulates her imagination; LEE's questions force Esma to challenge her assumptions and expand her associations. After Esma articulates a potential idea, she returns to the main screen of the interface to find a visual record of the conversation (fig. 3.11.6).

## 3.12 SYNTHESIZING IDEAS

Two or three weeks into her project, Esma returns to the interface (fig. 3.12.1). She zooms into the visualization of the conversation she had with LEE two weeks prior, recalling some interesting ideas (fig. 3.12.2). Esma clicks on a few insight nodes to reveal detailed information (fig. 3.12.3) before dragging and dropping one insight over another (fig. 3.12.4). This activates LEE (figs. 3.12.5 & 3.12.6), who jumps directly into a "What If?" exercise (fig. 3.12.7). Esma is caught slightly off-guard but willingly plays along, having had prior experience playing the game. Esma and LEE trade potential ideas back and forth (fig. 3.12.8) until LEE's response

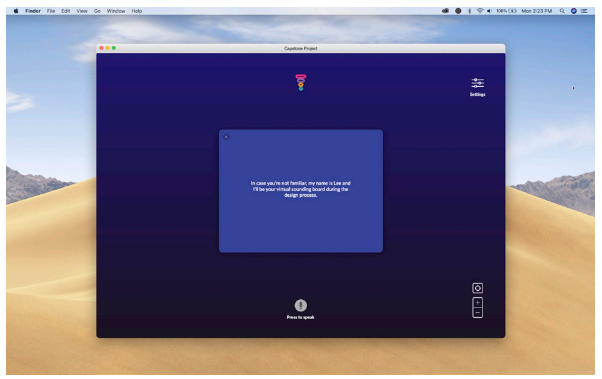


fig. 3.11.1

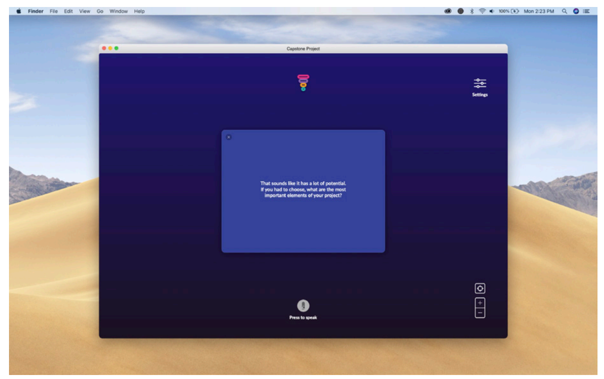


fig. 3.11.2

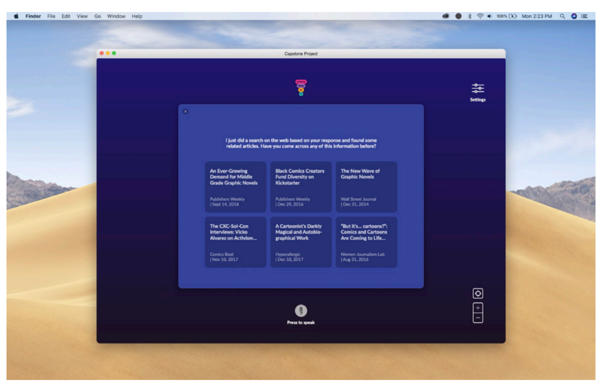


fig. 3.11.3

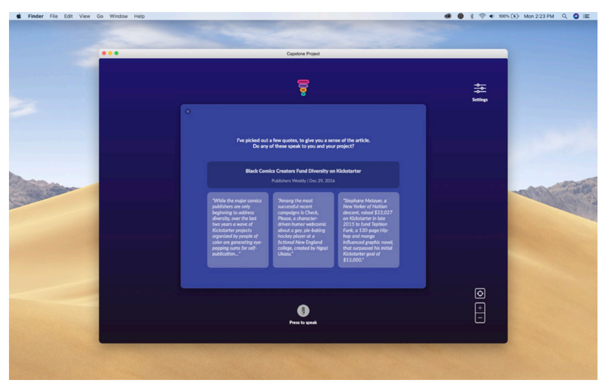


fig. 3.11.4

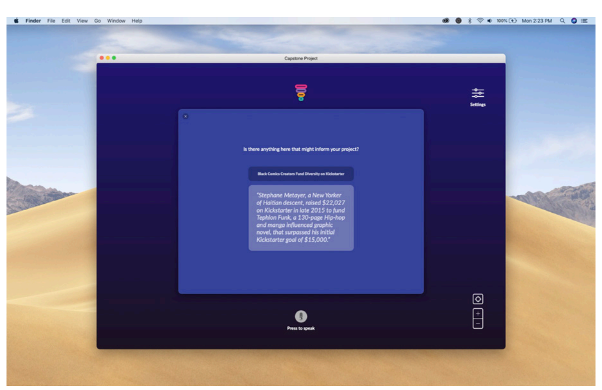


fig. 3.11.5

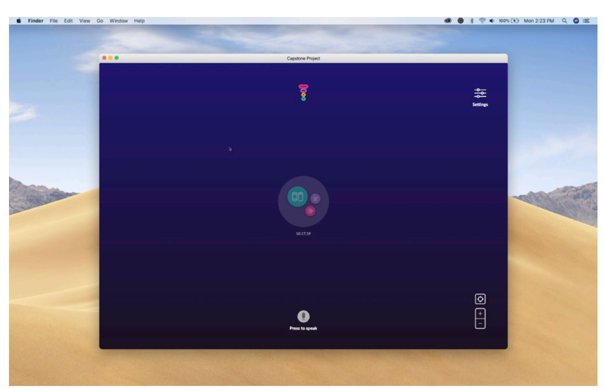


fig. 3.11.6



triggers a noticeable reaction from Esma. LEE picks up on Esma's reaction via sentiment analysis and checks to confirm (fig. 3.12.9). Esma elects to stop the ideation game at this point and returns to the main screen of the interface, where LEE has propagated a new idea node that Esma can interact with in the future (fig. 3.12.10).

## 3.13 FIXATION INTERRUPTION

Four or five weeks into the project, Esma is developing refined visuals for her design system. When LEE highlights a design element directly in her design document, Esma clicks the notification to learn more (fig. 3.13.1). LEE asks if Esma is having trouble (fig. 3.13.2). "What makes you say that?" Esma asks. LEE points out that Esma has been working on a single element in the document for half an hour (fig. 3.13.3), suggesting that they play an association game to get Esma out of her creative funk (fig. 3.13.4). LEE conducts a search of the web comparing Esma's visual content to existing work (fig. 3.13.5). LEE pulls up multiple historical examples of designed artifacts that resemble the element Esma was fixating on, checking to see if Esma had intended the visual correlation (fig. 3.13.6). Esma is not aware of the connection, so LEE asks her how she might relate the visual link to her project context (fig. 3.13.7). When Esma is unclear how to respond, LEE breaks down the prompt, asking her to provide a simple word association to the visual reference instead (fig. 3.13.8). With the stakes lower, Esma generates a few off-the-cuff associations. LEE displays Esma's responses and asks her how the keywords could relate to her project context (fig. 3.13.9). Esma focuses on one of the word associations and discards the rest. This recontextualizes her design decisions, causing her to reconsider her visual approach. Finally, LEE asks her to articulate potential ways Esma might reinforce the new association in subsequent iterations (fig. 3.13.10), encouraging her to design on a new artboard instead of reworking a single version (fig. 3.13.11). Esma returns to her artboard as the LEE notification fades to grey (fig. 3.13.12), signaling the completion of the interaction.

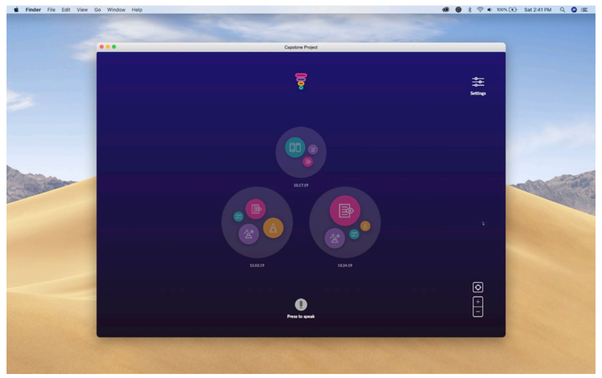


fig. 3.12.1

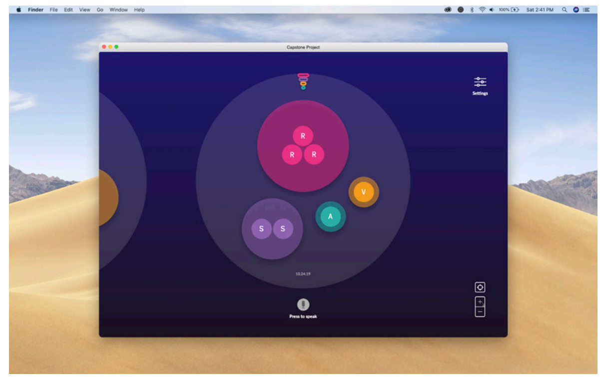


fig. 3.12.2

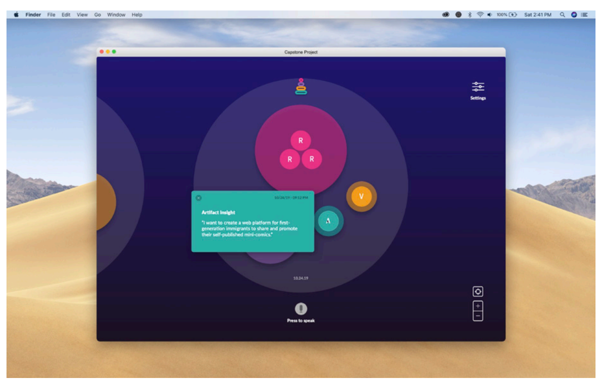


fig. 3.12.3

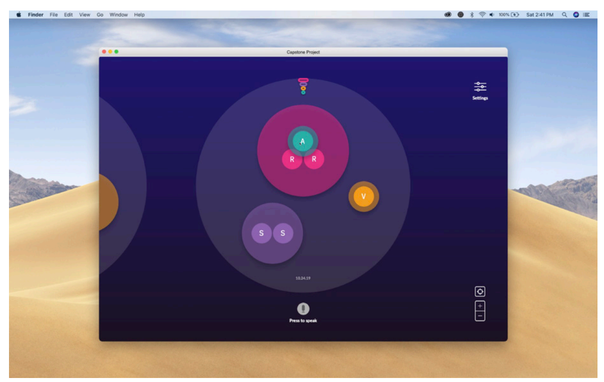


fig. 3.12.4

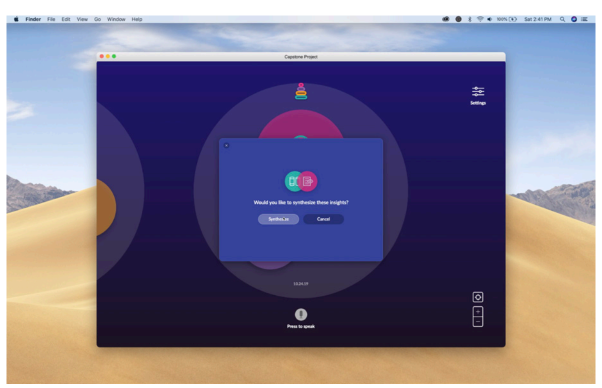


fig. 3.12.5

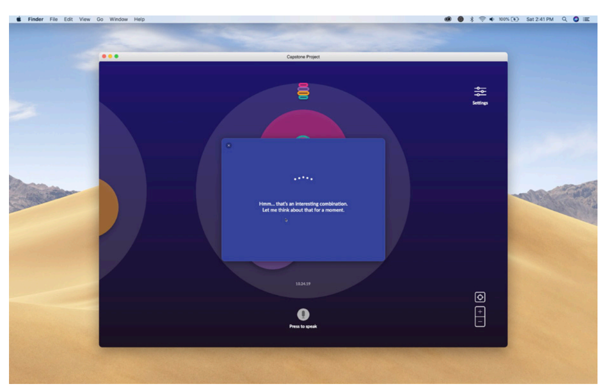
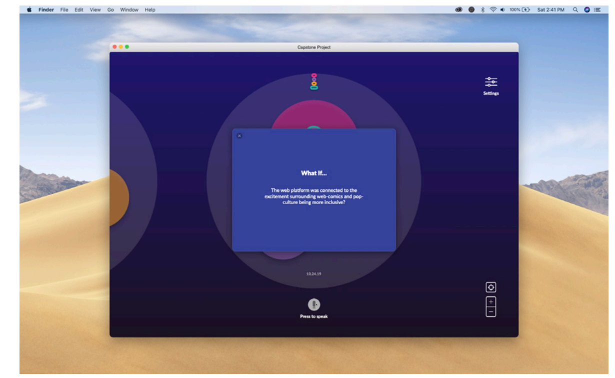


fig. 3.12.6





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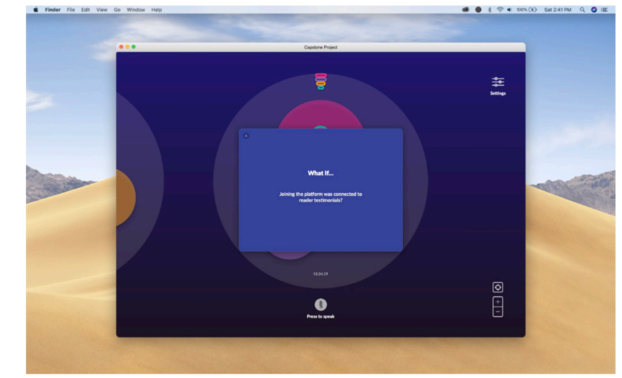
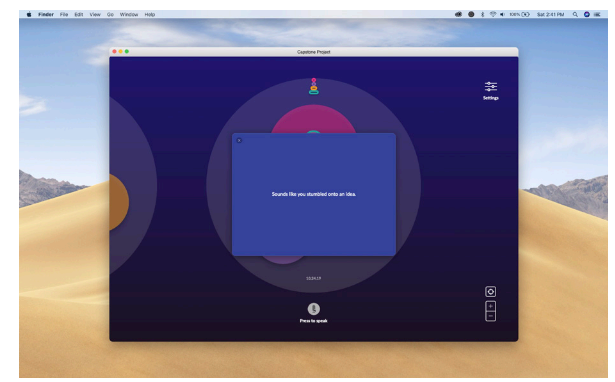


fig. 3.12.8



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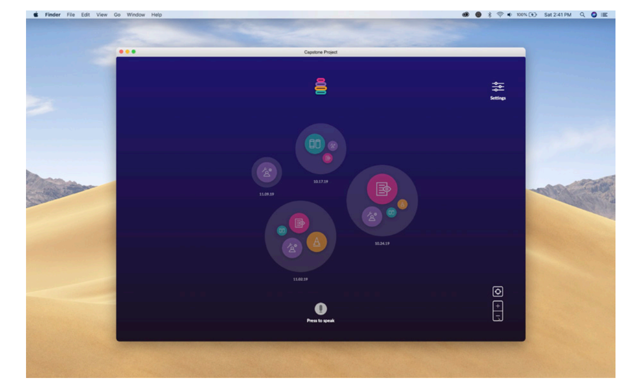

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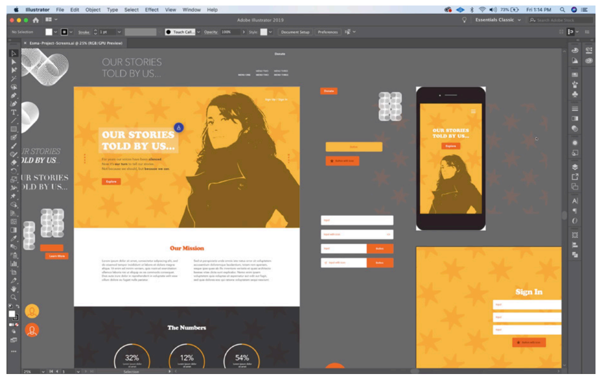

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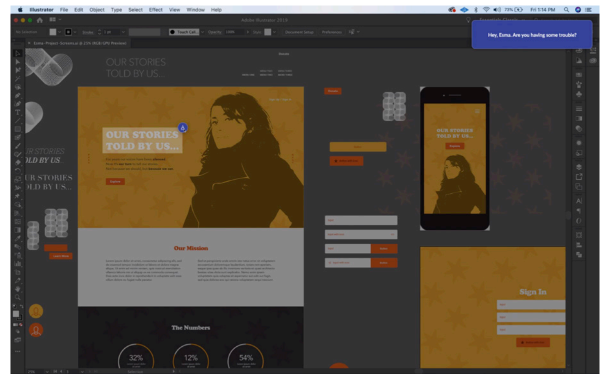


fig. 3.13.2

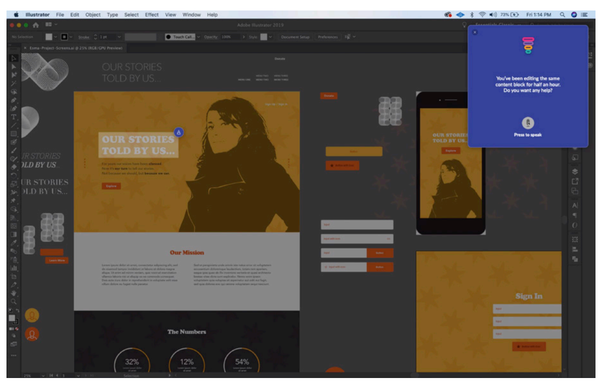
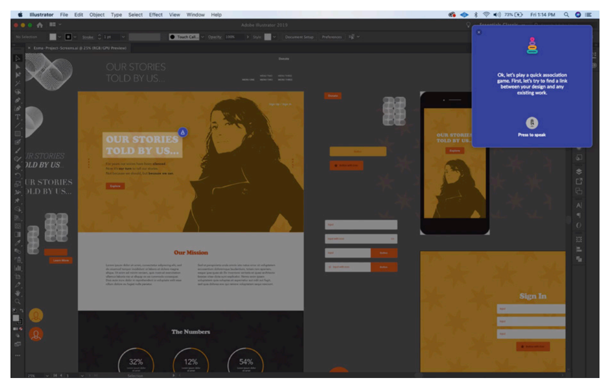


fig. 3.13.3



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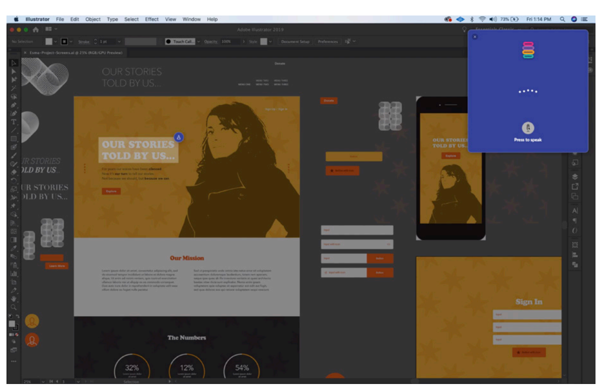
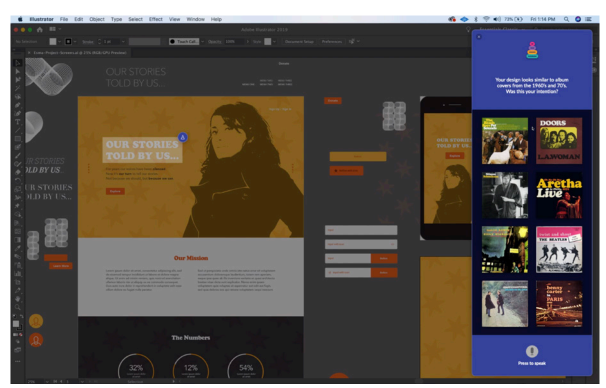


fig. 3.13.5



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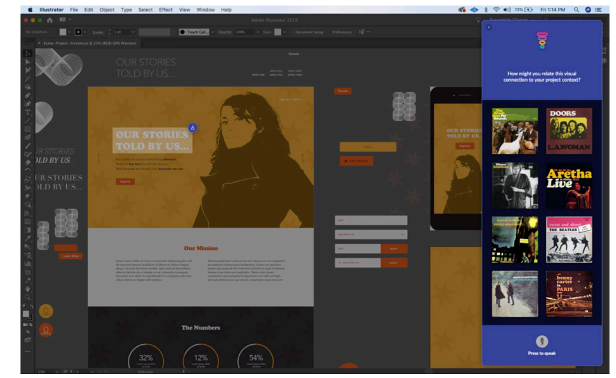

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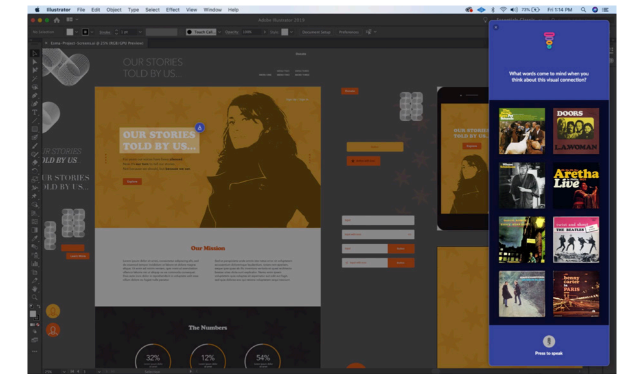

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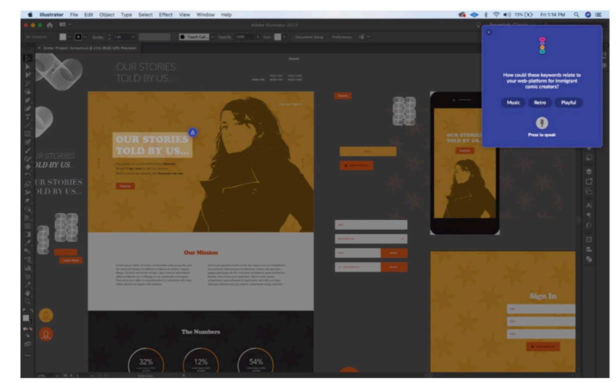
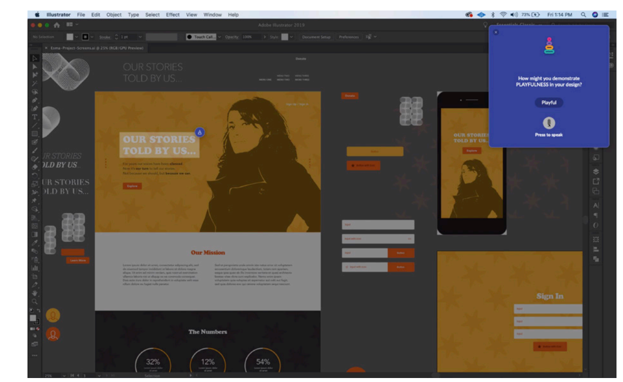


fig. 3.13.9



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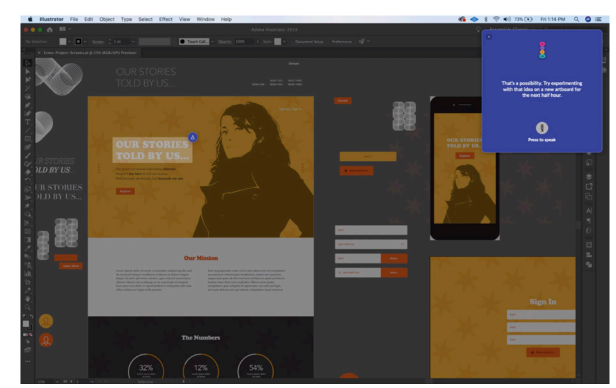

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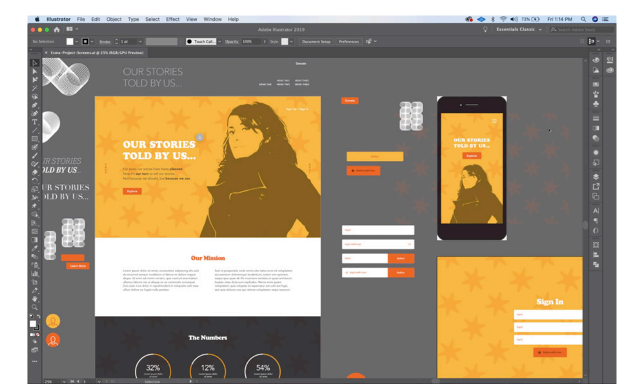

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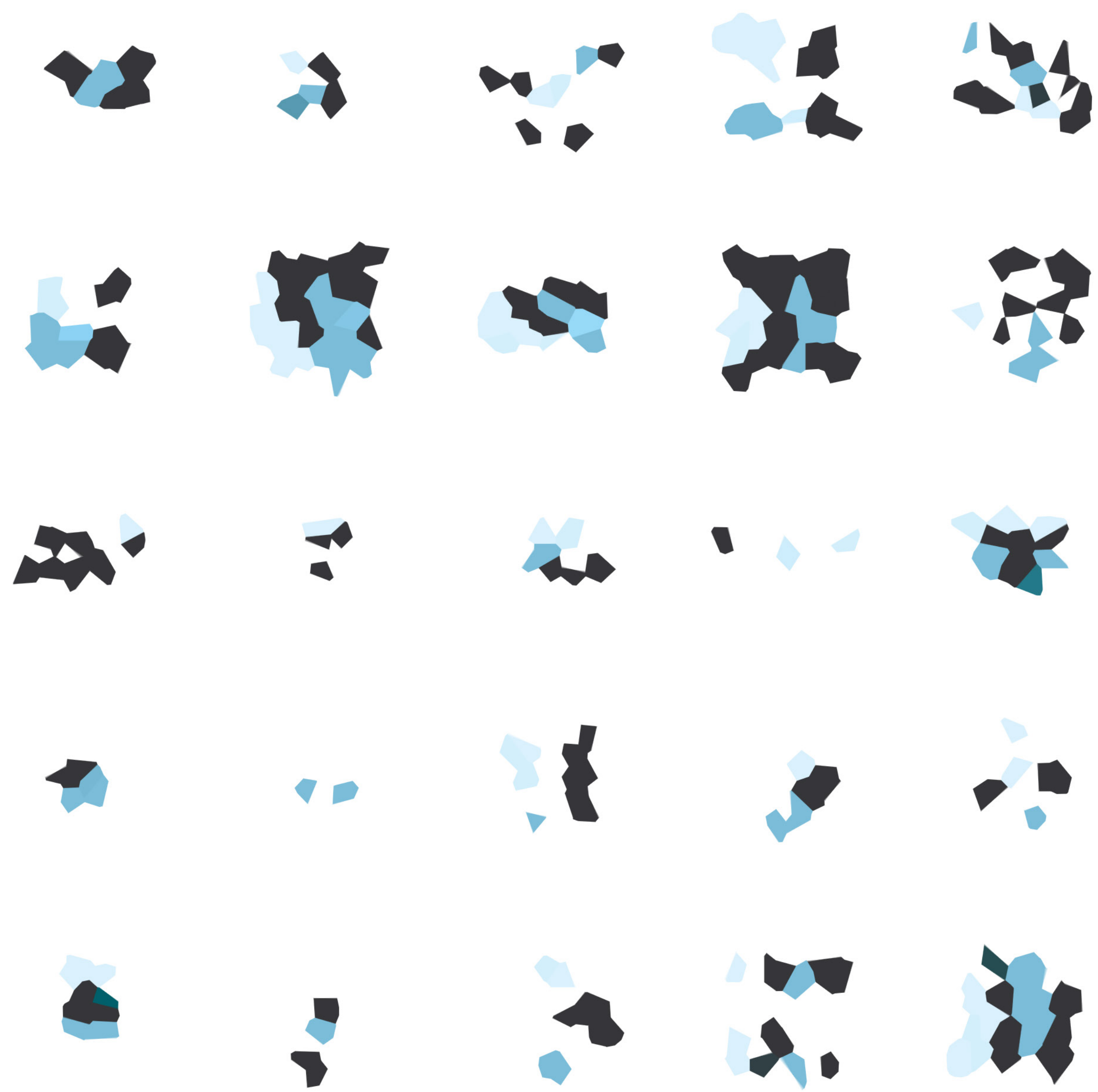


DISCUSSION



I began this investigation asking the question

> **How might the design of a conversational virtual agent employ improvisational methods to mitigate negative design fixation and creative stagnation in upper-level undergraduate graphic design students during recurring computer-based ideation stages of an independent, multi-week design project?**

My research sub-questions related to key improvisation principles

> **timing | adaptation | articulation | association**

These were useful to begin the ideation process, but, as I soon learned, opened the doors to many other questions. I address a number of these principles in my visual and interaction studies.

## BUILDING THE CONVERSATION

Throughout the student's design project, the virtual agent and student are building a visualization of their shared conversation history. This is not a one way street. The virtual agent is only able to generate the visual mapping if the student engages with the system. Building the conversation requires the student talk back, incorporate ideas from past conversations and continue to experiment with insight nodes generated along the way. **(Studies 3.6, 3.9 & 3.10)**

## REPRESENTING THE CONVERSATION

One possibility is that the virtual agent uses speech analysis to automatically divide the conversation into insight “nodes,” tagging each node with a different category relating to the student’s design system: research, services, artifacts and visual vocabulary. As seen in the prototype, these nodes take the form of molecules or paramecium-like encapsulations. Of course, there are many other representational approaches to explore. The visual schema studies offer alternatives, but are only cursory explorations. **(Studies 3.6, 3.9 & 3.10)**

## ENCOURAGING EXPERIMENTATION

Encouraging the student to experiment, especially later in the process when they are more inclined to fixate, can be a difficult task. This was evident when I observed the senior capstone students. By the time of their holiday break, approximately 2/3 into their project, the students were wholly invested in their ideas. In part, this was and is necessary; in a systems-based design project, there are many elements to prototype, leaving little time for the students to experiment with ideas that won’t make it into the final design. However, experimentation is necessary to develop an idea and grow as a designer. The difficulty may be twofold: (1) the student may feel pressed for time and (2) she may not have readily available methods to spark the experimentation process. I address both of these concerns in my studies. By encouraging the student to keep experiments short (i.e. within 30 minutes), the virtual agent attempts to reduce the perceived stress and pressure of making progress on their design. By always being available, the virtual agent provides the student an easy channel for vocalizing ideas. Additionally, the functional simplicity of dragging and dropping insight nodes to synthesize ideas in the interface attempts to remove cognitive barriers that the student may have around “playing” with ideas. **(Studies 3.1, 3.4, 3.7, 3.8 & 3.10)**



## ADAPTING TO THE USER

Students are not the only ones expected to practice adaptation. A major affordance of a machine-learning based system is its ability to change programmatic behavior over time in response to the user’s specific needs and context. Potential ways that the system could adapt over time would be in the frequency and kind of interventions it performed. For instance, while LEE may offer concept-challenging creative prompts to Esma during the nascent design stages, it would defer from offering such prompts later on, opting instead for form-based critiques and association exercises when Esma is developing refined visuals. **(Studies 3.4, 3.5, 3.7 & 3.8)**

## ESTABLISHING A CREATIVE RELATIONSHIP

In order to make the experience approachable and not overly-complicated or annoying, I needed to be considerate of the way that LEE, the virtual agent behaved with the design student. While the technology has come a long way since its earliest uses, virtual agents can easily become a nuisance. The virtual agent employs a number of strategies to avoid user aggravation in this regard. These include period check ins with the student to assess their willingness to converse, subtle notifications so as not to barge in unnecessarily, use of encouraging and non-judgemental tone of voice, and, perhaps most importantly, stored knowledge/memory of the student’s project as it develops over time. This last point is crucial; an important feature of “good” conversation is the ability for both parties to have some contextual memory of the other, less they appear flippant or unempathetic. **(Studies 3.8, 3.11 & 3.13)**

# OPPORTUNITIES



In the context of design students, there are opportunities to explore different kinds of fixation. As systems-based design methodology becomes the inevitable norm (if it hasn't already), designers may exhibit different kinds of fixated behavior. With that shift, so too will the virtual agent's responsive behavior need to shift; the kinds of creative exercises that are applicable to designing a travel brochure differ greatly from those that are applicable to designing a revamped healthcare website. In order to design the most relevant interventions, designers should pay special attention to future research concerning the shift in fixated behavior as it relates to systems-based designing,

During my design process, some instructors were concerned regarding the fluidity of the interface. For a system that attempts to encourage improvisational behavior, the system remained fairly "rational" in its execution. While I made a concerted effort to experiment with various approaches to fluid interaction (i.e. dragging and dropping insights to stimulate creative exercises), I believe there are other, perhaps more intuitive ways of designing the system. The rationality of the platform may be due to my own fixation (how I wish I had this technology during my own design process!). Further study is needed to propose alternative expressions of an improvisational interface.

A ramification of the proposed design system is its ability to archive a history of interactions. Presumably, if a student engages with the virtual agent often enough during their project, they wouldn't need to document their process along the way. The system could generate a history of the student's design explorations, providing a detailed synopsis of the changes in research, services, artifacts and visual vocabulary with the click of a mouse. More importantly, with repeated interaction over multiple design projects, the virtual agent would begin to learn more and more about the individual designer, their style, interests, habits and particular hangups. It is conceivable that the agent's suggestions would eventually become so intuitive and contextually resonant that the designer would not want to design without it!

While I did consider nuances in the virtual agent's speech patterns during conversation, designers should be mindful of the AI's personality when designing for future conversational user interface (CUI) and intelligent systems. Some students prefer not to be coddled, to receive brutally honest critique when designing. Other students may want more considerate, tempered feedback. The hierarchical dynamic between a teacher and student may be beneficial to some, while the peer-to-peer dynamic may be better for others. From a user's perspective, having the option to change the personality, age, ethnicity or gender of the virtual agent would allow them to tailor the experience to their personal preferences, putting more control in their hands.

# IMPLICATIONS

This research builds upon improvisational design pedagogy currently taught at the College of Design at North Carolina State University and provides another critical voice to a relatively new discussion surrounding artificial intelligence as creative enhancement. As a consequence, some broader implications arise.

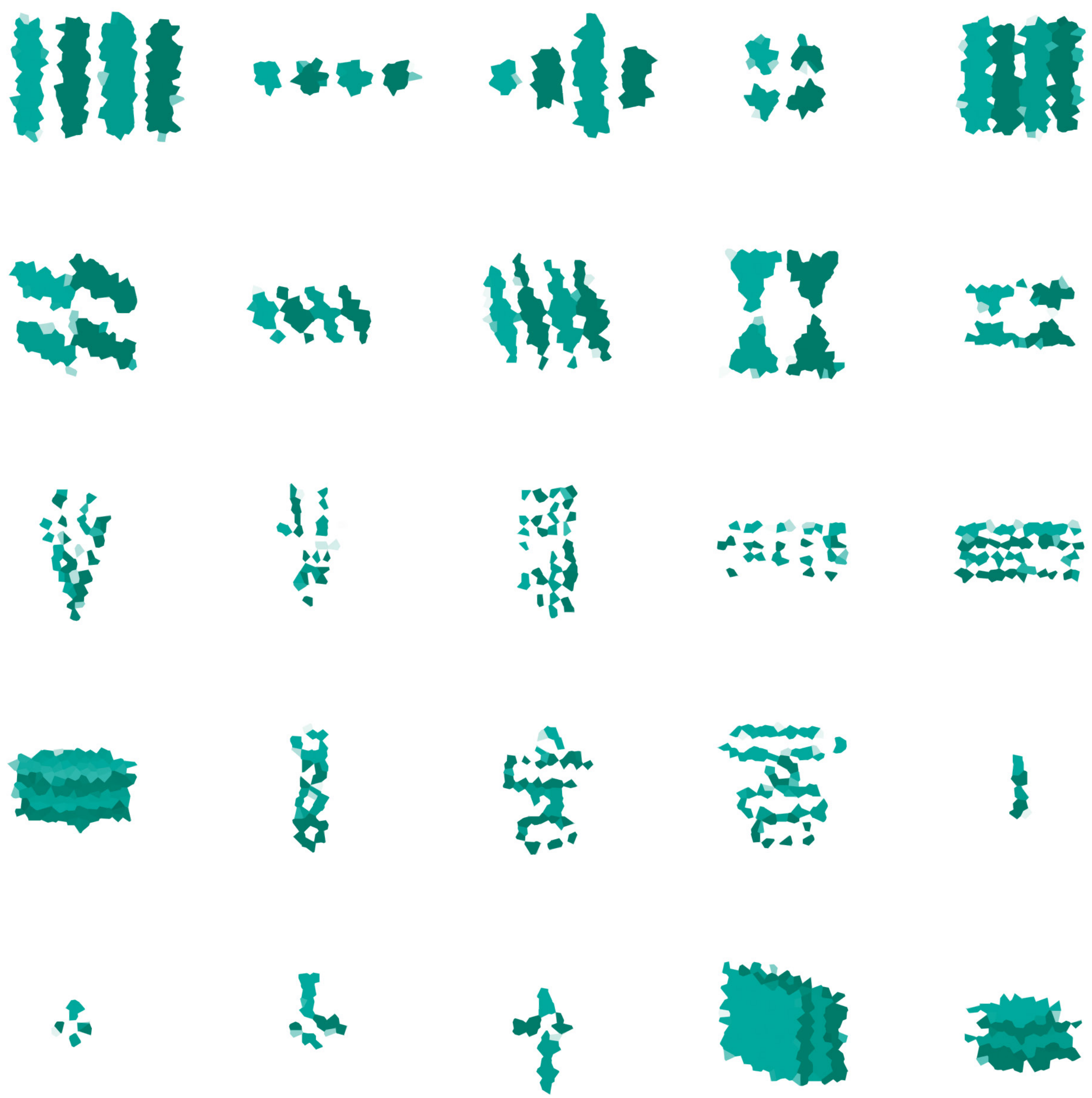
The relationship between student and virtual agent indicated in these studies implies the beginning of a kind of creative symbiosis. Some may find this premise controversial. In addition to empowering students to develop their own set of methods and strategies to take with them into the professional world, this scenario suggests that a student would carry their virtual agent, their version of LEE with them, throughout their career. As is, there is no exit strategy for weaning off the system, if the student ever got so attached that they couldn't foresee giving the relationship up.

In one way this is highly presumptuous; who's to say that such a system would ever be so poignant, so appropriate or moving that a designer couldn't not use it? And yet, it wasn't so long ago that we, as designers experienced a paradigm shift to desktop publishing and digital image manipulation. Now we can't possibly imagine conducting the majority of our work outside a computer interface. This is not to imply that a virtual agent is merely a tool to be used, nor am I making a one-to-one comparison between machine-learning and traditional design software. The kinds of active behavior-shaping methods that a virtual agent might deploy go beyond the psychological impact of using the "pen tool." However, I would argue that technologies of all kinds, from a letterpress to Adobe Illustrator, have significant impact on what, and how we make. I see the shift to intelligent creative systems as part of a spectrum of technology partnership, not as the designer relinquishing creative control or losing part of what it means to design.

# CONCLUSION



I have taken a speculative approach to investigating the potential role virtual agents play in a student's design process. Embedding improvisation methods in an artificially intelligent system may seem like a peculiar choice, almost counterintuitive. For the uninitiated, improvisation can seem messy, even chaotic. Although serendipity is crucial, improvisation should not be confused for chaos. For the seasoned musical improviser, there is meta-cognizant awareness of the situation in play, guiding the trajectory of the performance somewhere (if not known exactly where). Improvisors have strategies and structures in place to maintain group coherency, such as "centering" and behavioral integration (Bastien & Hostager, 1988; Healey, Leach & Bryan-Kinns, 2005; Magni, Proserpio, Hoegl, & Provera, 2009; Alperson, 2010). Applying improvisation's fuzzy structure to a machine-learning based system like the one I propose in these studies, although tricky, is plausible. More importantly, the benefits of improvisation, namely increased adaptability and divergent cognition, are critical competencies for a designer at any level. The added risk of premature fixation when using computer-based design tools warrants intervention, especially for design students without extensive experience. As I suggest in my studies, introducing interventions within the computer itself would allow the student to work intuitively until her intuition expires, at which point the system would provide contextually appropriate suggestions and creative prompts to keep the process moving. Such a system mimics the back-and-forth of an improvisational performance where one performer listens, reacts and builds on top of the notes of another. Instead of improvising with a human partner, the virtual agent becomes the designer's creative confidant. Given the recent proliferation of intelligent systems and machine learning in and out of design, this relationship, although unconventional, may not be far from reality.



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