A Transdisciplinary Approach to Integrate Art Thinking into the Industrial Design Process

by

Anna N. Owings

A thesis submitted to the Graduate Faculty of
Auburn University
in partial fulfillment of the
requirements for the Degree of
Master of Industrial Design

Auburn, Alabama
May 4, 2024

Keywords: Industrial Design, Artistic
Thinking, Design Thinking, Art, Design

Approved by

Benjamin Bush, Chair, Associate Professor, Industrial Design
Rich Britnell, Professor, Industrial Design
Tin-Man Lau, Graduate Program Officer, PlayCore Professor, Industrial Design

Abstract

This thesis presents guidelines for industrial designers to utilize a transdisciplinary approach that incorporates aspects from both design and artistic thinking to aid them in designing products. A transdisciplinary approach is problem-focused (Rosenfield, 1992), holistic (Max-Neef, 2005), and requires at least two disciplines to collaborate in integrating the theories, methods, and strategies of multiple disciplines. The purpose of applying transdisciplinary models is to develop innovative solutions to distinct, 'real-world' problems. It exceeds interdisciplinary work in that it seeks to develop holistic perspectives by integrating different disciplinary approaches, which in turn allows for the genesis of new frameworks to understand problems to generate new solutions. (Hay, 2017). The purpose of applying this approach is to incorporate aspects of both art and design thinking into the industrial design process. Because art can evoke a wide range of emotions, one could argue that negative emotions would deter a consumer from purchasing; however, many people today enjoy experiences that produce these emotions, like horror movies or sad music. Studies have found that the more negative the emotions evoked are, the more people pay attention to the work and feel moved. This is due to a term coined 'aesthetic distance,' which refers to the viewer being aware that the art is causing a negative feeling, not a negative circumstance in his or her life (Winner, 2019). Many linear models of advertising persuasion today completely disregard the role of emotion and focus solely on the importance of economic rationality, which has proven ineffective. The benefit of emotional appeal is a longing that encourages consumers to buy a product because of how it makes them feel (Matušínská, 2022).

Acknowledgments

Firstly, I would like to thank each of my committee members, Ben Bush, Rich Britnell, and Tin-Man Lau, who made this study possible. Their guidance and feedback carried me throughout all stages of the writing process, and they provided me with resources to make the development of this study possible.

I would also like to thank Dr. Beth Topping, who kindly reviewed my thesis and gave me valuable feedback to improve the structure of my writing to improve the effectiveness and readability of this study.

Lastly, I would like to thank my family for supporting and encouraging me wholeheartedly throughout the entirety of completing this project. Additionally, I would like to extend a special thank you to my parents for instilling in me the value of hard work and providing me with the confidence I needed to complete this project

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1.1 Problem Statement

Due to the guidelines currently set in place for industrial designers, design thinking, and design methodology, products today have become lackluster and sterile. Marketers' theories on why consumers buy often fall short because they utilize a pragmatic approach when an understanding of consumer purchase behavior must be based on the knowledge of human emotion and how it influences decision-making (Kennedy, 2022). The issue with most products on the market today is that industrial designers have a lack of understanding, or lack of interest, in comprehending how users feel about the product. However, designers should give meaning to the product to make it understandable and discoverable (Batagoda, 2017). Expressing or evoking emotion through a product—as art does via paintings, immersive experiences, etc.—should be of utmost importance to the designer because emotions are considered one of the primary factors that affect purchasing decisions. Aesthetics play a role in purchasing, too, in that research shows that consumers are attracted more to types of brand personalities based on visual appeal. The attractions are emotion-based and not rational.

An additional issue with design today is that everything has become so 'well-designed' that there is no room for further innovation, and utilizing different thinking processes and cognitive strategies could be an effective approach to overcoming this obstacle. The design factors have become so formulaic that it is sometimes hard to tell different brands apart. While making design 'user-centric' appears beneficial in theory, it ultimately generalizes users. This is a shortcoming in design because humans are profoundly complex and beautifully unique, to generalize them would be adverse, especially to those who fall under 'niche' categories (Tsopela, 2021). This study is beneficial because it relates to personalization and the creation of 'attachment' to consumer products, therefore increasing the lifespan of a product.

1.2 Need for Study

"Anything can make us look, only art can make us see,"

—Archibald MacLeish, *Poetry and Experience* (1963).

Incorporating art thinking and artistic techniques into the industrial design process has the potential to produce a more novel, expressive product; however, with limited research on the topic, it is still unclear how these thinking strategies and techniques can be applied to promote an increasingly emotional response or interaction from the user. Even so, the users' decision-making of what products he or she decides to purchase is a form of expression. This could potentially be to the designer's advantage if utilized correctly.

Employing a transdisciplinary approach by combining the industrial design process with the artistic process will benefit the design community by allowing designers to become comfortable with being uncomfortable. Architecture and design have utilized an interdisciplinary process for quite some time, working with professionals across various disciplines, such as engineering. It recognizes how various modes of perception and representation can be implemented for spatial analysis and exploration. However, a transdisciplinary approach will be utilized for this thesis, further blurring the lines between disciplines. Utilizing transdisciplinary processes does not mean adding more tools throughout the design process, but rather, operating as 'lines of flight' that open design to new ways of thinking (Brisben et al., 2019).

Incorporating artistic thinking and methodology into the design process can ultimately allow the designer to become more empathetic, therefore creating a more user-centered product. The designer's increased passion can allow for improved product designs as well. An additional benefit to an interdisciplinary approach would be that not only does the designer feel deeply during

the creation of the product, but the user will also feel deeply when interacting with the product. Studies have also shown that simply viewing art, can decrease stress levels, increase empathy, cause an immediate release of dopamine, lead to stronger critical thinking skills, and relief from mental exhaustion. Various art, however, is intended to make the interpreter feel uncomfortable, but why would a consumer want to buy a product that makes them feel uncomfortable? People today enjoy many forms of media that are designed to make them feel uneasy, such as horror movies, and they have enjoyed the umbrella of safety that is created by coming to terms with the idea that it is art, not reality (Winner, 2019).

1.3 Objectives of Study

The areas of research listed below will be utilized to develop guidelines for the practical use of art methodology and art thinking practices within the process of industrial design. Employing a transdisciplinary approach, this thesis will also provide examples of use for different strategies and methods practiced within the artistic process.

Objectives:

- Research art thinking
- Research art processes
- Research artistic thinking processes
- Research implicit artistic strategies
- Research explicit artistic strategies
- Research case studies for common artistic practices and processes
- Research methods for implementing a transdisciplinary approach
- Develop guidelines for industrial designers
- Execute an industrial design project process that showcases the use of the guidelines.
- Document the study—thesis.

1.4 Assumptions

For purposes of this study all forms of media including books, articles, documentaries, etc., are assumed to be validated before the date of publication. It can also be assumed that there is a need for a tool to help industrial designers utilize aspects of art thinking strategies and methodology throughout the design process. Finally, it can be assumed that design with integration of art thinking strategies and methodology would increase the value of the product.

1.5 Scope and Limitations

This study will focus on creating transdisciplinary guidelines via the application of art thinking processes and cognitive strategies for Industrial Designers exclusively. Due to time limitations, it does not address guidelines for other disciplines such as Graphic Design or Art. This study does not aim to prove that this design process is superior to others but allows designers to explore an alternative way of designing that could potentially be more beneficial in certain contexts.

'Art' in the context of this study refers to music and visual art forms such as painting, sculpture, filmmaking, printmaking, and architecture; other mediums such as literature and photography will not be mentioned. Due to financial and time limitations, the effects of the application of these guidelines will not be further examined.

1.6 Anticipated Outcomes

The primary outcome of this study will be guidelines to assist industrial designers in creating a more novel, expressive product. The guidelines will utilize a transdisciplinary approach that incorporates methods and thinking processes from both the Arts and Industrial Design.

Long-term effects on society are expected to be consistent with resistance art, however, the results will be more subtle as industrial design is much less literal in expression in correlation to artistic expression.

1.7 Definition of Terms

Artifice: Clever or artful skill; an ingenious device or expedient (Merriam-Webster.com, 2022).

Artistic Methodology: The system of principles that guide the creation of works of literature and art (encyclopedia2.thefreedictionary.com, 2022).

Artistic Process: A unique combination of vision, creativity, intuition, and collaboration balanced with craft, technique, accountability, discipline, and use of time and resources (artsaction.com, 2016).

Constraints: Thematic, aesthetic, and material limitations artists utilize to proceed with a guiding framework and maintain thematic coherence throughout a body of work (Jacobs, 2020).

Conversation with Work: Phrase that refers to artists creating a 'dialogue' with their work, reacting to it, and making incremental changes along the way (Jacobs, 2020).

Epistemology: A branch of philosophy that investigates the origin, nature, methods, and limits of human knowledge (dictionary.com, 2022).

Human-centered Design: A problem-solving technique that puts real people at the center of the development process, enabling you to create products and services that resonate and are tailored to your audience's needs (Landry, 2020). Unlike user-centric design, this process incorporates the user's emotional or psychological preferences as well. (onlinedegrees.kent.edu, 2018).

Iconoclastic: Attacking or ignoring cherished beliefs and long-held traditions, etc., as being based on error, superstition, or lack of creativity (dictionary.com, 2022).

Phenomenological: The study of structures of consciousness from as experiences from the first-person point of view. The central structure of an experience is intentionality, its being directed towards something, as it is an experience of or about some object (Smith, 2018).

Primary Generators: Generators guide the search for the problem in the artistic process, artists use these as frameworks to set their challenges (Jacobs, 2020).

Problem-creation: A process in which artists create and reframe original problems, it is not solution-based.

Resource Banks: During this process, artists begin consuming, absorbing, categorizing, and filing information for possible source material. This results in a 'well' for creativity and is compiled throughout the entirety of the artist's career.

Transdisciplinary: A transdisciplinary approach is problem-focused (Rosenfield, 1992), holistic (Max-Neef, 2005), and requires at least two disciplines to collaboratively develop innovative conceptual models that integrate the theories and methods of multiple disciplines to develop new solutions to specific, common, real-world problems. It surpasses interdisciplinary work in that it seeks to develop holistic perspectives by integrating different disciplinary perspectives, thereby creating new frameworks to understand problems to develop solutions (Hay, 2017).

User-centric Design: An iterative design process in which designers focus on the users and their needs in each phase of the design process (interaction-design.org, 2018). A less emotionally empathetic approach focused primarily on the tangible, physiological ways users interact with a platform (Interaction Design Foundation, 2016).

Chapter 2
Literature Review

2.1. Industrial Design

2.1.1. History

Mass production was loosely based on principles of specialization and division of labor from Adam Smith's, 'The Wealth of Nations' in 1776; however, there are records of its application to manufacturing in Ancient Greece (Tanenbaum, 2019). During this time design was dominated by an emphasis on utility while giving little attention to aesthetics. This was a time when many people believed products did not need to be beautiful and their only purpose was to solve an existing problem. This modality began to shift in 1913 when Henry Ford created the first moving assembly line. Ford's innovation allowed for notably faster and cheaper production, which culminated in manufacturers being able to invest in more aesthetically pleasing designs (History.com, 2011).

In the 1960s, design continued to struggle to distinguish itself as an individual professional field from engineering and science. In his 1969 book *The Sciences of the Artificial*, Herbert A. Simon is one of the first researchers to describe design as a way of thinking. A few short years later, Horst Rittel and his counterpart Melvin M. Webber first coined the term, 'wicked problems.' Rittel is one of the first researchers to try to define design theory while concentrating on design methods. His contribution is also significant in that he defends the importance of human experience (Taylor, 2020).

Finally, in 1991 IDEO founders Tim Brown and David Kelley shed light on design thinking, making it accessible to individuals who have not been educated in design methodology (Dam & Siang, 2022).

2.1.2. Double Diamond

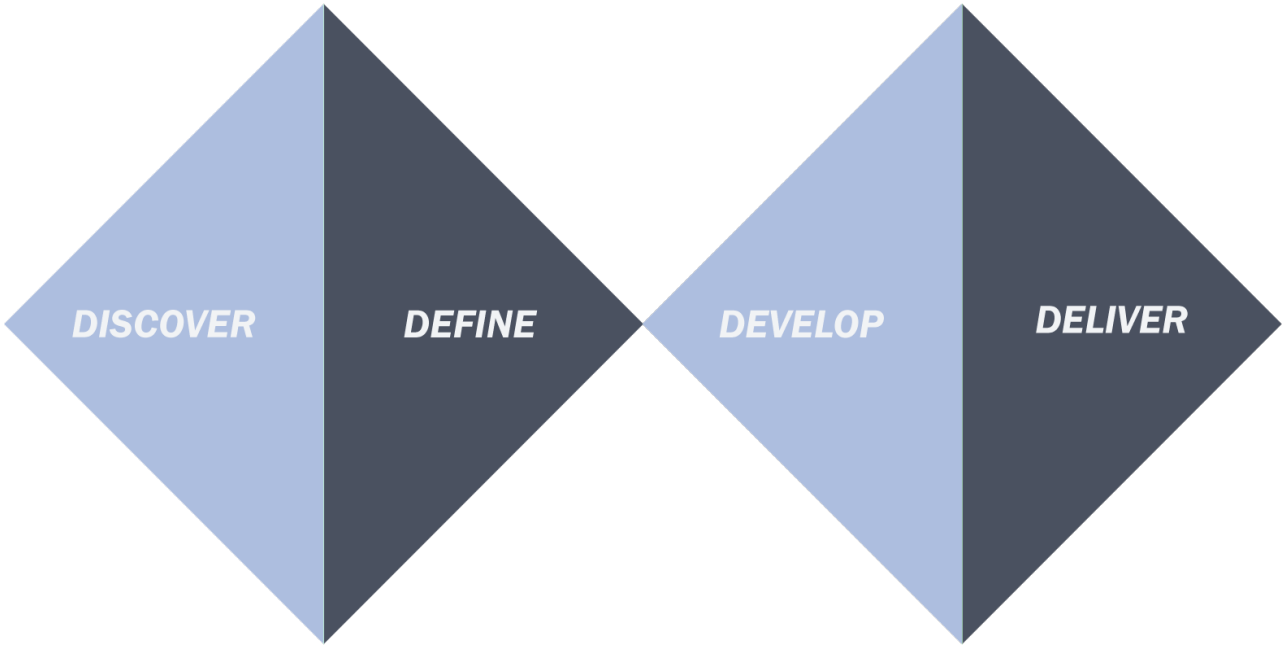


Figure 2.1 Industrial Design Double Diamond

The Double Diamond model is a framework for designers to use that was created and popularized by the British Design Council in 2003. The Design Council wanted a straightforward process for deliverables, regardless of the methodology used. The Double Diamond framework consists of two diamonds: the first diamond serves as the problem, while the second diamond represents the solution (UXPin, 2024).

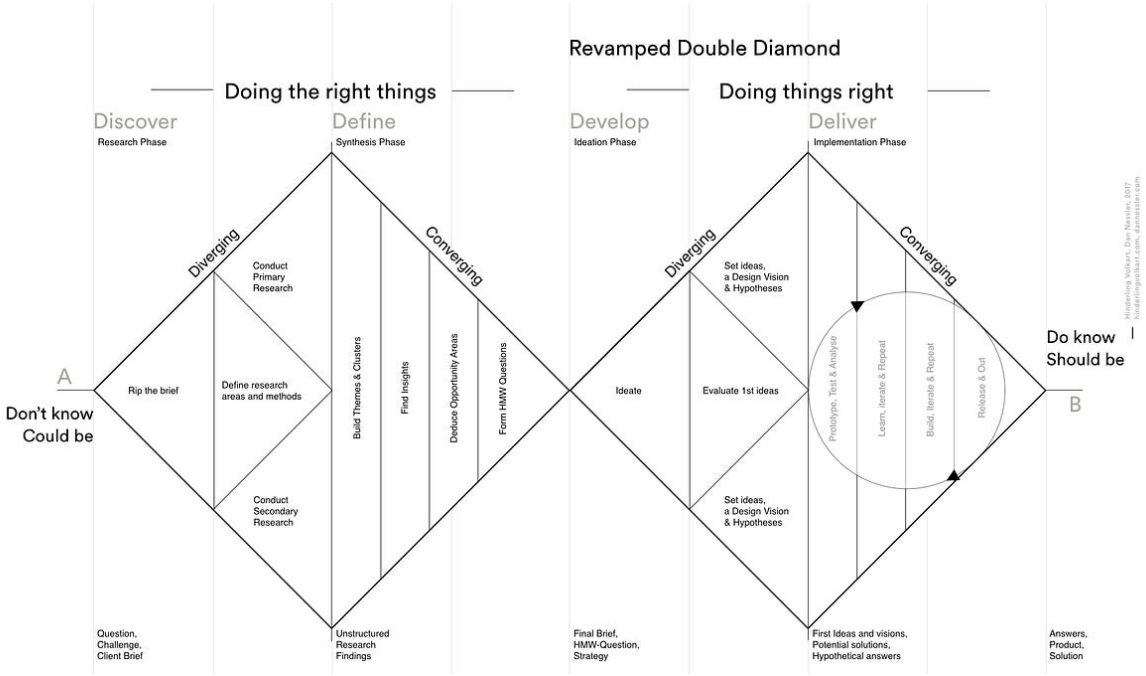


Figure 2.2 Dan Nessler's Double Diamond Framework (2018)

The Double Diamond consists of four distinct phases:

- Discover
- Define
- Develop
- Deliver

Dan Nessler (2018) later remodeled the Double Diamond framework. He opted to make it more detailed, making it more apt to suit industrial designers' needs. A more detailed synopsis of Dan Nessler's modified Double Diamond framework will be discussed in Chapter 3, as it forms the basis for the transdisciplinary guidelines that will be created.

2.1.3. Limitations in Industrial Design

The following sub-sections will address various limitations that are associated with the industrial design process. The limitations are as follows: a growing culture of consumerism, designers only obtaining cursory knowledge due to shortened research, and a lack of evolution in

the industrial design process. Developing a transdisciplinary approach that integrates art thinking and methodology has the potential to mend many of the previously mentioned matters. Although the following limitations are notable, it should also be taken into account that industrial design is a broad field, and the industrial design process is not as rigid as the following limitations may make it seem.

2.1.3.1. Shift to Consumerism

Industrial design as is known today is not as it used to be, and that is ultimately its defect. In his book, Barry Allen explains how design focusing solely on user-centricity can harm the outcome of products:

> The art of design has an edge over artifice because only an accomplishment of design can make a thing that reliably works well and isn't just well-made. Of course, I mean design in the philosophical sense of this book. That's not what is often called today. That design is preoccupied with stimulating desire and attracting consumers. This aestheticization of the commodity is a twentieth-century phenomenon, a product of the expansion of the consumer market and the democratization of taste. Such 'design' is often errant, playful, obsessed with look and feel. Less important is the works being well made. Even less, its working well. Least of all, its real cost. (Allen, 2008)

Although industrial design today is more than simply 'look and feel' as Barry claims, attracting consumers is a crucial component to consider in present-day design. Design, however, should not completely lack a user-centered approach, but perhaps take into consideration what the designer will be passionate about designing. Client briefs will always be part of the designer's

process; however, reframing the brief in a way that makes the designer more passionate about the work he or she is creating is vital in creating a 'ground-breaking' product. This ideology is utilized by both artists and architects in the industry today, and designers could learn from them by practicing a more 'attached' approach:

> The artist and architect are at the center of what they conceive since the desired outcome is often driven by a topic, issue, or idea that is framed in a personal position or aesthetic. The critic is then able to assist by providing a context and determining the cultural value of the work through critical review and contextualization of it within a broader field of knowledge, history, and theory. But, for design—including practices like communication or product design, for example—this is not the case. From the outset, social context and the resolution of specific design problems frame a designer's intent. The designer's individual tastes, emotions, or desires do not form part of the solution, (Brisbin & Thiessen, 2020).

It seems as if design is one of the only creative-related fields that shies away from encouraging individual tastes and desires. Designers being immediately confined to a 'box' that he or she had no authority in creating, or even reframing, can ultimately result in outcomes that are limited in variety and creativity. The authors even go as far as to emphasize that it also results in art and architecture having more productive and successful critiques, which is a critical part of the creative process. Although Brisbin and Thiessen bring up notable points to consider, their argument lacks concrete evidence to back up their claims.

2.1.3.2. Depth of Critical Knowledge

There seems to be a divide in the depth of critical knowledge of artists and architects compared to designers.

> As part of this editorial process, we observed a difference in the depth of critical history and knowledge in design compared to the art and architecture disciplines, which we attribute to an upbringing in more vocational and craft knowledge and its relative newness as a discipline. As a result, there is a lack of robust epistemology or critical thinking and writing that interrogates or aims to make sense of, design's critical function, (Brisbin & Thiessen, 2020).

Going back to the basics, where industrial design begins, allows one to assess the root of the problem. Because of the lack of knowledge and understanding designers face, it is often found that he or she is not able to fully justify his or her design. This could be due to a lack of critical thinking, confinement of inspiration, and a rushed research phase within the design process. If a designer were able to understand his or her designs as well as an artist or an architect, he or she might be better equipped to create and defend the designs. Brisbin and Thiessen further showcase this claim by explaining:

> However, we postulate whether criticality may be more implicit in design practice, and less explicit in design thinking, because the cultural view of design is determined socially, through use and response, and not through its theoretical question-forming and rationalizing. This means designers are 'specialists at being generalists… expert in the configuration of specialist knowledge' (Brisbin & Thiessen, 2020).

It is somewhat ironic that the authors repeatedly refer to designers as ‘generalists’, but simultaneously lack the stamina to endure ambiguous tasks. It is also arguable that artists are ‘generalists’, but perhaps in a different way. Designers do generalize; however, it is done in a methodical and procedural approach that stunts imaginative opportunity and lacks personalization and meaning. This is problematic to designers and their processes because even though a designer might be able to design efficiently, he or she might only understand it in a limited way. This ultimately stunts knowledge generation and progress. Blurring the lines between art and design, as art and architecture already practice today, could be beneficial to both disciplines, but especially to design to cultivate ‘formal uniqueness’ and ‘new-ness,’ (Brisbin & Thiessen, 2020). Brisbin and Thiessen also argue that a better understanding of the intertwined relationship between creation and destruction can aid in design sustainability efforts and more thoughtful designs:

> Thus, architecture and design destroy environments and natural resources by, and in, the spaces and objects they create. The issue is not that this process can be avoided, but rather what it destroyed requires to be ethically and materially justified in relation to what is created, which means understanding the implications of the created futures, or defutures. Gaining such knowledge needs to be educationally of equal importance to creation and creativity. Learning what to destroy, the consequences of destruction, and what not to destroy requires investment, time, and practice. Like an act of creation, there is no guarantee that one’s ambition will be realized, (Brisbin & Thiessen, 2020).

Designers today are not required to take a sustainability course, so they inherently lack the understanding of the relationship between what they create and what it will ultimately dismantle.

When sustainability courses are offered, however, they tend to be quite surface-level and hardly give any practical insight or knowledge on how to implement this into the design process. Due to this lack of knowledge, designers ultimately sustain the unsustainable (Brisbin & Thiessen, 2020).

2.1.4. Connecting Knowledge

Connecting knowledge and bridging the gap between art and design could benefit design in a plethora of ways. In their book "Routledge Companion to Criticality in Art, Architecture, and Design," Brisbin and Thiessen emphasize the importance of connecting knowledge of other fields of expertise and incorporating it into design:

> This is ultimately an argument against battening down the hatches of design discourse while everyone outside gets on with the project of tackling complex problems by connecting knowledge and expertise. Designed artifacts never belonged to design alone, and therefore warrant an interdisciplinary interrogation." (Brisbin et al., 2020)

Brisbin and Thiessen take a logical approach in claiming that design could benefit from an interdisciplinary approach. However, the purpose of this study is to transcend an interdisciplinary approach, to bear a transdisciplinary approach. There is still debate in literature today on what deciphers interdisciplinary from transdisciplinary; however, the term interdisciplinary can be loosely defined as the analysis, synthesis, and harmonizing of 'links between disciplines into a coordinated and coherent whole,' and ultimately leads to a new level of thinking about studying a new topic or even to a new discipline, (Fawcett, 2013). Because an interdisciplinary approach requires one or more people from each respective discipline, this thesis will not be utilizing this method. As an alternative, the research provided justifies a new

transdisciplinary approach. This approach further blurs the lines between disciplines in comparison to interdisciplinary approaches in that it transcends each of their traditional boundaries. It is a holistic approach that goes beyond the views of distinct disciplines to create a common conceptual-theoretical-empirical structure for research, (Fawcett, 2013). Architecture takes aspects from artistic processes just as art takes aspects from architectural processes, so why is design not utilizing a transdisciplinary methodology as well? A transdisciplinary approach could be extremely beneficial to design and could help break down the 'box' that is created when designers are given a brief. Brisbin and Thiessen continue their argument by explaining how the user-centered culture within design tends to be counter-productive, especially considering long-term effects:

> Currently, all design practices exist in a fundamental condition of unknowing, restriction, and subordination that act to delimit any potential for affirmative transformational change.
>
> Following critical points:
>
> - Unknowing rests with a dialectic of sustainment
> - Restriction comes from the iron cage of discipline
> - The truism of Einstein's observation resonates here: 'w[e] can't solve problems by using the same kind of thinking we used when we created them.'
> - Subordination to service is a disservice of service
>   - 'Taking these observations seriously means bringing the dialectic of sustainment to the very center of architecture and design practices so they may be destroyed and recreated. They cannot effectively

> contribute to responding to crisis while being implicated in the situation of continuity and extension. This is what, in the end, all that 'sustainable architecture and design' do, de facto—they sustain the unsustainable.' (Brisbin et al., 2020)

A paramount understanding that all designers must come to is that novelty does not derive from practices that are of a traditional and habitual nature. One cannot understand the full potentiality of a result while, preceding ideation, restricting oneself to a list of parameters that are considered customary. Growth demands change, and industrial design will have difficulty keeping up with the evolution of various disciplines that are acquiring knowledge from outside sources—such as architecture and art—while utilizing a methodology that was cultivated in and has hardly been modified since the 90s.

2.2. Idea of Art

Many people believe being artistic or having the ability to create art is innate; however, this is false, and the ability to learn art lies within everyone, just as it does in design. In his book, "Artifice and Design: Art and Technology in Human Experience," Allen backs up this claim via history:

> Art is not human nature. If we take a long view, if we appreciate humanity as an evolved entity, there's no escaping the conclusion that for most of Homo Sapiens' existence—our first hundred thousand or more years—art, design, technical invention, ingenuity, even knowledge were not conspicuous qualities of human life. The evidence pretty clearly shows that art is not an evolutionary adaptation, not something humans have always instinctively done. Instead, the potential for art and design, like the potential for

> knowledge (perhaps even speech) had to be discovered and cultivated, making art more like a good idea than an instinctive behavior (Allen, 2008).

Art is not something that humanity was born with, and the perception that it can be learned is the foundation on which this study is built. Until art was created, no one truly knew the impact it could have on individuals and society. Similarly, because art thinking has yet to be incorporated into the design process, no one truly knows the impact it could have on society and individuals as well. Authors Carole Gray and Julian Malins shed light on how art thinking could aid design thinking in that it does not shy away from asking the 'messy' questions, and often these questions create ground-breaking solutions. In "Visualizing Research: A Guide to the Research Process in Art and Design," the authors take a historical approach to how art thinking could be beneficial to a plethora of practices:

> Einstein recommended a research strategy of 'loose opportunism', and Feyerabend (1988) reinforces this:
>
> > For what appears as 'sloppiness', 'chaos', or 'opportunism'… has a most important function in the development of those very theories which we today regard as essential parts of our knowledge. These deviations, these errors, are preconditions of progress… Without 'chaos', no knowledge. Without a frequent dismissal of reason, no progress' (Feyerabend, 1908, p. 164).
>
> Research methodologies should take advantage of current cultural contexts and technologies. This can help us to extend the range of existing methods—to use multimedia, multi-sensory methods. Galileo invented the telescope so he could see further, explore further, extend knowledge—if a research tool is required why not invent it, (Gray & Malins, 2017)?

Einstein's statement further reflects artistic thinking by claiming there should be a 'frequent dismissal of reason' and without it, there can be no growth. This is a fundamental aspect of artistic methodology in that there are no questions, thoughts, or ideas that are off-limits and deemed unreasonable. Designers consistently find themselves and their ideas hindered by 'boxes' that are placed upon them by clients, marketing requirements, etc. Although these factors cannot be completely disregarded, creative freedom is a key ingredient for true innovation.

2.2.1. Street Art

Street art is unique in that it treads the line between illegality and authority. One of the most famous art activists today is a street artist named Banksy who has had an incredible impact on socio-political change in American society. A large part of his international recognition is the sense of allure because his identity remains unknown, (Brenner, 2019). Banksy has revolutionized the art world by bringing rapid international attention to street art. His work is unmistakable with his unparalleled stenciled style combined with his love of dark humor, controversial images, and mockery of society.

Although his works often include images with negative underlying messages, he still manages to bring joy to people as they pass by his work and ultimately causes them to reflect on socio-political concerns today. Banksy has had such a significant impact on society today that a term was coined after him, 'The Banksy Effect,' in tribute to his skyrocketing popularity. His art is not limited to changing society and politics, but also modifying art as well. He has cultivated a way to bridge the gap between street art and 'fine art' to create his style, (Brenner, 2019). Because Banksy has found a way to converge two very distinctive styles of art, it is not

unreasonable to assume that converging art thinking and methods into the design process is plausible as well.

2.2.2. Problem-Creation

'Problem-creation', or 'problem-finding,' can be seen as a reaction against the use of traditional problem-solving methods and is viewed as completely independent from problem-solving. The problem-finding view believes that the traditional problem-solving view is inadequate in justifying how creators realize a problem exists in the first place and how they are motivated to understand the problem (Kozbelt et. al, 2010). To showcase the inherent value of the problem-finding skill, psychologist Mark Brown offers a historical example of how finding the *right* question can have a tremendous impact on finding the *right* solution, "Nomadic societies were based on the question 'How do we get to water?' They became agrarian and stable cultures when they began asking 'How do we get water to come to us?'" (Gelb, 2009).

A key distinction between the artistic problem-solving process and that of designs is that designers are commonly given the problem, or the client brief, while artists create their own and spend time further defining the problem they have created. Problem-finding and solving are not distinct stages, they occur in a 'cyclic fashion' throughout the creation of a single work for artists (Mace & Ward, 2002). Jacobs further illustrates why problem creation is a significant skill to possess in creative fields:

> Artists do not wait for a problem to be handed to them or look for a problem in what already exists; rather, they create it from within, through their primed and prepared mind. Unlike designers, artists are more comfortable creating and reframing the original problem and less focused on a solution (Cross, 2001). This can be valuable

when inventive thought is needed." (Jacobs, 2018)

Many researchers have found that finding the right problem is much more important than solving the problem. In a case study (Getzels & Csikszentmihalyi, 1976) a key finding was that finding a problem is more indicative of creative behavior than solving a problem, and problem-finding scores relate directly to originality. It was also noted that time spent did not increase drawing quality; however, time spent formulating the problem before beginning did increase the quality of drawings. Studies also demonstrate that designers can generate more varied solutions when the problem is precisely defined. In their book, "Routledge Companion to Criticality in Art, Architecture, and Design," Brisbin and Thiessen back this claim that design has become too rigid by explaining:

> What is asserted here is not that service is bad, but rather, what is critical is what is served. This issue is neglected in design education and practice by a condition of service acceptance that so often leaves a 'client brief', 'market requirements', and expressed 'user-needs' as over-determining design (the designing of design) (Brisbin et al. 2020).The 'designing of design' is an interesting term because there is truth within this phrase. In a creative field, there are rigid guidelines and methods to be applied, almost as if there is a rule book to design. Having a more flexible design process could allow designers to explore more innovative solutions or create in a way that is tailored to the designer's strengths and weaknesses.

2.2.2.1 Generators and Constraints

Generators and constraints, additional strategies for problem-finding, often go hand in hand with artists. Constraints are mostly based on indisputable facts, or physical requirements that

cannot be avoided (Kupferberg, 2023). Generators aid artists in finding a 'way into the problem'. In a case study conducted by McDonnell (2011), it was found that a key difference between designers and artists is that artists utilize primary generators. Primary generators are constraints artists impose on their works to challenge themselves, further define the problem, and/or achieve personal goals. The goal is specific to the artist and is primarily based on subjective judgment rather than being restricted by logic. The selection criteria the artist chooses to explore oftentimes form the basis of 'language' for the artist's body of work, allowing them to maintain thematic and aesthetic coherence throughout a body of work. The art-making process is overarching and includes ongoing practice rather than single bodies of work (Jacobs, 2020). Constraints and generators can be broken down into 5 categories: *physical* constraints, *prototypes and development* constraints, *knowledge* constraints, *rules*, and *motivational* constraints (pressure, pleasure, and opportunity (Kupferberg, 2023).

Figure 2.3: Iktinos and Kallikrates, Parthenon, Acropolis, Athens, 447–432 B.C.E. (photo: Steven Zucker, CC BY-NC-SA 2.0)

Physical constraints are heavily influenced by the domain that is being specified. For example, scientists' physical constraints often consist of data, whereas physical constraints for

artists primarily consist of materials. In hopes of illustrating physical constraints in explicit terms, Kupferberg (2023) utilizes the field of architecture as an example:

> First of all architecture is strongly site-specific (Graham, 2003). The Parthenon would certainly have given off a very different impression or evoked other ambivalent and intensive emotions of mass, volume and light if it had been placed somewhere else than on the top of Acropolis (this intuition is confirmed by the fact that the present building is only a shadow of its ancient glory). Physical constraints (stone) probably also constrained the chosen classical style.

It seems that physical constraints can be broken down into categories, and these categories can then be broken down into sub-categories. The main category being the site, and the sub-categories being components of the sight (mass, volume, light). Classical architects began to espy how the human eye can be deceptive, for example, columns that were placed too close together appeared thicker. Physical constraints can also be utilized as generators and contribute to the overall purpose of art: to evoke emotion. These emotions, or generators, could include words like “unity” and “harmony” (an important notion for the Greeks), or “calm” (an important emotion for Matisse) (Kupferberg, 2023).

Utilizing constraints and generators can benefit the design process in that it stimulates more generative creativity. If initial parameters are too restrictive in the initial stages of the design process, it could increase the likelihood of creativity being lost (Jacobs, 2020). Many of the constraints in the design process will be defined by market requirements, client briefs, etc.; however, designers can utilize generators to further refine the brief and set challenges for themselves which will likely result in more generative creativity.

2.2.2.2 Conversation with Work

Artists refer to this method as 'feeling' your way through work. He or she begins to develop a 'dialogue' with the pieces, reacting to them, and making incremental changes throughout the creative process. This is also a strategy utilized in problem-finding, as it is an ongoing strategy utilized throughout the entirety of the artistic process. In the article Intersections in Design Thinking and Art Thinking: Towards Interdisciplinary Innovation, the author explains this concept further:

> As the artist makes decisions, he or she converses in a way with the work as they proceed, a unique experience that develops situationally (Mace, 1997). If artists let the solution develop while responding to the work throughout, rather than just applying a known solution, more creativity results (Jacobs, 2020).

This could be beneficial to Industrial Design not only because it results in more creativity, but also could be beneficial throughout the sketching and model-making phases of the design process. Too often, designers begin making a model of a sketch he or she created only to realize the form, feel, or overall idea is not what they expected it to be. If designers were to employ a 'conversation' with the design, the designer might be able to tweak his or her design to create a potentially better solution. An exemplification of this strategy would be Gerhard Richter as he explains a portion of his artistic process. In the documentary Gerhard Richter Painting, Richter utilizes this artistic methodology and 'converses' with his work:

> [Richter]: When I first approach a canvas, theoretically and practically I can smear anything I want on it. Then there is a condition I must react to by changing it or destroying it. There's no concept. It's not like a figurative painting with a template. Something happens spontaneously. Not by itself, but without plan or reason.

…

[Interviewer]: Composition by chance. So, the question is: you paint without a plan, but you know exactly when its right. So, what's the correlation between planlessness and making the judgment: 'Now it's a painting'?

[Richter]: Each step forward is more difficult, and I feel less and less free until I conclude there's nothing left to do. When, according to my standard, nothing is wrong anymore, then I stop. Then it's good. (Belz, 2012, 00:54:22)

As Richter begins to paint, there is no solution or 'end goal' while he is creating, ultimately, he opts to go for what 'feels right'. While designers are primarily focused on clients' standards, focusing on their internal standards could be beneficial in creating a more genuine, perhaps even more innovative, design.

2.2.3 Embracing Ambiguity

Successful artists produce an immense amount of both good and bad work. While designers are familiar with iteration and failure, artists tend to create in an uncertain marketplace for which there may be no acceptance or audience (Gardner, 1993). An embrace of ambiguity allows the artist to take a 'step back' from his or her work and make connections between and evaluations of ideas. Both artists and designers are comfortable with ambiguity, which may be evident throughout the sketching process; however, the artist has a larger tolerance to an embrace of ambiguity. This is exemplified by Robert Rauschenberg (1925-2008) as he illustrates his obscure perspective of painting:

[Rauschenberg]: I may have said that painting relates as much to life as it does to art or vice versa, but I don't think so. I said that you couldn't make it either and you had to work in that hole between.

[Interviewer]: What is that space?

[Rauschenberg]: Uh, it's undefined. That makes the adventure of painting (Belz, 2012, 00:54: 20).

On an individual scale a low tolerance for ambiguity can cause hesitancy in decision-making, flawed choices, and career avoidance (Robinson et. al, 2018). In education, design students are often uncomfortable without specific instruction or rigid guidelines, guidance, etc. This results in a reluctance to test new ideas. Finally, in a business setting a designer with less experience may generate less innovative solutions (Jacobs, 2020). Low tolerance for ambiguity results in a risk-averse mindset (Robinson et. al, 2018). Robinson explicitly identifies how a low tolerance to ambiguity can hurt designers not only during education but in the workplace as well. If designers were able to adopt this mindset that many artists, throughout history and today, currently practice, they could create more innovative solutions.

To increase one's tolerance for ambiguity, a shift in his or her mindset must occur such as viewing ambiguous tasks as a challenge rather than a threat. In an experimental group, locus of control had a significant impact on an individual's increase in tolerance for ambiguity. Participants with internal loci experienced the largest average increase in ambiguity tolerance (Banning, 2003). For reference, people with external loci might blame their teachers as the reason for their bad grades, whereas people with internal loci would blame it on their lack of studying (Sabbot, 2013).

2.2.4 Emotional Engagement and Expressiveness

The point of art is to communicate. We use language to communicate ideas, and we use art to communicate feelings, which is expression (Winner, 2019). Many artists report using emotions

as a source of material for their work. Research in psychology indicates that self-empathy and self-awareness lead to more empathy for others. Jacobs (2020) explains:

> Studies show that artists are more emotional than scientists, and designers fall somewhere in between (Feist, 1999). Wakefield (1994) uses the term 'empathy with oneself' as a way to describe the artist's exploration of emotional states and conflicts as source material or a means of problem-finding (or concept/ theme-finding) and solving. The use of the word empathy is notable in relation to the empathy stage of the design thinking process in which the focus is on empathy for the user (through the use of ethnographic studies, research, etc.). For the artist, the focus is towards the self.

The emotions artists experience throughout the creation process can range from pleasure and satisfaction to melancholia and even depression. This could be beneficial to a designer in that this would allow him or her to become more human-centered, therefore allowing for a broader range of creative solutions, (Jacobs, 2020).

Many artists will tell you that the true value of art is to express something about the creator or how he or she is feeling at the time of creating the piece. This idea seems to begin with the Renaissance artist and architect Leone Battista Alberti and his book On Painting (1435), and in Leonardo's Treatise on Painting (circa 1482). Both artists explain that a painting should make the viewer feel something, and in a way relive and understand the true meaning of the work. In his book, "Artifice and Design: Art and Technology in Human Experience," Barry Allen emphasizes both Leonardo's and Alberti's ideas by explaining:

> A convincing depiction of sorrow should make us want to cry. Only such images are expressive in the way these Renaissance artists think the best painting is. This idea remained an appealing one down to Henry Bergson and Leo Tolstoy at the end of

> the nineteenth century. Despite Tolstoy's iconoclastic contempt for Renaissance art, he follows Alberti's line on expression What is Art? (1896). The point of art is to communicate. We use language to communicate ideas, and we use art to communicate feelings, which is expression. Art should cause the audience to feel the very feeling the artist felt (Allen, 2008).

Artists are extremely connected and passionate about their works. This idea of communicating through their work is not foreign to design; however, artists approach this in a much more free and ambiguous nature. Many, if not all, artists utilize this technique to their advantage. One of these artists is Gerhard Richter, and in Gerhard Richter Painting, he explains:

> To talk about painting is not only ridiculous but perhaps pointless, too. You can only express in words what words are capable of expressing, what language can communicate. Painting has nothing to do with that. That includes the typical question: 'What were you thinking of?' You can't think anything; painting is another form of thinking (Belz, 2012, 00:09:31).

Richter exemplifies how artists ambiguously express themselves; however, this expression also can be completely literal depending on the artist's taste.

Figure 1.4 The Welcoming Hands (Borgeois, 1996)

Louise Bourgeois (1911-2010) explains how she was able to utilize emotional engagement to her advantage in her sculpture The Welcoming Hands:

> *[Bourgeois]:* This is where it came from. So, it is really our hands.
>
> *[Interviewer]:* Why is it so important for it to be your hands?
>
> *[Bourgeois]:* Because it means… because it shows how much I care about the whole thing. It shows how much emotion this express is true (Wallach, 2008, 01:22:07).

There are also parallels between expression in art and expression in design. Expression in art communicates feelings and provokes these same emotions to the viewer; however, design communicates function through its works. This would be beneficial to design if the designer wants

to create a specific user experience, or also provoke action from a user. In contrast to that of the artist, designers almost take a 'detached' approach as they are only thinking about the user who will be utilizing this product.

2.2.4.1 Expressing Emotion

It is evident that art expresses emotions to its viewers and listeners; however, it is often overlooked how in-depth these emotions can be:

> What psychological research shows us is that people, whether musically trained or not, typically report perceiving quite specific emotions from playing or listening to music. And these emotions go way beyond basic ones like happiness and sadness to include feelings like nostalgia, melancholy, tenderness, and amazement. While emotion theorists might debate whether all these terms are actually names for emotions, these are clearly states restricted to sentient beings and thus can only be metaphorically but not literally conveyed by music, (Winner, 2019).

Music can not only express emotions but can express complicated ones. Although music as an art form can be more literal in comparison to other mediums of art, it is still in a metaphorical sense and mostly leaves interpretation up to the listener. Winner elaborates more on how music can express emotions to those listening:

> When we are sad we speak more slowly, more softly, and in a lower register. Thus when music is slow and soft and low, we perceive it as sad…Research has also shown that people agree on which basic emotions are expressed by music even in a culturally unfamiliar form. The psychological research provides no support for the claim that music does not express emotions," (Winner, 2019).

Winner illustrates how people inherently link the speed and tone of someone talking to emotions, and it is done the same way in music. Although this is not possible in visual art and probably will not be in design either, it is useful to see how emotions are expressed between all art forms.

Visual art expresses emotions in quite a different manner in comparison to music. Its approach is much more metaphorical, ambiguous, and open to interpretation. This is because visual art cannot rely on words, speed, or tone:

> There is agreement across ages and across cultures about the expressive properties of visual forms. Moreover, our proclivity to see expressive qualities in visual forms is not limited to pictures functioning as art: we see the same kinds of expressive properties in rocks, trees, columns, cracks, drapery, and other mundane objects if we are predisposed to look at them this way, (Winner, 2019).

Some might look at rocks and see loneliness; however, others might look at them and see freedom. The range of perspectives of interpretation is incredibly broad; however, if it could be homed in, this could aid design in contributing towards a common cause, such as environmental concerns. Perhaps the designer will have a specific environmental concern they want to convey while designing, but if the only takeaway is to care for the environment that is commendable as well. Because of music's resemblance to speech prosody, it can express emotion, but our perception of emotion in art is derived from our ability to see expressive properties in all forms. Why the former is successful in expressing emotion is known; however, the latter remains a mystery, (Winner, 2019) and will ultimately be the primary challenge throughout this study.

2.2.4.2 Evoking Emotion

As mentioned earlier, how music can express emotion is known, however, the way it can evoke emotion is much more mysterious and many believe it is not possible at all:

> The philosophical puzzle is how music can cause us to feel emotions. Emotions are about something. Yet when we hear sadness in music and thus feel sad ourselves, there is no object to our sadness. Nothing bad has happened to make us feel sad. This puzzle has led some philosophers to deny that we feel emotions from music. They admit that we can feel pleasure and we can feel moved, but when we say we feel sad or happy, we are just wrong. We hear emotion in the music and mistakenly believe we are actually feeling that emotion, (Winner, 2019).

Although nothing 'bad' has happened to the listener when hearing a sad song, it is possible they can feel it either via empathy or relating to a certain event in his or her past. The idea that most people just 'think' they are feeling sad and are somehow mistaken ultimately lacks rationality in that a person could be 'wrong' about how they are feeling. How could a philosopher interpret the emotions of another better than the individual does? Winner goes on to explain:

> Other philosophers, however, see nothing incoherent about the idea of an objectless emotion. We mirror in ourselves the emotion we hear in the music and we feel that emotion. Research clearly supports the position that music elicits emotions in the listener… Could we all be wrong… We know that the sadness from Elgar's cello concerto evokes is caused by the performance, and not by an actual tragedy. This cannot help but soften the sadness. Overall, the research on this topic fails to provide support for the philosophical position that we cannot feel emotion from music, (Winner, 2019).

Winner's argument provides specific instances in which a person can feel an emotion without being involved. Scores in movies play a significant role in the overall mood of a movie, such as Jurassic Park when they see the first dinosaur of their time can convey a sense of amazement, or in Jaws when the Great White is near it creates a sense of fear, or even suspense.

While watching a sad play, many of the audience members will cry, would that be considered a 'mistaken' feeling, too? While plays and music can evoke strong emotions in the viewer, visual art takes a more subtle approach:

> And emotional responses to visual art seem to be less powerful than emotional responses to music. I have suggested that this may be due to the fact that music envelops us, takes place over time, and makes us feel like moving far more than do other art forms. The way we normally interact with visual art is to glance briefly and move on, and this mode of interaction is guaranteed to not evoke strong emotions, (Winner, 2019).

The author explains that for visual art to evoke an emotion in the viewer, the viewer cannot simply walk by and expect to have an emotional reaction. The viewer must sit with, process, and interpret the work to achieve this effect. This could be a challenge for this study in that it will be difficult to evoke an emotional reaction from seeing someone's bag, for example, as they are walking across the street; however, it could be possible to evoke an emotional response out of the person who purchases the bag. They will have time to sit with and interpret the product before, during, and after purchasing. Winner continues in explaining how art can force people to look inward toward themselves:

> When people do report feeling like crying when looking at art, they are clearly feeling moved. And there is intriguing evidence that when we are powerfully moved by works of visual art, an area of the brain known to be associated with introspection, the default mode network, is activated. This finding suggests (but alone does not serve as proof) that visual art has the power to make us look inside ourselves. If this is true, then visual art that moves us can foster self-understanding,

(Winner, 2019).

Although, as the author previously stated, this finding does not alone serve as proof, it is the first piece of concrete evidence that suggests art can evoke emotions. While it is uncertain how this can be translated into design, it could benefit not only Industrial Design as an industry but also society in that it can encourage individuals to become more self-aware and empathetic.

2.2.4.3 Negative Emotions

While one might initially assume art that is intended to express and/or evoke negative emotions would deter the viewer from enjoying the piece itself, Winner explains why this misconception is not valid:

> Negative emotions from art are not the exception but the rule. Psychologist Menninghaus and colleagues have posited that compared to positive emotions induced by art, negative emotions result in our paying more attention, feeling more emotionally engaged, and coming away with a more strongly encoded memory of the experience. Experiencing painful emotions likely also motivates us to construct meaning—as a way of giving the painful experience a positive role, (Winner, 2019).

The author continues her argument in explaining that the more negative the content, the more positive and moved people begin to feel. Winner explains why people have and continue to enjoy art forms that are meant to evoke negative emotions:

> Aristotle said we don't like to look at painful things in life but get pleasure from seeing things in art. We like tragedy on stage because of its cathartic effect. We like sad music. We look at paintings of suffering, dying people, we go to horror movies, scary movies, suspenseful movies. Does this mean we are masochists? We can

> answer this in the negative, because research shows that when we experience art with painful content we
>
> not only feel negative emotions but also positive ones. And that is primarily because of aesthetic distance. That is, we know that our emotions are caused by art, not 'real life,' (Winner, 2019).

The author continues her argument by explaining that experiencing negative emotions encourages 'meaning-making' as humans try to create something positive out of a distressing experience. This argument is significant to the research done in this thesis in that it explains why humans enjoy art that is supposed to be interpreted as 'painful'. It was previously unknown if translating the power of protest art into consumer products would be successful in that protest art is meant to make viewers uncomfortable, and why would anyone want to purchase a product that makes them feel negative emotions? Winner's research shows that this interaction produces positive emotions as well and the negative emotions ultimately have less impact on the viewer because they are aware of said 'aesthetic distance,' which is extremely beneficial. The reasoning behind so many individuals seeking negative emotions in art yet choosing to evade them in their day-to-day lives is that there is a sense of safety in knowing that it is art and not reality, (Winner, 2019).

2.3. Purchase Decisions and Emotions

Evoking emotions is a key factor in art throughout history, and what gives it the ability to be so powerful. The purpose of this study is to translate this effect from art into consumer products. This could be beneficial to design because emotions also play a key role in consumers' purchasing decisions:

> Consumption experiences and product usage can evoke customers' emotional

> responses, both during and after consumption, and such emotions in turn determine customers' purchase decisions and post-purchase behaviors…There is evidence that customers' emotional responses to store environments, e-store designs, and advertisements impact their subsequent purchase decisions, (Guo et al., 2020).

Understanding how and why emotions influence consumers' purchase decisions could aid the designer in creating a more novel, long-lasting product. Art elicits emotional responses by primarily relying on creating an emotional response from the viewer, and with consumers naturally relying on their emotions to make purchase decisions, the goal of translating these effects into Industrial Design is feasible.

2.4 Purchase Decisions and Aesthetics

Art is also able to captivate its viewer based on aesthetics alone, and understanding the role aesthetics play in consumer purchase decisions could aid the designer in developing more empathy for the user. The aesthetic assessment of a product relates to the gratification of seeing the product, without considering its functionality. In a large qualitative study (N=142), subjects were asked to choose between two answering machines and then later questioned why they made the decision they did. It was found that several appearance factors played key roles in the subjects' decision-making:

> The number of ways in which appearance played a role for consumers differed between 0 and 5; most subjects mentioned two different ways in which appearance influenced their product choice. The aesthetic and symbolic roles were mentioned most often. The preferred shape (e.g., rounded or angular, color, or size were found

> to differ depending on the way in which product appearance played a role for subjects. For example, bright colors may be valued from an aesthetic point of view but may diminish the impression of quality (i.e., functional value) (Creusen & Schoormans, 2004).

Understanding what motivates users to purchase a specific kind of product—aesthetic, symbolic, ergonomic, or functional—is crucial to the initial stages of the design process. How these factors influence individuals, however, differs between subjects. Designers can use this information to their advantage when designing for a specific category:

> For products for which prestige, exclusiveness, or novelty are important, an atypical appearance is advisable. For such products, preference declines when it becomes more widely available and thus more typical, because uniqueness is valued (Ward and Loken, 1988). An atypical appearance is also advisable when a product must be differentiated from other products in the category—for example, when there are competing alternatives. Strong differentiation even may lead consumers to consider first the product as a member of its own individual class (Rosch et al., 1976, p. 434). Also, new functional attributes are communicated better by an atypical appearance (Creusen & Schoormans, 2004).

Chapter 3

Developing a Transdisciplinary Approach to Integrate Art Thinking into the Industrial Design Process

In this chapter, I will develop a transdisciplinary approach to integrate art thinking into industrial design. Utilizing Nessler's Double Diamond framework (2018) as a basis for this approach, I have created a modified double diamond framework with an accompanying flow chart to facilitate a step-by-step guide for industrial designers to follow. Both tools have been adapted to accommodate prolonged research and delayed closure, while also integrating overarching mindsets and explicit strategies fundamental to the new transdisciplinary design process.

3.1. Double Diamond

The Double Diamond model is a framework for designers to use that was created and popularized by the British Design Council in 2003. The Design Council wanted a straightforward process for deliverables, regardless of the methodology used. The Double Diamond framework consists of two diamonds: the first diamond serves as the problem, while the second diamond represents the solution (UXPin, 2024).

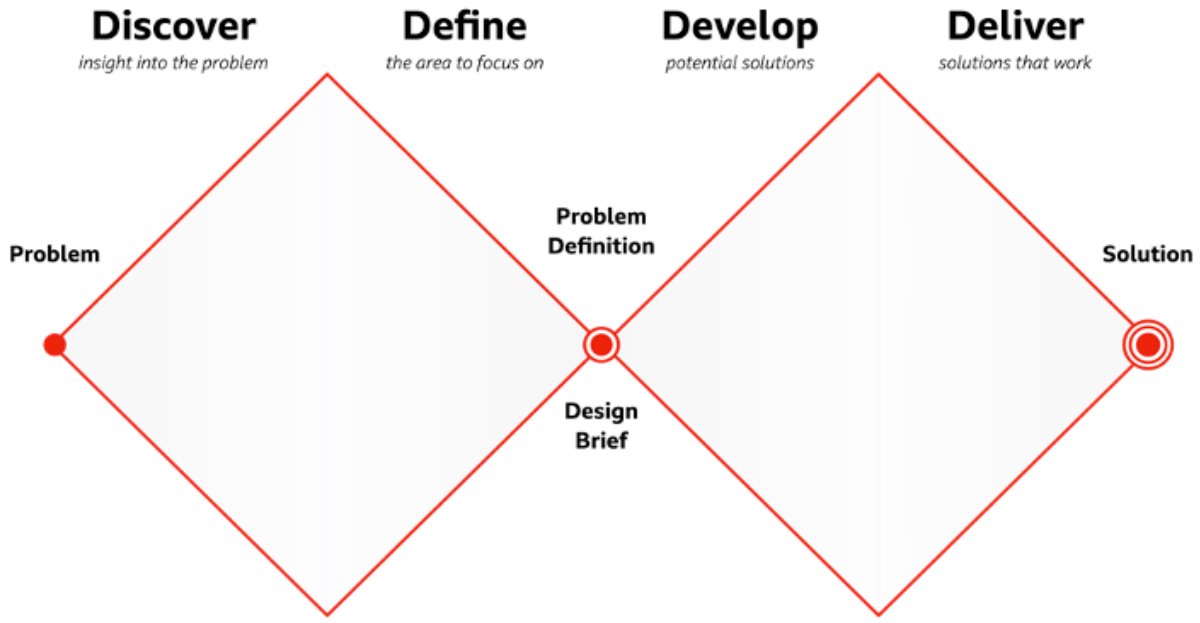


Figure 3.1 Double Diamond Framework (Ramsden, 2023)

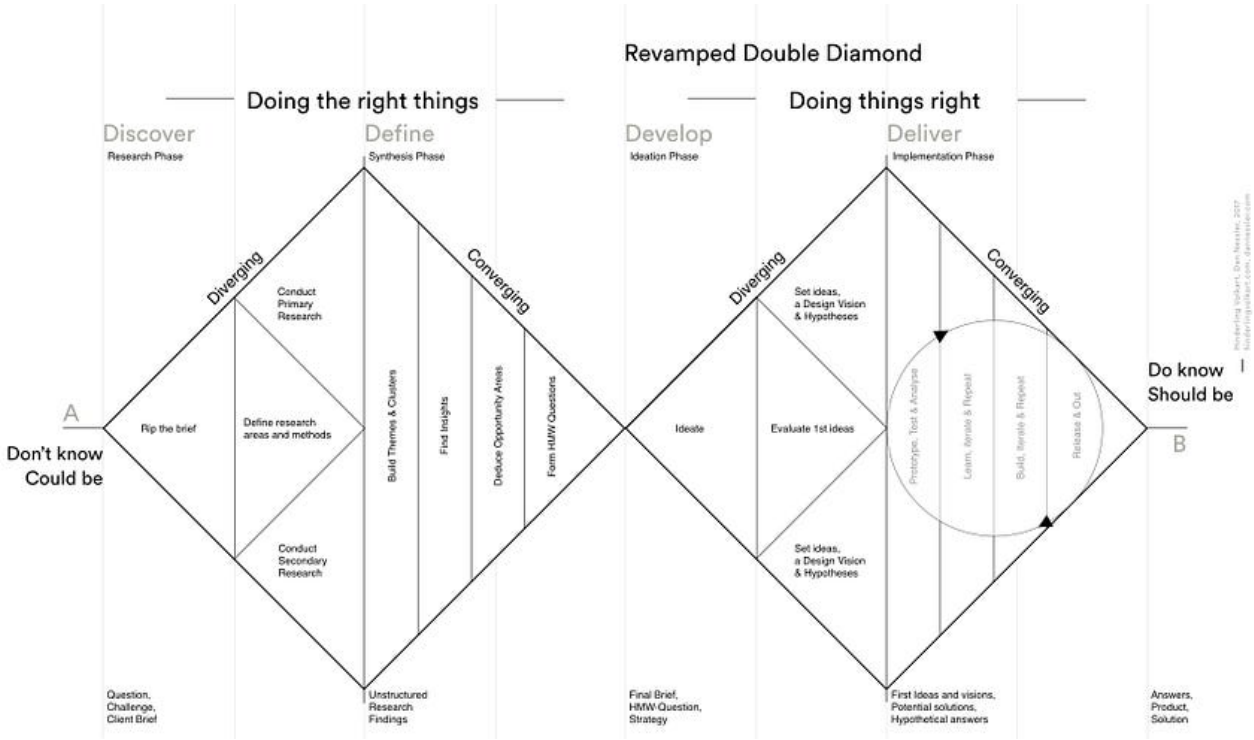


Figure 3.2 Dan Nessler's Double Diamond Framework (Nessler, 2018)

In 2018, Dan Nessler constructed his rendition of the Double Diamond Framework. Nessler's variation of the Double Diamond framework is much more detailed; however, maintains the overall ideas of the original framework (Nessler, 2018). The framework created in this chapter will utilize Nessler's version of the Double Diamond framework as a basis for integrating artistic thinking into the industrial design process.

The Double Diamond design process can be divided into four phases, or the four Ds as described by Nessler. Each phase is either converging or diverging. Diverging phases emphasize limiting yourself as little as possible, whereas converging phases primarily focus on narrowing your scope. Nessler describes each of these phases, which he refers to as the 'four Ds of design,' while giving a step-by-step approach to his 2018 Double Diamond framework:

- **Discover/ Research (diverging)**
    - The first phase helps the designer to understand the initial situation or challenge, define what knowledge they need, and how to obtain that knowledge.
- **Define/Synthesis (converging)**
    - Utilizing the research that was obtained during the discovery phase, the second phase helps designers to better understand their research and identify whether they are solving the *right* problem.
- **Develop/ Ideation (diverging)**
    - The third phase is about creating solutions and evaluating different ways to solve the core problems discovered during the first two phases.
- **Deliver/ Implementation (converging)**

- The fourth and final phase is about producing tangible solutions. This phase is iterative and may need to be repeated several times. Building, testing, failing, and learning is key to the delivery phase.

Nessler (2018) emphasizes that his variation of the Double Diamond framework is an approach to design, but not *the* approach to design. It is iterative and not as rigid as it may seem.

3.2. Approach to Integrate Art Thinking into the Industrial Design Process

In this section, only the parts that are altered or are an addition to incorporate artistic thinking into the design process will be discussed in detail, for a more in-depth description of Nessler's Double Diamond Framework and the industrial design process, refer to *How to apply a design thinking, HCD, UX or any creative process from scratch — Revised & New Version* (Nessler, 2018).

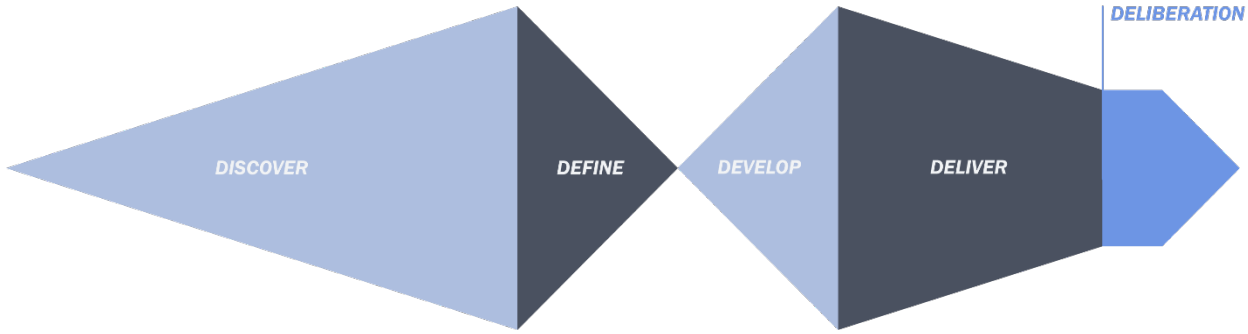


Figure 3.3 Transdisciplinary Double Diamond Framework

Figure 3.3 serves as a visual representation of the new transdisciplinary design process and is only utilized to highlight overall differences from the original Double Diamond framework. The differences will be highlighted in greater detail utilizing the flowchart in.

The discovery and delivery phases of the transdisciplinary double diamond framework are larger, indicating that artists are more likely to and more comfortable with lingering in these phases

in comparison to designers. It is also worth mentioning that in addition to the four Ds referred to in section 3.1, a fifth D has been added to the new framework: Deliberation. This phase is neither converging nor diverging because it is a reflection period. This concept will also be discussed in greater detail utilizing the flow chart that is derived from the Transdisciplinary Double Diamond framework. The phases for the new approach are as follows:

- Discover
- Define
- Develop
- Deliver
- Deliberate

Because the artistic process is cyclic and oftentimes does not involve time constraints, recommendations have been made on how much time to devote during each phase of the transdisciplinary process:

- 40% of the project should be devoted to the Discover phase
- 10% to the Define Phase
- 10% to the Develop phase
- 30% to the Deliver phase
- 10% to the Deliberate phase

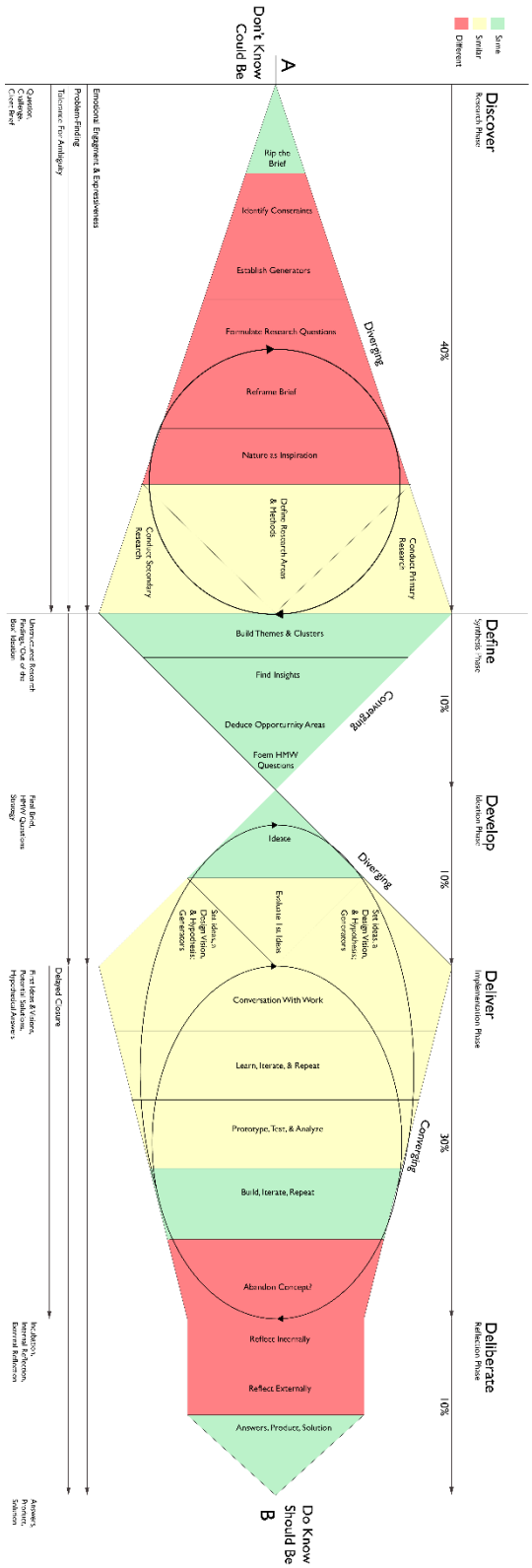


Figure 3.4 Transdisciplinary Double Diamond Framework

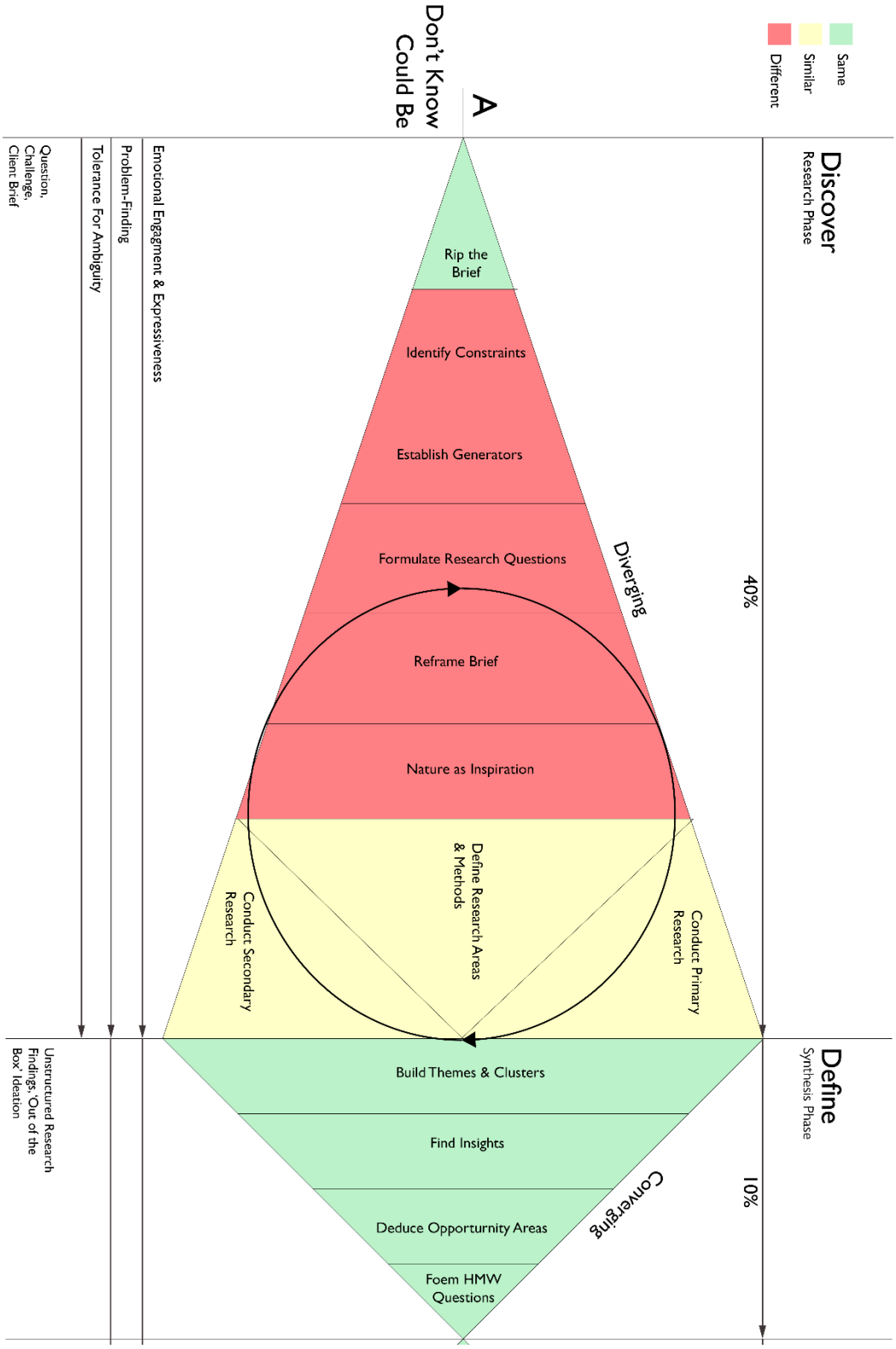


Figure 3.5 Transdisciplinary Double Diamond Framework: Discover & Define

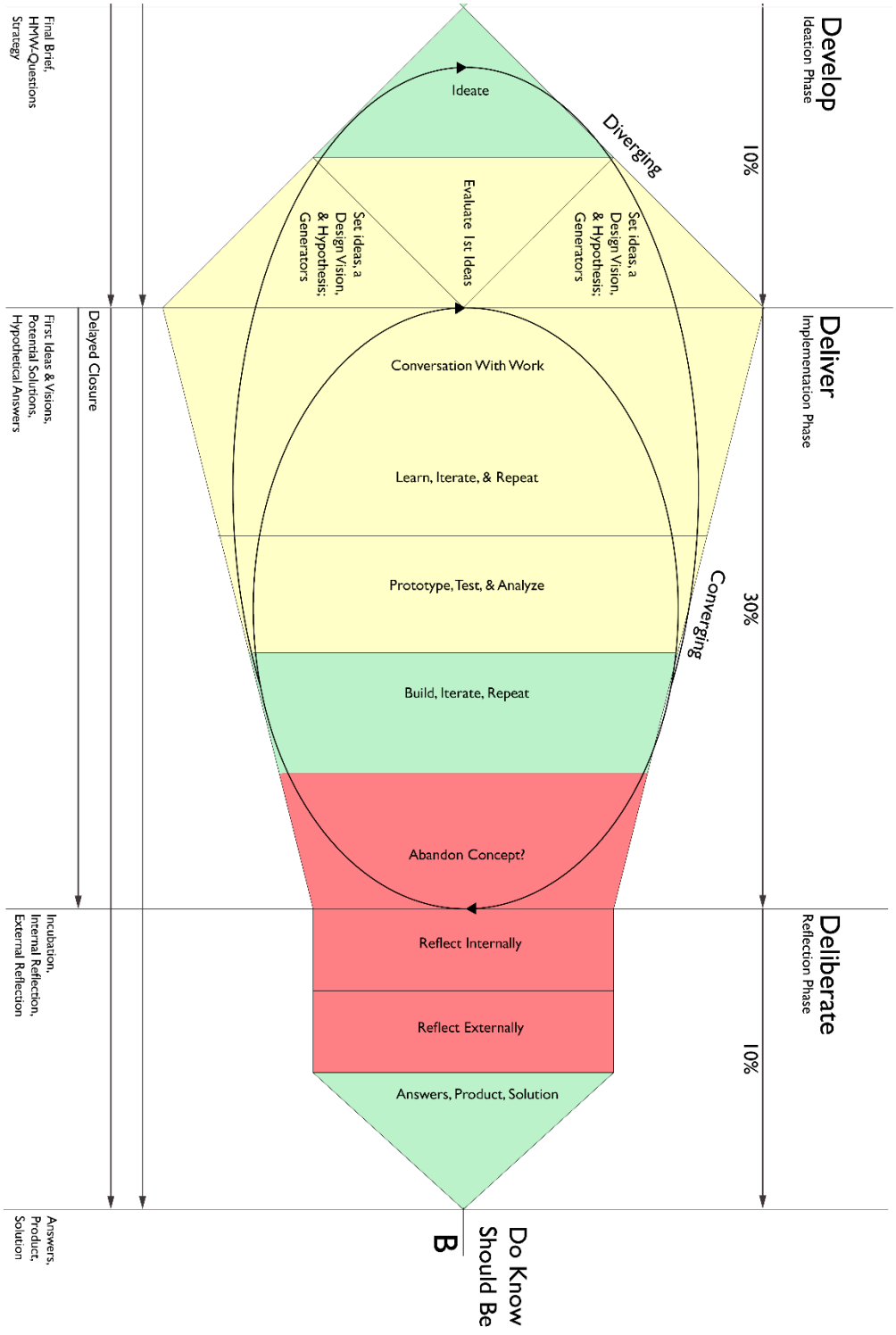


Figure 3.6 Transdisciplinary Double Diamond Framework: Develop, Deliver, & Deliberate

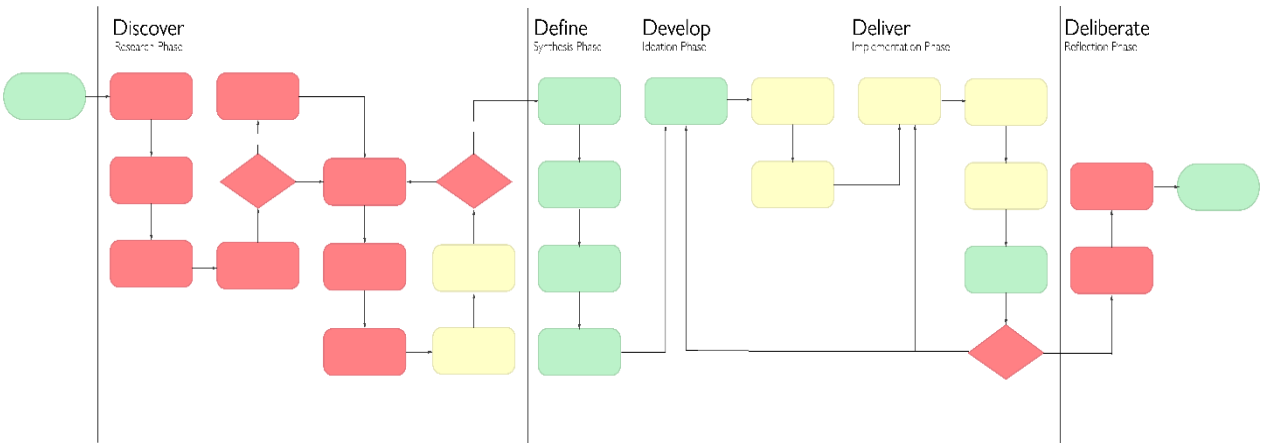


Figure 3.7 Transdisciplinary Flowchart

The flowchart pictured in figure 3.7 is derived from the modified Double Diamond framework, figure 3.8, to assist in breaking down and explaining each step of the new transdisciplinary industrial design process. It is color-coded as follows:

- Red: Different from the original industrial design process
- Yellow: Similar to the original industrial design process
- Green: Same as the industrial design process

During the flowchart walkthrough, the employment of specific strategies may be suggested at specific times throughout the new transdisciplinary industrial design process; however, it is important to remember that the artistic process is subjective and cyclic, so the reader may utilize these strategies at their disposal any time they deem appropriate.

3.2.1 Discover

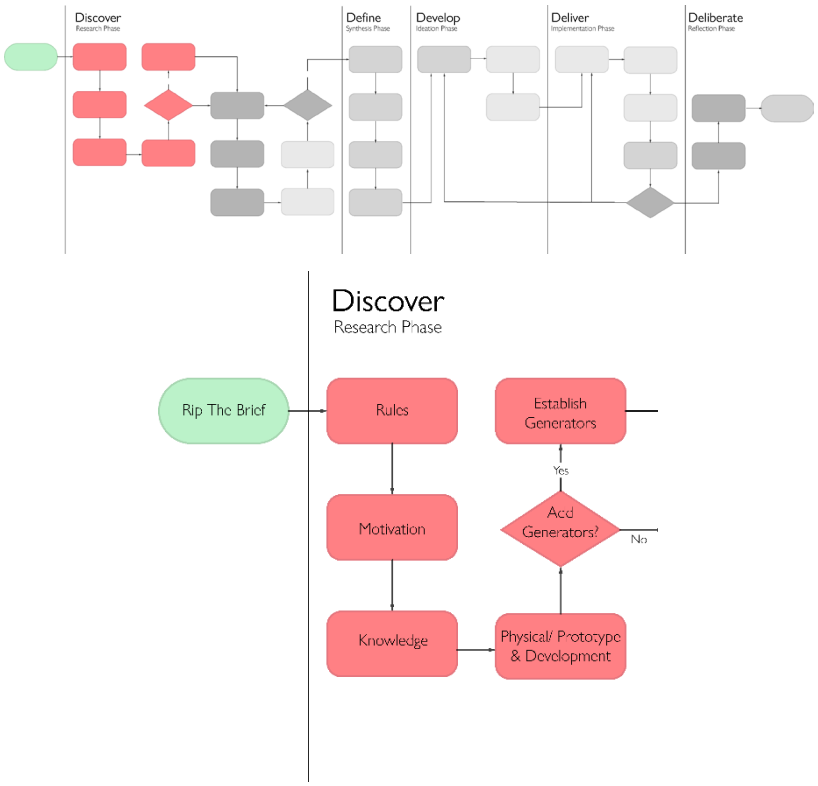


Figure 3.8 Transdisciplinary Flow Chart: Discover 1

The initial step in the transdisciplinary design process is analyzing the given design brief, identifying the constraints that are pre-existing, and establishing any additional constraints—otherwise known as generators—that could be added based on subjective preferences of the designer.

The design brief is the problem the designer must solve. It also includes specified criteria for the deliverable(s) of said project. Examples of these criteria include but are not limited to, functionality requirement(s) of the product, the potential user(s) of the product, and the context of where and when the product will be used. In Nessler's (2018) Revamped Double Diamond

Framework, he refers to this process as, 'Ripping the brief,' where the designer then opts to examine the given challenge and determine what additional information needs to be acquired, and what knowledge they would like to acquire during the discovery phase. However, in the new transdisciplinary framework, the designer will first be tasked to *create problems.*

According to Wakefield, because creative problems consist of open problems and open solutions, they inherently require problem-finding. This starts with identifying constraints and establishing generators, as they provide a 'way into' the problem (Jacobs, 2019). Constraints can be divided into five categories; however, for the purpose of this study the last two categories have been grouped together because they are dependent on each other. The categories are as follows: rules, motivational (pressure, pleasure, and opportunity), knowledge, physical, and prototype and development. The first category is given to the designer, as 'rules' refers to the final cause of each relevant discipline, art, and design. Kupferberg (2023) claims that the final cause of art is to evoke emotion and turn facts into fiction. For the purpose of this framework, the final cause for industrial design will be defined as turning fiction into functionality. As for motivational constraints, this is a concrete way for designers to utilize their past life experiences towards their designs and incorporate emotion into their process, as many artists do. Physical constraints are then identified by the designer, which in turn affects the prototype and developmental constraints. The physical constraints can be identified with defining the location of the product that will be designed as explicitly as possible. For example, if the product to be designed is a tote bag, the physical location cannot be defined explicitly because it is a product that is meant to be mobile and carried with the person who possesses it. Because the physical constraint is mobility, the prototype and development constraints are altered to accommodate this requirement to be materials that are lightweight enough to carry.

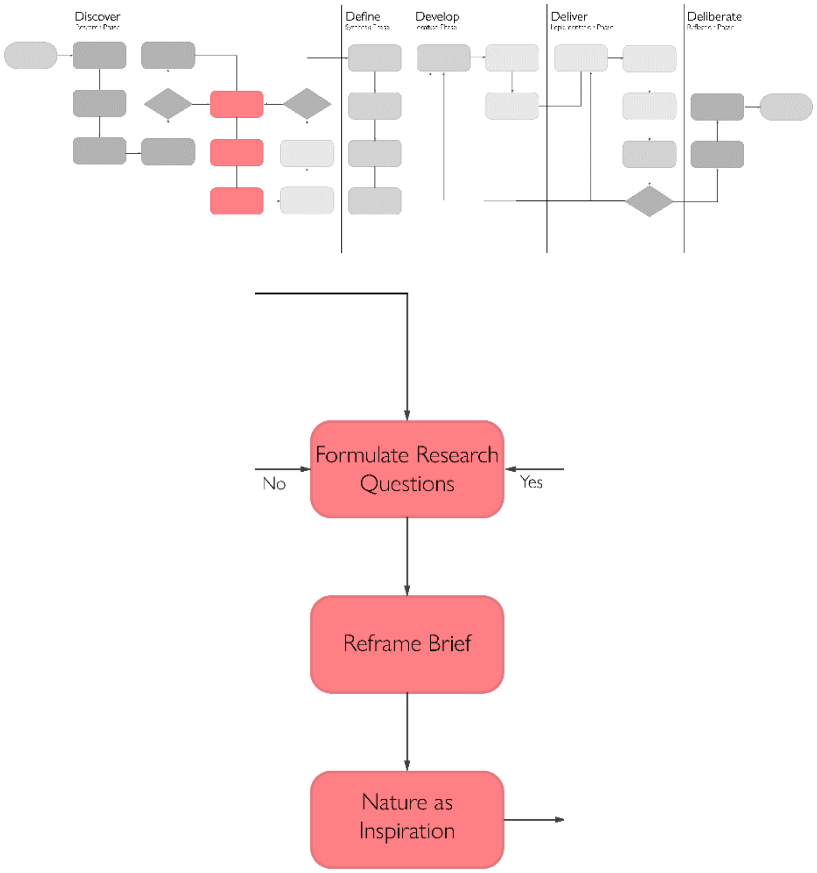


Figure 3.9 Transdisciplinary Flowchart: Discover 2

The next step in the transdisciplinary framework is to formulate research questions. This is different from the traditional design process because it encourages designers to not deter from asking questions that are 'messy' or credulous. Curiosità [Curiosity], one of the seven da Vincian principles, is the basis for the remainder of research in the transdisciplinary framework. Gelb (2009) defines Curiosità, "An insatiably curious approach to life and an unrelenting request for continuous learning." The key to sharpening your question-asking skills is to develop a child-like curiosity and begin asking naïve questions that practical individuals are susceptible to discount. Da Vinci's questioning was often striking in its simplicity, such as "Why is the sky blue?" Although tolerance for ambiguity is significant throughout the entirety of the research phase, it is of utmost

importance for this stage in the framework. For more information on how to increase one's tolerance for ambiguity refer to *How to Think Like Leonardo da Vinci, Seven Steps to Genius Everyday,* (Gelb, 2009).

After formulating research questions, the designer is then tasked to reframe the brief. Successful problem-solving often requires replacing or reframing the initial question. A simple way to do this is, for example, instead of asking, "How might we design a better toaster?" Alternatively, the designer should ask "In what ways might we heat and brown bread?" Questions can be framed in various ways, and the 'framing' will dramatically influence the ability to find solutions. A concrete way to apply this ideology is to list all of the components of the product and reframing each accompanying function into a question. For example, if the product to be designed is a table, the components at the most basic level would be the legs and the seat, with the accompanying functions being supporting weight and acting as a foundation. The questions could then be formulated as, "In what ways might we support the weight of things?", or "In what ways might we act as a foundation?" This will lead the designer to think of 'out of the box' solutions and have a plethora of avenues to research further, but its efficacy is heavily dependent on how well the problem is defined prior. For example, questions that could include but are not limited to: Does it have armrests? Does it roll? Does it recline? Is there a footrest? The same ideology of 'reframing' will be applied in the next step of the transdisciplinary framework: looking to nature for inspiration.

An additional strategy da Vinci preferred is taking inspiration from nature in his designs. For example, when Leonardo Da Vinci designed the spiral staircase for the French king's chateau at Blois, he gained insight from the 'twists' on the conch shells that he had gathered along the coast of Italy years before. When the telephone was invented, Alexander Graham Bell modeled it after the human ear. Upon inventing the pull tab on aluminum cans, the inventor asked himself, "What

in nature opens easily?" His immediate thought was a banana, which led to his next question, "How can the design of a banana serve as a model for the task at hand?" (Gelb, 2018). If the product has multiple functions, as most do, it might be more resourceful to simplify the question into various parts to gain more insight. Utilizing the previously mentioned example of a chair, the questions can now be reframed as, "What in nature supports weight easily?", or "What in nature acts as a foundation easily?" After the designer has identified, recorded, and potentially generated the constraints and generators, they can now utilize these as a catalyst for defining research areas and methods.

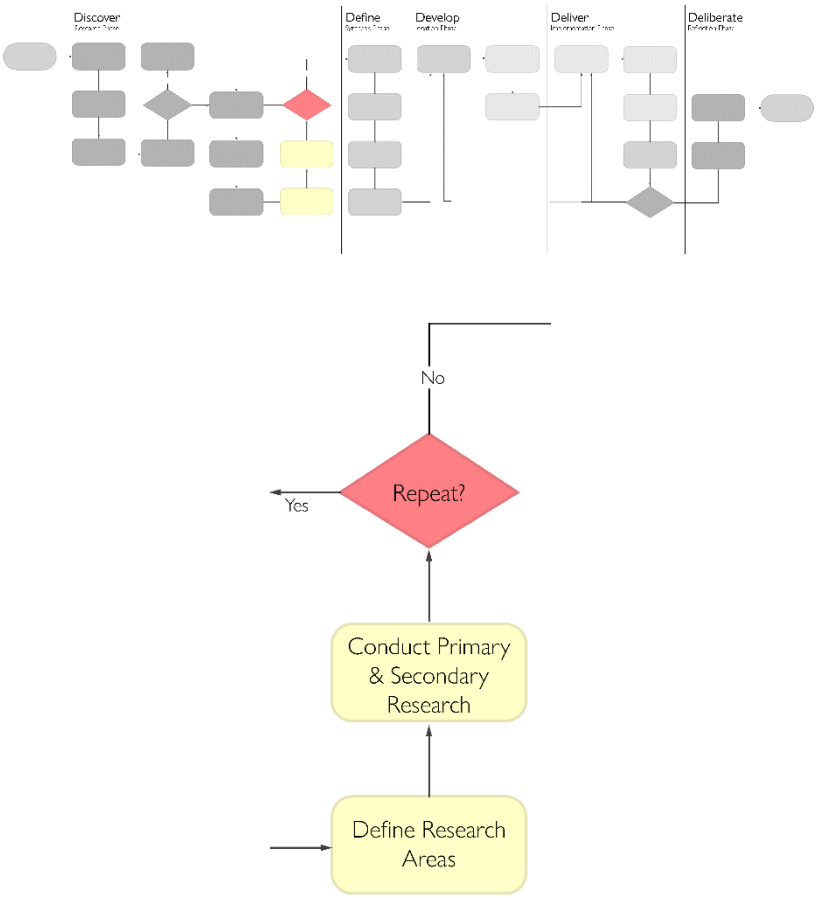


Figure 3.10 Transdisciplinary Flowchart: Discover 3

In the new transdisciplinary framework, the designer need not concern themselves with refining their research scope just yet. This phase is about staying open to possibilities and as mentioned previously, tolerance for ambiguity is crucial during this phase. This phase is about absorbing, categorizing, and filing information for *possible* source material, not finding the *right* source material (Jacobs, 2020). This includes conducting what Nessler (2018) describes as primary (field) and secondary (desk) research.

According to Jacobs (2020), many artists utilize their notebooks, or resource banks, as a form of 'ongoing, deep immersion in the domain of artmaking practice that provides artists with a source of creativity.' A way many artists employ the use of resource banks is by keeping a

notebook. For more information regarding resource banks, refer to *Intersections in Design and Art Thinking,* (Jacobs, 2020).

3.2.2. Define

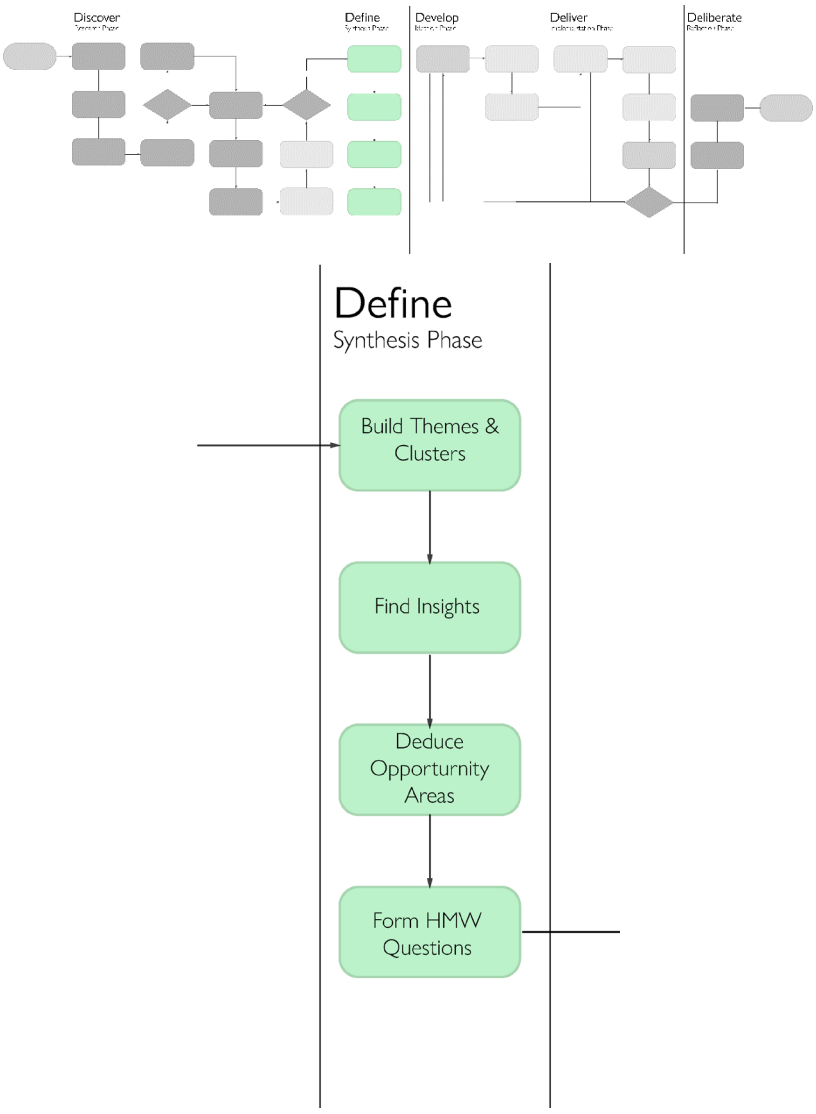


Figure 3.11 Transdisciplinary Flow Chart - Define

The Define phase of the transdisciplinary framework is the only portion that has not been altered from Nessler's (2018) Double Diamond framework. Because of this, the define phase will

not be discussed in detail. For information regarding the define phase of the Industrial Design process, refer to *How to apply a design thinking, HCD, UX or any creative process from scratch — Revised & New Version* (Nessler, 2018).

Nessler lists the following steps for designers to carry out the define phase as follows:

- Lay out all your research findings and build themes and clusters.
- Find insights – the dormant truth behind the facts or the words between the lines.
- Deduce opportunity areas and potential fields of action.
- Form redefined "How Might We" research questions or a strategy paper.

The output of this phase should result in unstructured research findings.

3.2.4. Develop

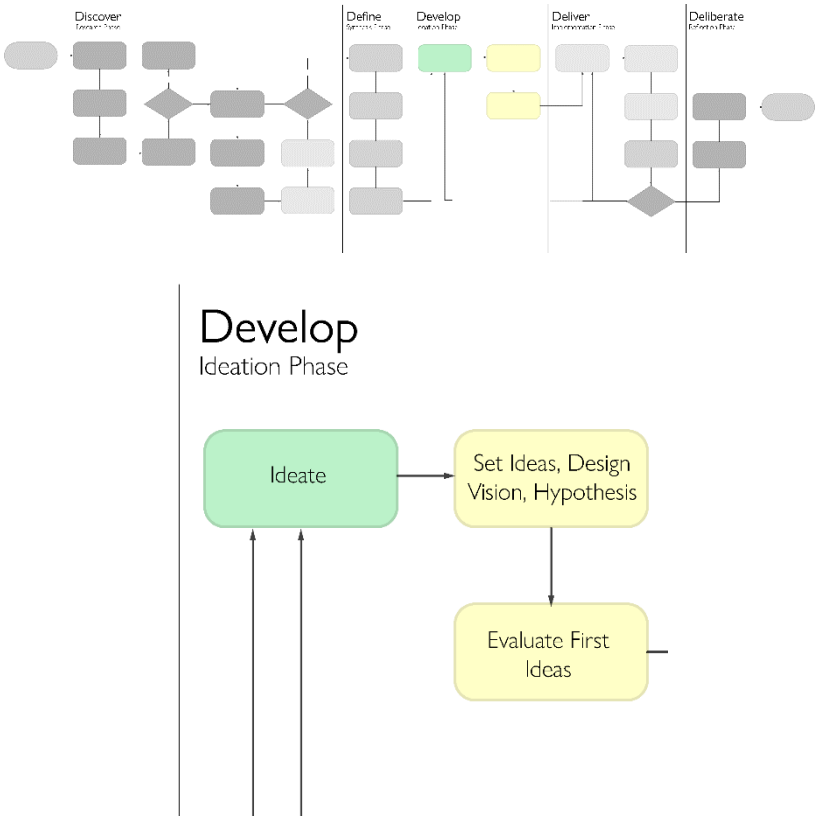


Figure 3.12 Transdisciplinary Flowchart: Develop

Next, the designer will begin to ideate, utilizing all of the information they researched and organized in the previous two phases. In the development phase of the new transdisciplinary design process, it is very similar to that of Nessler's (2018) original Double Diamond framework. Nessler describes the steps for the development phase as follows:

- Ideate—generate as many ideas or potential solutions as possible.
- Evaluate the first ideas you want to bring into further exploration.
- Set the ideas, the design vision, or your hypothesis to a point when you can make them tangible.

3.2.5. Deliver

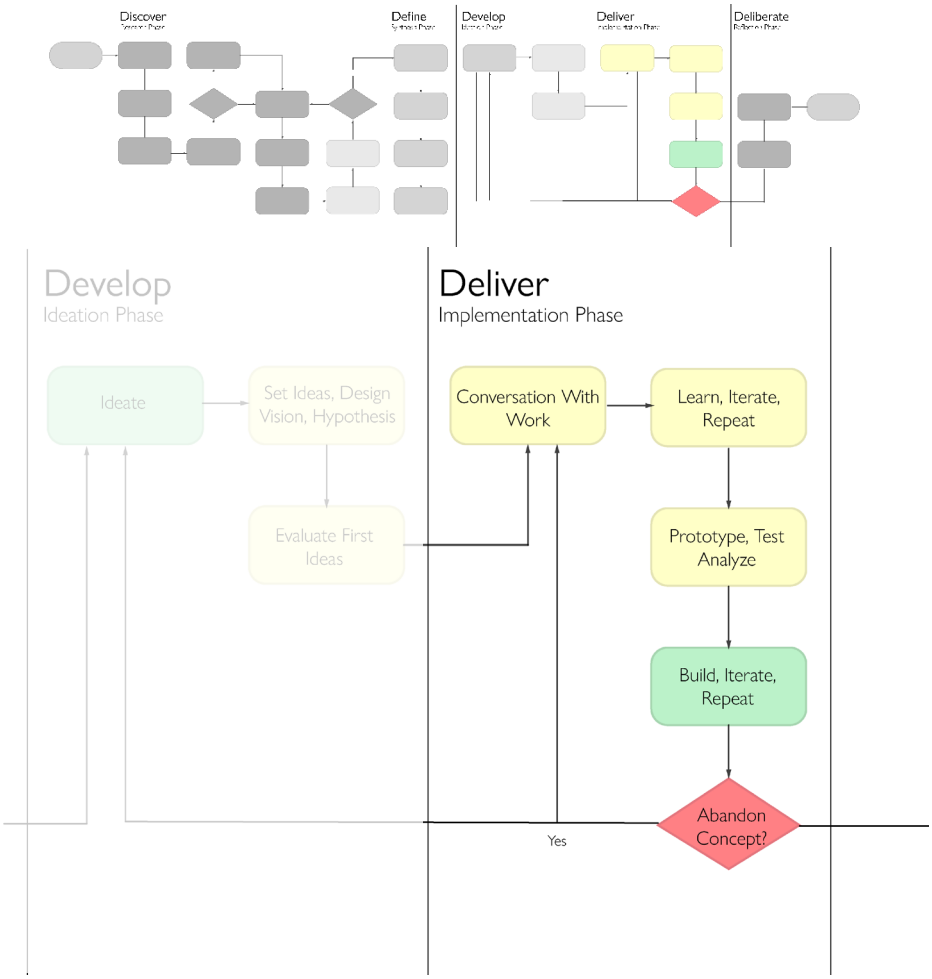


Figure 3.13 Transdisciplinary Flowchart: Deliver

During the delivery phase, according to Nessler's (2018) original Double Diamond framework, he instructs the designer to do the following:

- Prototype, Test & Analyze (make your best ideas tangible, test them, and see what you get out).
- Learn, Iterate & Repeat (designers bring in their findings, possible rethinking, redoing, and/ or retesting).

- Build, Iterate & repeat as often as necessary (the better the results get the more you bring your product to a real-world, usable, and stable product).
- Release your solution and push it out to your users.

In contrast, the transdisciplinary framework begins with an artistic problem-finding strategy that has been coined 'conversation with work.' Many artists claim that their pieces 'pose questions to them' as they are working on them and will continue working until it 'feels' right to them. While this is comparable to the iterative nature of industrial design, artists are more likely to *linger* in this iterative nature and delay closure. It is recommended to repeat this cycle at least once; however, due to time limitations, about 30% of the project time, from conception to completion, should be devoted to the delivery phase of the transdisciplinary framework. While it is recommended to utilize 'conversation with work' during the delivery phase of the transdisciplinary framework, any of the artistic problem-finding strategies can be utilized at any time throughout the process.

'Conversation with work' is heavily reliant on trusting one's intuition. This problem-finding strategy consists primarily of 'What If?" questions. Some examples could be, "What if I shrunk it?" "What if a took a component away?" What if I switched two components? It is experimenting with what is already there. The designer will begin by engaging in 'dialogue' with the concepts that were created at the beginning of the delivery phase and can continue to do this throughout the model-making process as well.

Another key difference from Nessler's (2018) Double Diamond framework is that the designer has the opportunity to completely abandon their concept—time permitting—if it does not 'feel' right, as artists inherently say. The designer is given the choice to either restart the delivery phase and return to ideation, return to 'conversation with work', or continue to the deliberation phase.

Despite the differences between Nessler's (2018) Double Diamond framework and the new proposed transdisciplinary framework, the output of the delivery phase remains similar: a final product or the solution and answer to the challenge that was *found*. Next, the designer will continue to the fifth and final phase of the transdisciplinary framework: deliberation, or the reflection stage.

3.2.6. Deliberate

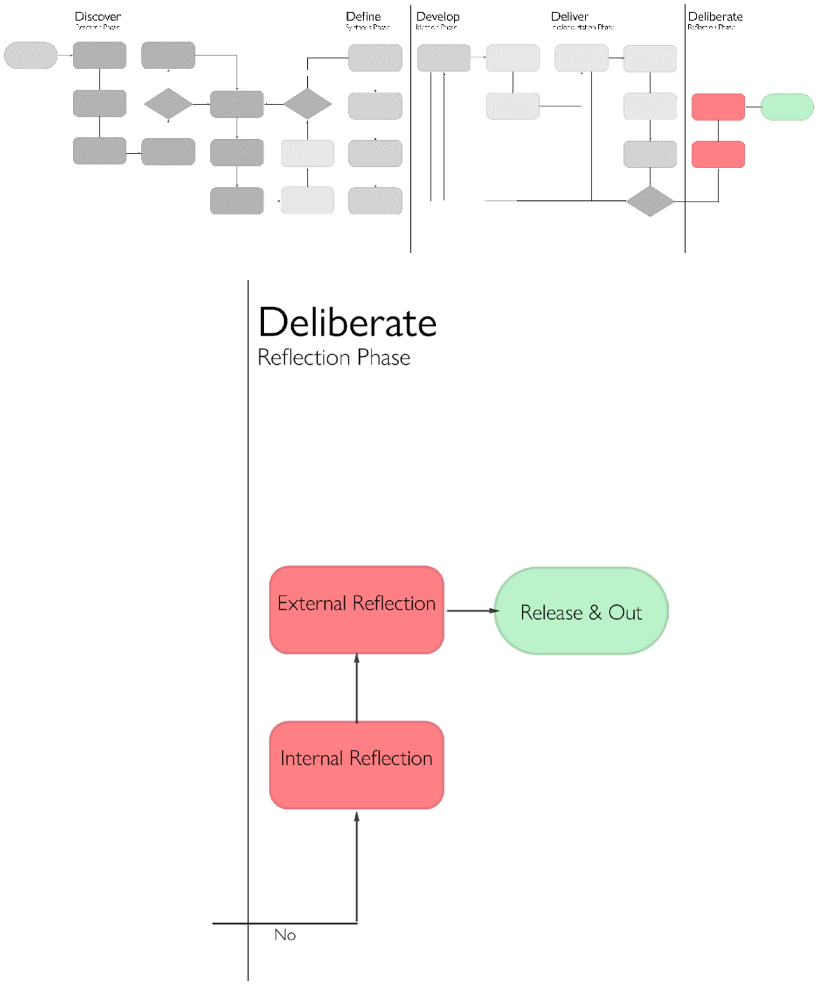


Figure 3.14 Transdisciplinary Flow Chart - Deliberate

An additional phase that is not included in Nessler's (2018) Double Diamond framework, deliberation, will be the fifth and final phase of the transdisciplinary double diamond framework. The designer is asked to reflect both internally and externally

Internal reflection involves contemplating if the final deliverable aligns with the overall design goals that were set at the beginning of the transdisciplinary framework. External reflection requires reflecting on how a 'would-be' audience would perceive the design, and if the anticipated perception would align with the original design intent. Following external reflection, the designer can then assess their intuition by asking a colleague how they perceive the design. This will also help improve intrapersonal, or 'self-knowledge', which is an essential component in artistry (Gelb, 2018). Before reflection, the designer may want to reserve time to step away from the work, or 'incubate'. It is recommended to think about each question for at least ten minutes. If the designer struggles with mind-wandering, Gelb (2018) explains writing the question down on a blank piece of paper—preferably to fill the page—and taping it on the wall. As the mind begins to wander, read the question out loud to bring the mind back to the question at hand.

To make the proposed transdisciplinary framework more accommodating to industrial designers, a workbook has been assembled detailing a step-by-step guide to aid in following along in the process. The workbook is detailed in the succeeding section.

3.2.7. Transdisciplinary Design Tool

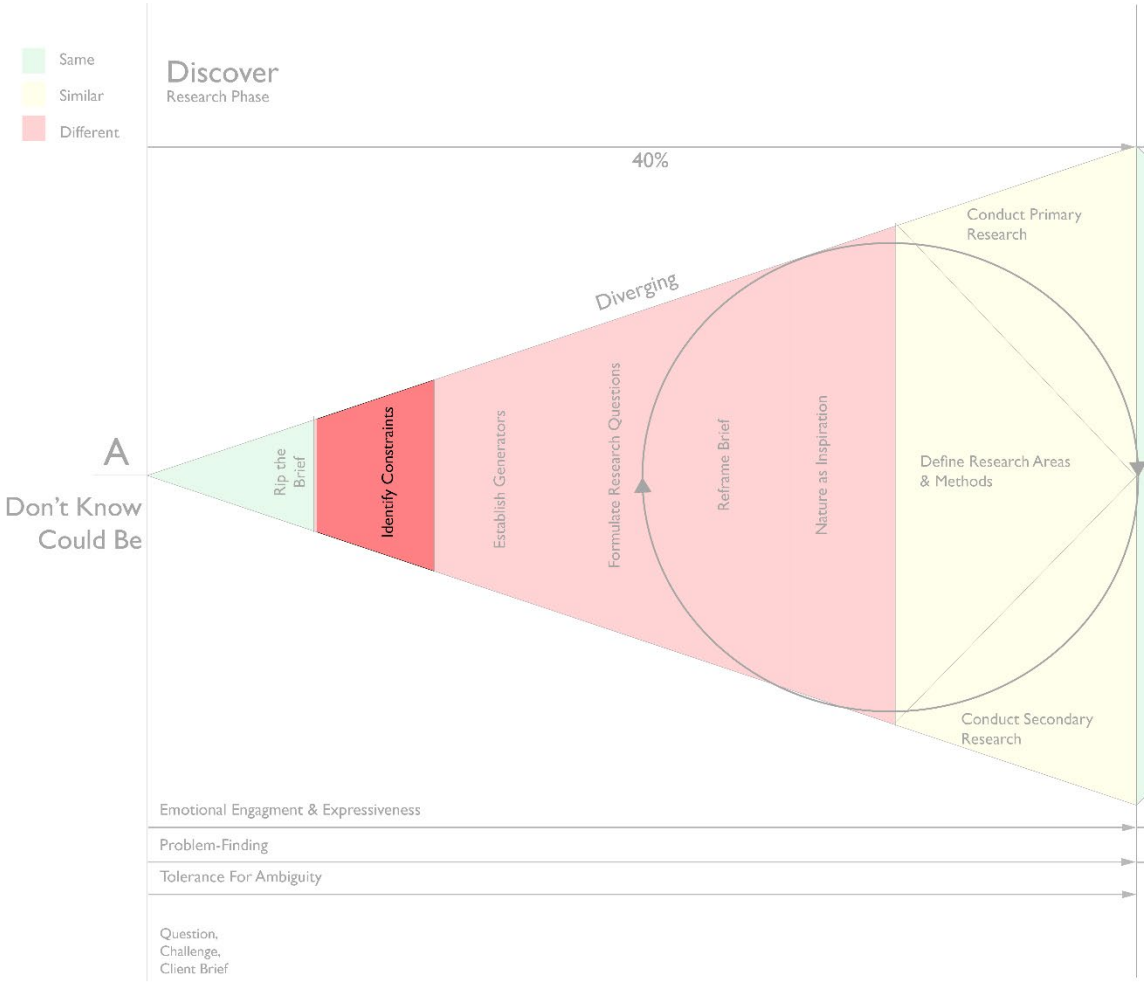


Figure 3.15 Design Tool Constraints

RULES:

Art: To evoke emotion; to turn facts into fiction

Design: To turn fiction into functionality

You: Open-mindedness, curiosity, trusting intuition as much as logical reasoning, 10-minute breaks every hour

MOTIVATION:

Answers to the following questions can be rational or emotional. Be as specific as possible. After filling out the open response boxes, extract an emotion/ theme for how each situation you describe makes you feel, or the feeling you associate with it. These feelings will be useful in creating generators later on. Describe each feeling in only one word. This way, you are only extracting the most important themes and/ or emotions.

Pressure: In what areas of your life do you, or have you, felt pressure? Professional? Personal? Did any significant events in your life contribute to feeling more pressure in certain areas?

Pleasure: In what areas of your life do you feel pressure? Professional? Personal? Did any events in your life contribute to feeling more pressure in certain areas?

Opportunity: In what areas of your life do you feel pressure? Professional? Personal? Did any events in your life contribute to feeling more pressure in certain areas?

Figure 3.16 Workbook: Constraints 1

KNOWLEDGE:

What pre-existing knowledge do you have of the product? What knowledge do you have of the structure, or the 'bones', of the product you will be designing (e.g., the skeleton to the human body)? If you are unable to draw it in detail from memory, research the structure of the product until you have a better understanding. Draw a quick sketch of the structure in the white space below.

PHYSICAL:

Product Category: What product will you be designing?

Components & Function(s): List all components of product with accompanying function(s).

For example, if you are designing a chair, does it have wheels? Levers? Armrests? The accompanying functions would then be rolling, reclining, and supporting weight.

Component(s)	Function(s)

Geographical Location: Will your product be outdoors or affected by the natural elements? If so, this could influence your material constraints.

Context Location: Will your product be in a kitchen? A bathroom? Describe where your product will be and how that affects the material constraints.

For example, if you're designing a purse, the materials are limited to something that is light enough to hold.

Figure 3.17 Workbook: Constraints 2

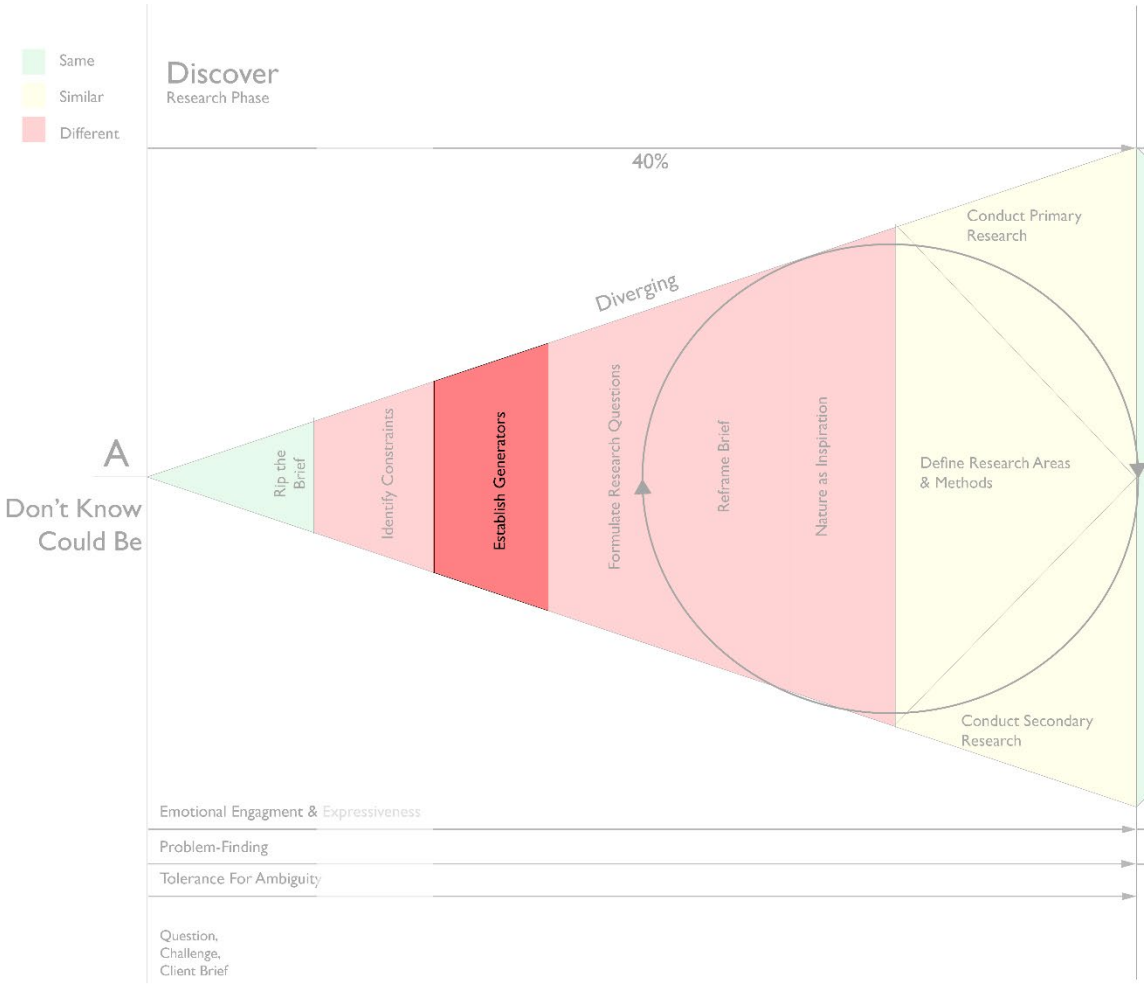


Figure 3.18 Design Tool: Generators

GENERATORS:

Personal Experience: Do you have any personal experience with the product? If so, what challenges have you noticed while using it? If not, think of problems you might face when interacting with the product.

Theme(s) & Internal Inspiration: What themes would you like to incorportate? These can be inspired by themes discussed in the Motivation section, or newly generated constraints based on subjective, aesthetic preference. If so, list them in the box below. The 'generators' you construct can range from abstract ideas to explicit constraints (e.g., physical materials)

Figure 3.19 Workbook: Generators

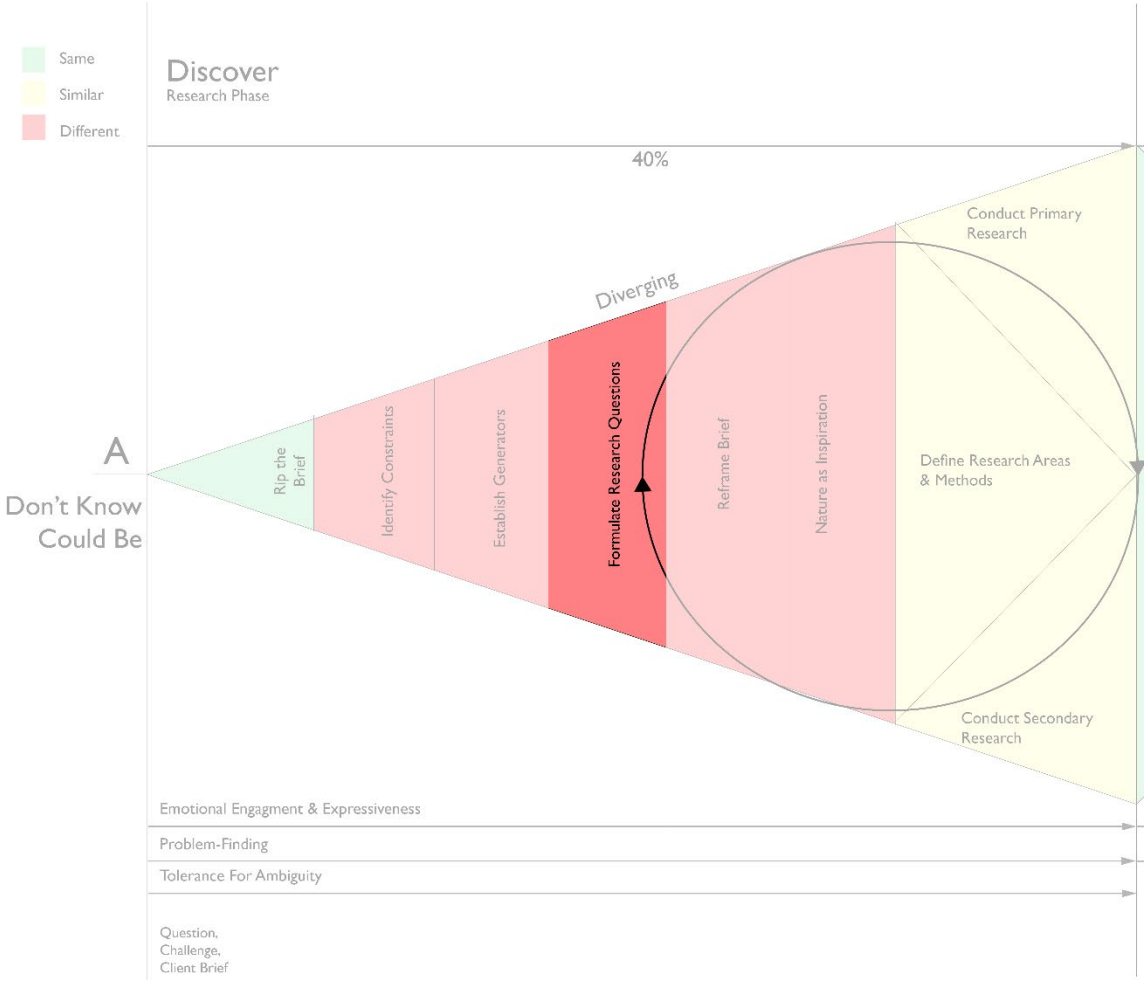


Figure 3.20 Design Tool: Research Questions

FORMULATING RESEARCH QUESTIONS

During the discovery phase, artists are less concerned with finding the right information than they are with finding the right question(s) as a way into the problem. As you go through this section and answer the following questions—or formulate your own—it is less about recording information that is useful, but recording information that could be useful.
After the section is completed, go back through your answers and highlight all of the information that you would like to take inspiration from during the development phase. This will often lead you to more questions that need to be answered to have a full understanding of the task at hand.

START WITH WHAT? HOW? WHO? AND WHY?

Example Questions: Below, I've listed some starter research questions compiled by Michael Gelb (2018) to inspire 'curiosità,' one of the many Da Vincian principles. Try your best to answer all of them. If you still do not understand the problem clearly, you may add your questions in the accompanying free space, but it is not required. Do not shy away from asking 'naïve' or child-like questions; all questions are valid and worth exploring.

WHAT?	
What is the problem?	
What are the underlying issues?	
What preconceptions, prejudices, or paradigms may be influencing my perception?	
What problems may be caused by solving the problem?	

HOW?	
How does the problem happen?	
How can I get more objective information or look at it fromj an unfamiliar perspective?	
How can it be changed?	

Figure 3.21 Workbook Research Questions

WHO?	
Who cares or is affected by the problem?	

WHY?	
Why is it necessary and why is it a problem?	
Why does the problem continue?	
Why have we always done it this way?	

ADDITIONAL QUESTIONS	

Figure 3.22 Workbook Research Questions 2

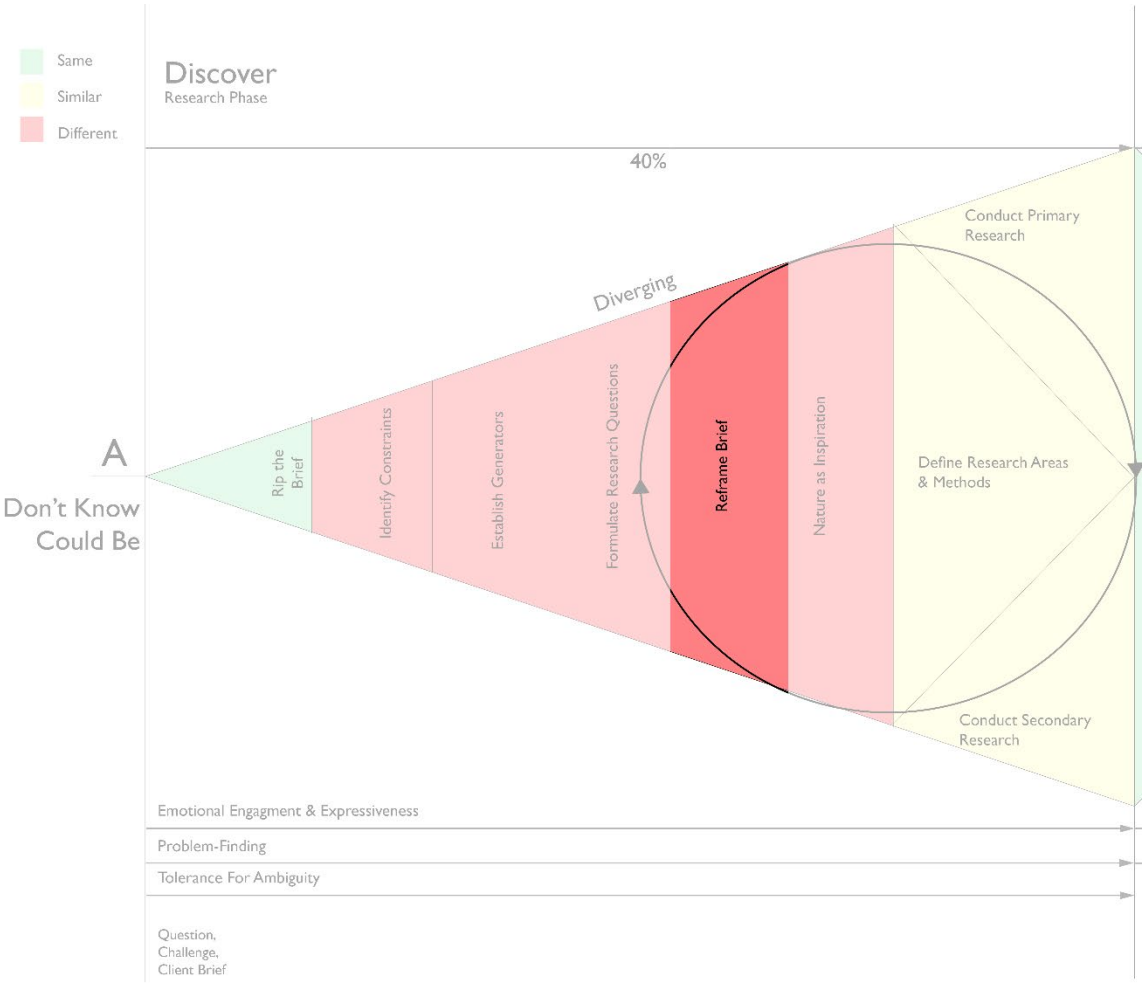


Figure 3.23 Design Tool: Reframe Brief

REFRAME BRIEF:

Instead of asking how we might design a better vanity, you should ask, "In what ways might we *insert function(s) of product*: Could these functions contribute to your design goals? How do these mechanisms work? What are they typically used for?

Figure 3.24 Workbook Reframe Brief

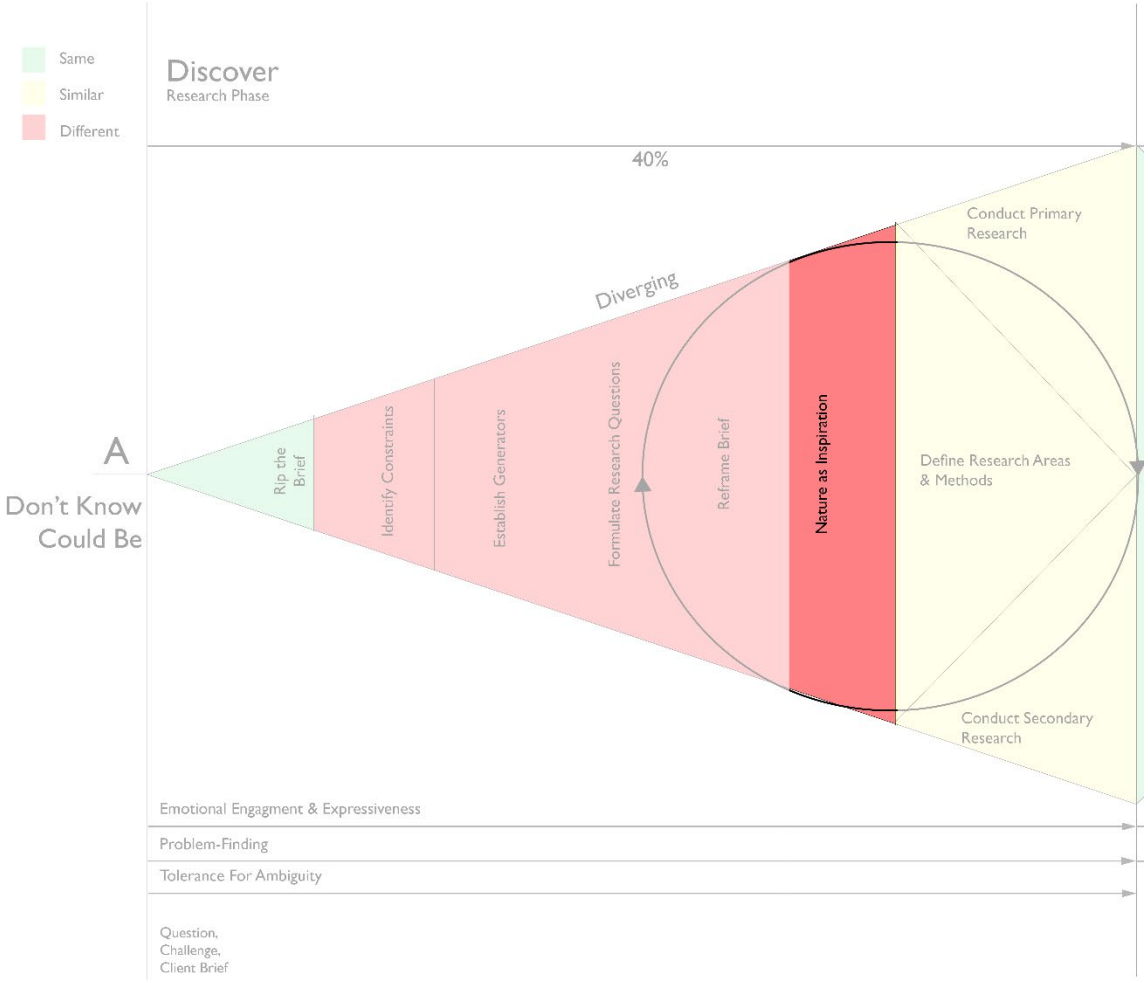


Figure 3.25 Design Tool Nature

NATURE AS INSPIRATION

Reframe the questions you formulated and answered above to ask, "What in nature *insert function(s)* easily?" For example, when Leonardo Da Vinci designed the spiral staircase for the French king's chateau at Blois, he took inspiration from the 'twists' on the conch shells that he had gathered along the coast of Italy years before. When the telephone was invented, Alexander Graham Bell modeled it after the human ear. Upon inventing the pull tab on aluminum cans, the inventor asked himself, "What in nature opens easily?" His immediate thought was a banana, which led to his next question, "How can the design of a banana serve as a model for the task at hand?" (Gelb, 2018) If you have multiple functions within a single question, it might be beneficial to simplify the question into various parts to gain more insight.

Additional Inspiration/ Information:

TECHNICAL	EMOTIONAL

Figure 3.26 Workbook Nature

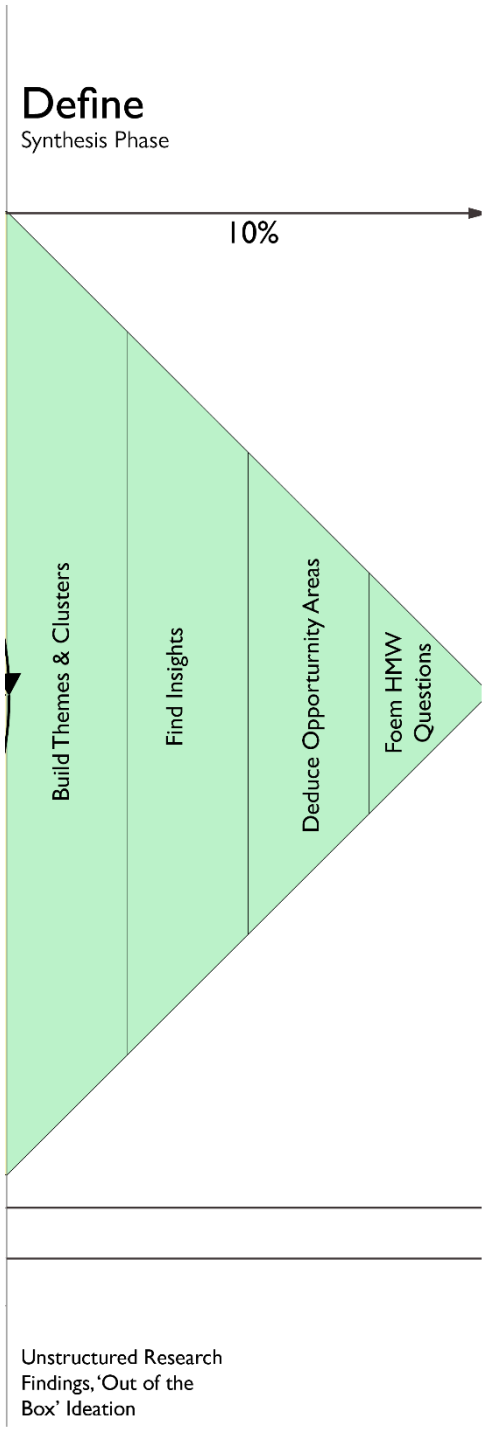


Figure 3.27 Design Tool: Define

DEFINE

SYNTHESIZE INFORMATION & SET DESIGN GOALS

DEFINE

Synthesize all the information that has been collected and decide what will be useful to your design process. Begin with What? Who? Why? Where? What are you designing? Who are you designing for? Where will this product be located? Why are you designing this product? What is the purpose? Be as specific as possible. This will allow the problem to be thoroughly defined.

What?

Who?

Why?

Where?

GOALS:

Set your overall design goals. Go back through your answers and decide which topics should contribute to your overall design.

8

Figure 3.28 Workbook Define 1

POTENTIAL INSPIRATION

Compile all potential inspiration and information you have found during your research in the white space below. Worry less about if it *will be* useful, and more about if it *could* be useful. This can include inspiration for function, form, or for the overall theme(s) and/ or emotion(s) you would like to express through your design. The inspiration does not have to be limited to the research that has been conducted in this workbook, external forms of personal inspiration are encouraged.

Figure 3.29 Workbook Define 2

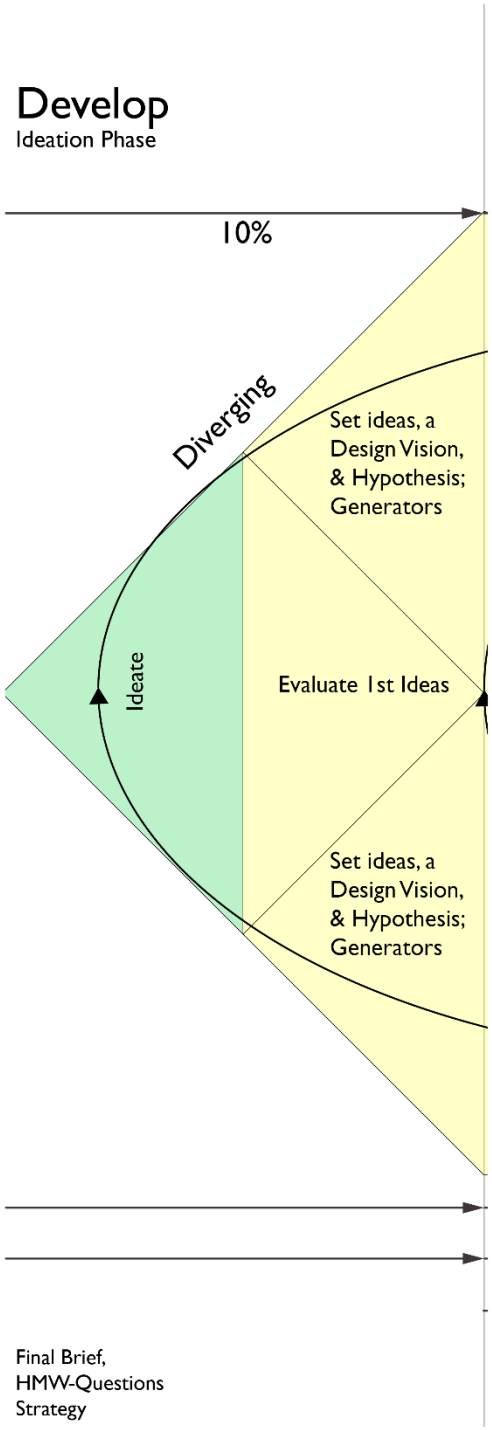


Figure 3.30 Design Tool: Develop

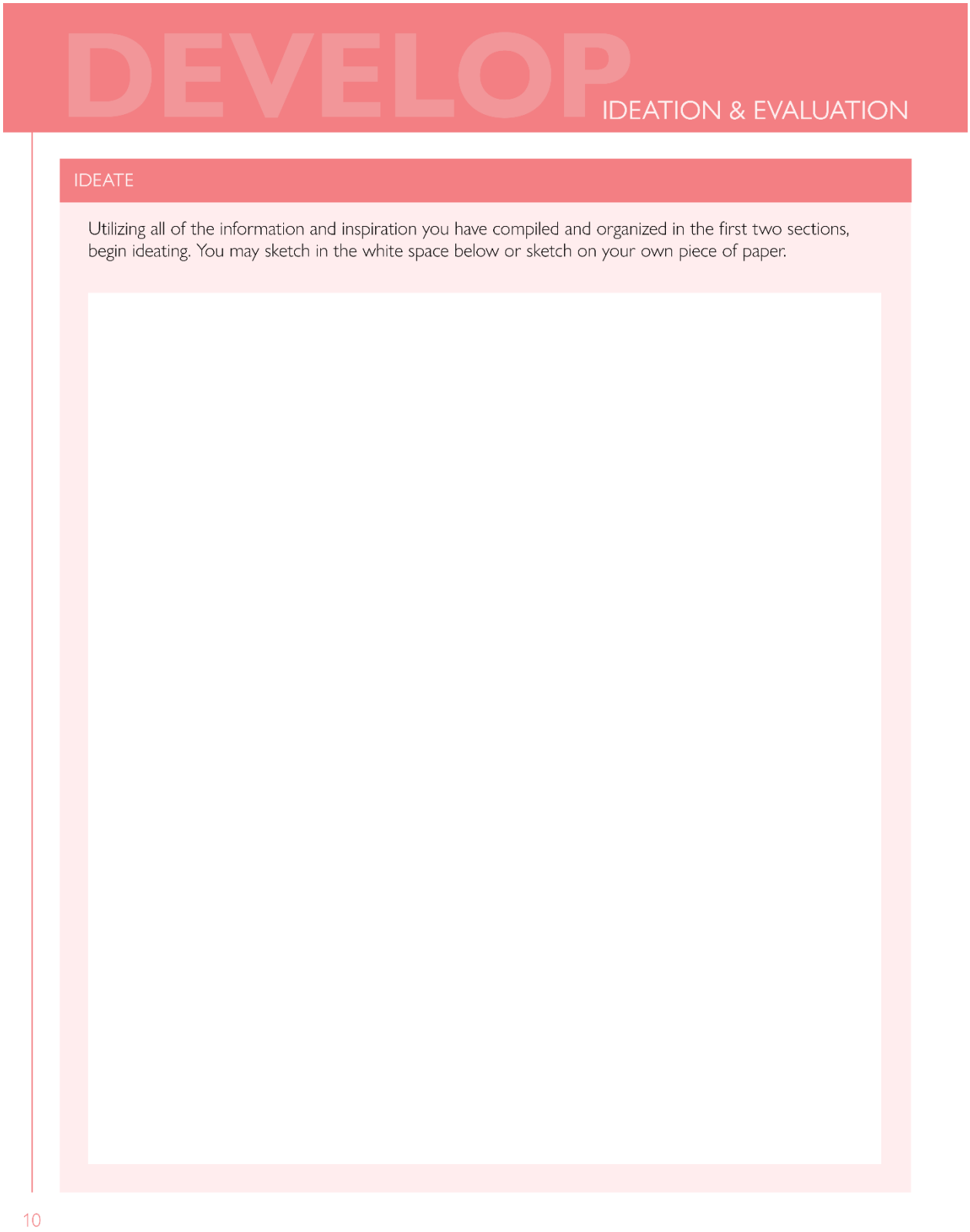


Figure 3.31 Workbook Develop

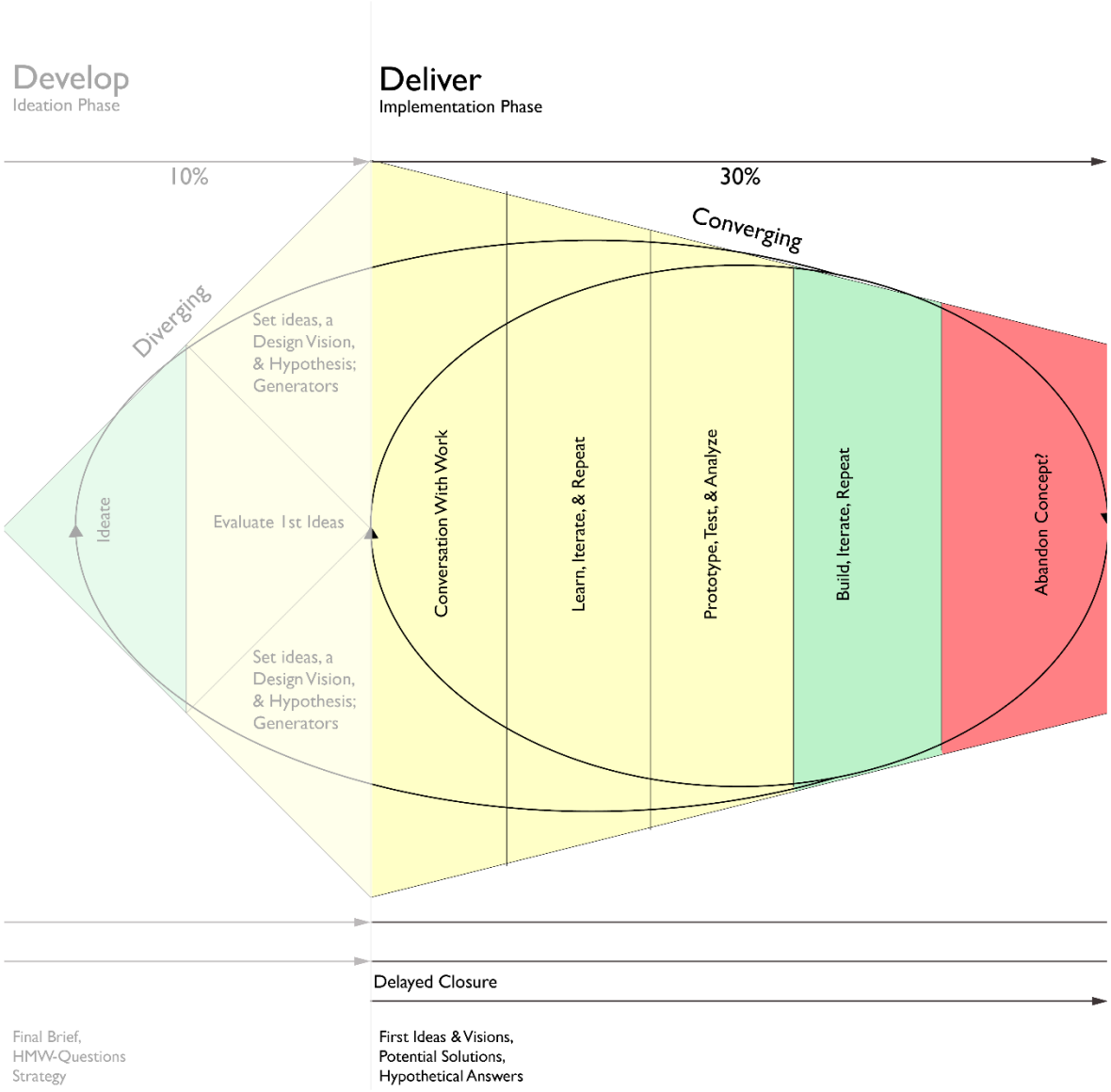


Figure 3.32 Design Tool: Deliver

DELIVER

CONVERSATION WITH WORK & DELAYED CLOSURE

Many artists claim that their pieces 'pose questions to them' as they are working on them. This is similar to the iterative nature of design; however, artists are more likley to linger in this iterative nature. Although it is recommended to do this during the delivery phase, any of the artistic problem-finding strategies can be utilized at any time throughout the transdisciplinary framework.. Many artists will continue working until it 'feels' right to them. Trust your intuition. This strategy will consist primarily of 'What If?" questions. Some examples could be, "What if I shrunk it?" "What if a took a component away?" What if I switched two components? It is experimenting with what is already there.

From Ideation to Modelmaking: Use the white space below to sketch, ask questions, etc., about your concepts or models.

After modelmaking, you can repeat this process by returning to the 'Conversation With Work' strategy or return to ideation if you are unsatisfied with and would like to abandon your current concept.

CONVERSATION WITH WORK

11

Figure 3.32 Workbook Deliver

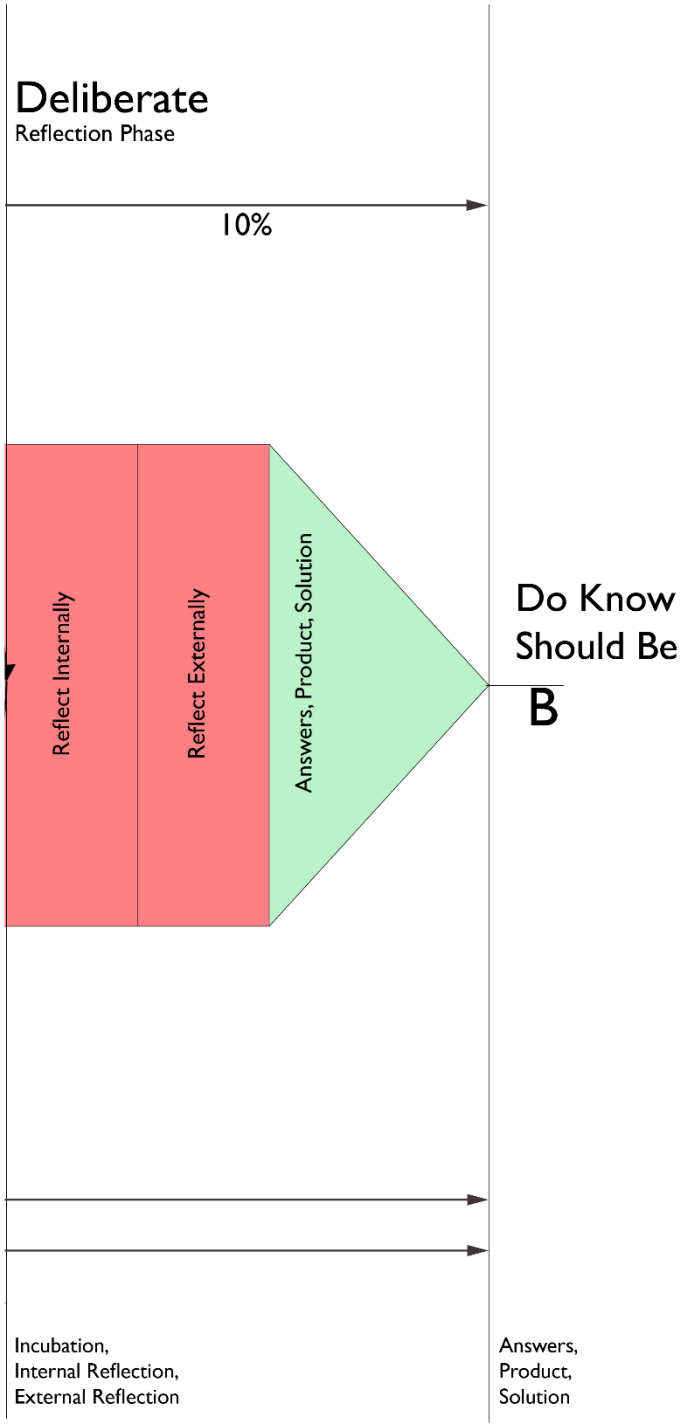


Figure 3.33 Design Tool: Deliberate

REFLECTION

Think about each question for at least ten minutes. If you have trouble with your mind wandering, Gelb (2018) explains a way to combat this is writing the question down on a blank piece of paper--preferably to fill the page--and tape it on your wall. If your mind starts racing again, read the question out loud to bring your mind back.

Internal: Internal reflection involves contemplating if your final deliverable aligns with the overall design goals you set at the beginning of the process.

External: Then reflect externally. This involves reflecting on how a 'would-be' audience would perceive your design and if this 'would-be' perception aligns with your original design intent. After externally reflecting, you can evaluate your intution, or sharpen your design skills, by asking a friend or colleage how they perceive your design. This will also help improve your self-knowledge which is crucial to artistry (Gelb, 2018).

12

Figure 3.34 Workbook Deliberate

Chapter 4

Demonstrating the Developed Transdisciplinary Approach for Industrial Designers

This chapter applies and demonstrates the transdisciplinary approach that was developed in Chapter 3. This approach aims to integrate artistic thinking into the industrial design process. This approach emphasizes the research and delivery phases of the process, as 40% of time should be devoted to the discover phase 10% to the define phase, 10% to the develop phase, 30% to the deliver phase, and the remaining 10% to the newly added deliberation phase. This approach will be demonstrated with the accompanying workbook detailed in chapter three by designing a vanity.

4.1 Discover

The first phase of the transdisciplinary approach is the discover phase which has then been divided into steps to ease the process: identifying constraints, establishing generators, formulating research questions, reframing the brief, formulating research questions, and looking to nature for inspiration.

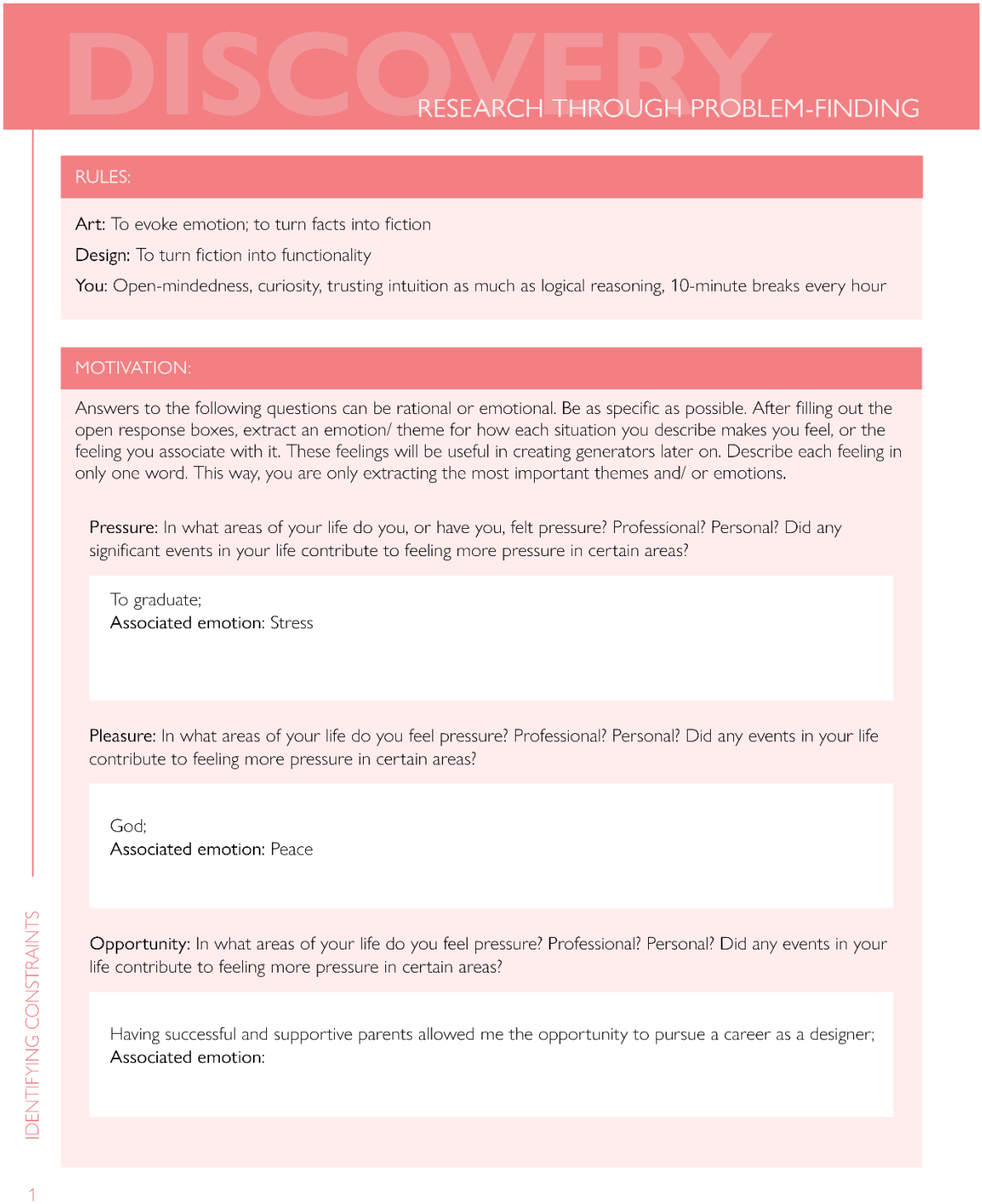


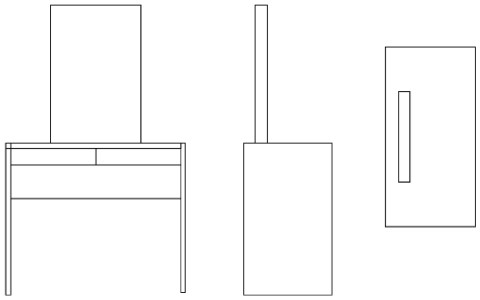
Figure 4.2 Constraints

The first category of constraints I identify is motivational constraints as seen in figure 1, as these constraints can potentially catalyze to increase emotional engagement. Motivational constraints can be divided into three sub-categories: pressure, pleasure, and opportunity. The

purpose of identifying these constraints is to aid in establishing generators later in the discovery phase if the designer has difficulty formulating their own. In this demonstration, I do not utilize my motivational constraints as generators, because I already had a set design vision in mind.

KNOWLEDGE:

What pre-existing knowledge do you have of the product? What knowledge do you have of the structure, or the 'bones', of the product you will be designing (e.g., the skeleton to the human body)? If you are unable to draw it in detail from memory, research the structure of the product until you have a better understanding. Draw a quick sketch of the structure in the white space below.



PHYSICAL:

Product Category: What product will you be designing? Vanity

Components & Function(s): List all components of product with accompanying function(s).

For example, if you are designing a chair, does it have wheels? Levers? Armrests? The accompanying functions would then be rolling, reclining, and supporting weight.

Component(s)	Function(s)
Mirror	reflection;
Legs	to support weight
Drawers	holding things, sliding
Lighting	to illuminate

Geographical Location: Will your product be outdoors or affected by the natural elements? If so, this could influence your material constraints.

Not affected by natural elements

Context Location: Will your product be in a kitchen? A bathroom? Describe where your product will be and how that affects the material constraints.

For example, if you're designing a purse, the materials are limited to something that is light enough to hold.

In user's bedroom, not affected by humidity of bathroom, or natural elements

Figure 4.3 Constraints 2

The next category of constraints to identify is knowledge. This is based on what you already know about the product you will be designing. This consists primarily of technical knowledge, so well you know the structure, or the bones of the product you will be designing. Because the structure of a vanity heavily varies, I did a technical drawing of a vanity in its most basic form.

Next, I identified the physical constraints. I started with listing out each component of the vanity with its accompanying function:

- Mirror—reflection
- Legs—to support weight
- Drawers—holding things, sliding
- Lighting—to illuminate

After doing this, I identified the geographical and context location. The geographical location held no significance as a vanity is a product meant to be indoors, so it is not affected by the natural element. I chose the user's bedroom as the context location, so the material constraints were also not affected by the indoor environment, such as factors like the moisture from the bathroom.

ESTABLISHING GENERATORS

3

GENERATORS:

Personal Experience: Do you have any personal experience with the product? If so, what challenges have you noticed while using it? If not, think of problems you might face when interacting with the product.

Object permanence - design to where you can see everything the vanity is meant to hold
Not close enough to mirror, leaning over - make a standing vanity; omit stool

Theme(s) & Internal Inspiration: What themes would you like to incorporate? These can be inspired by themes discussed in the Motivation section, or newly generated constraints based on subjective, aesthetic preference. If so, list them in the box below. The 'generators' you construct can range from abstract ideas to explicit constraints (e.g., physical materials)

Retro futurism:

Product could have flowy, organic form taking inspiration from lava lamps and neon craze

Figure 4.4 Generators

Next, I established generators by defining a problem: designing for object permanence and eliminating issues associated with being too far away from the mirror. Then, I promptly generated broad solutions to assist in ideation later in the transdisciplinary framework. I formulated additional generators based on aesthetic, subjective preferences. I chose retro-futurism, and I also wanted the design to feel similar to that of a lava lamp. I attached images for inspiration and to reference back to as seen in figure 4.3.

FORMULATING RESEARCH QUESTIONS

During the discovery phase, artists are less concerned with finding the right information than they are with finding the right question(s) as a way into the problem. As you go through this section and answer the following questions—or formulate your own—it is less about recording information that is useful, but recording information that could be useful.
After the section is completed, go back through your answers and highlight all of the information that you would like to take inspiration from during the development phase. This will often lead you to more questions that need to be answered to have a full understanding of the task at hand.

START WITH WHAT? HOW? WHO? AND WHY?

Example Questions: Below, I've listed some starter research questions compiled by Michael Gelb (2018) to inspire 'curiosità,' one of the many Da Vincian principles. Try your best to answer all of them. If you still do not understand the problem clearly, you may add your questions in the accompanying free space, but it is not required. Do not shy away from asking 'naïve' or child-like questions; all questions are valid and worth exploring.

WHAT?	
What is the problem?	Drawers; seating
What are the underlying issues?	Drawers hide items, and people are not able to see where everything is; seating causes mirrors to be too far away, and back pain from leaning
What preconceptions, prejudices, or paradigms may be influencing my perception?	Gender: assuming it will be used by a woman, preconceived ideas about how it should function
What problems may be caused by solving the problem?	Taking up too much space, clutter, dust on products;

HOW?	
How does the problem happen?	It happens when the user is unable to find products when they are unable to see when doing makeup (details)
How can I get more objective information or look at it fromj an unfamiliar perspective?	Ask someone who doesn't have a vanity.
How can it be changed?	Stationary drawers, no seating (standing vanity), adjustable/ mobile mirror

Figure 5.4 Research Questions 1

WHO?	
Who cares or is affected by the problem?	People who lack object permanence, ADD, forgetful people, unorganized people

WHY?	
Why is it necessary and why is it a problem?	It is necessary for organizational purposes. This means finding items promptly (a problem because unorganized people are often chronically late-time blind), fixing posture, and seeing details better.
Why does the problem continue?	Because most vanity tables follow the same form predetermined by functionality, the overall form and function of the product have never been challenged.
Why have we always done it this way?	Functionality (mirror for users to see themselves, drawers provide storage, seating for comfort) Historical Precedent: Vanities go back centuries over time; this basic design evolved to include features that increased functionality/ convenience Space efficiency – Well suited for bedrooms, bathrooms, and dressing areas where space is often limited Aesthetics – Timeless appeal; many people still love the look of traditional vanities

ADDITIONAL QUESTIONS	

Figure 4.6 Research Questions 2

Next, I began answering the questions detailed in figure 4.4 and figure 4.5. Many of the questions did not require research upon answering, as they utilize critical thinking skills. The questions that did require research were answered via traditional industrial design research methods. These questions provided greater insight into the problem. By answering these questions, I was able to identify:

- **What…**
  - *The problem is:* drawers and seating
  - *The underlying issues are:* Drawers hide items, thus not helping those who struggle with object permanence
  - *Preconceptions, prejudices, or paradigms may be influencing my perception:* gender bias
  - *Problems may be caused by solving the problem:* Taking up too much space, clutter, and dust build-up on products.
- **How…**
  - *The problem happens:* When the user is unable to find products; when they are unable to see while doing makeup (details)
  - *I can get more objective information or look at the problem from a difference perspective:* Questioning someone who does not own a vanity
  - *It can be changed:* gender bias
- **Who…**
  - *Cares or is affected by the problem:* People who lack object permanence, ADD, forgetful people, unorganized people
- **Why…**

- *It is necessary and why it is a problem:* Necessary for organizational purposes. This means finding items promptly (a problem because unorganized people are often chronically late due to time-blindness), fixing posture, and seeing details
- *The problem continues:* Because most vanity tables follow the same form that is prescribed by functionality; the overall form and function of the product have never been challenged.
- *It has always been done this way:*
  - Functionality: Mirror for users to see themselves, drawers provide storage, seating for comfort
  - Historical Precedent: Vanities go back centuries over time; the basic design evolved to include features that increased both functionality and convenience
  - Space efficiency: Vanities are well-suited for bedrooms, bathrooms, and dressing areas where space is oftentimes limited
  - Aesthetics: Timeless appeal, many people still love the look of traditional vanities

After answering the given research questions, I felt I had a thorough understanding of the problem, so I did not generate additional questions.

REFRAME BRIEF:

Instead of asking how we might design a better vanity, you should ask, "In what ways might we *insert function(s) of product*: Could these functions contribute to your design goals? How do these mechanisms work? What are they typically used for?

In what ways might we support the weight of things?

- **Solid Structures:**
- Foundations:
- Frames:
- Trusses:
- Arches:
- Cantilevers:
- Suspension Systems:
- Hydraulic Systems:
- Pneumatic systems:
- Magnetic Levitation:
- Counterweights:
- Ball bearings:
- Rollers and bearings:

In what ways can we protect without concealing?

- Open Shelving with Dust Covers:
- Display Cases with Transparent Panels:
- Storage Bins with Ventilated Lids:
- Hanging Storage with Dust Curtains:
- Vacuum-Sealed Bags:
- Clear Plastic Containers with Sealed Lids:
- Stackable Storage Boxes with Dust Flaps:
- Wall-Mounted Shelves with Transparent Covers:
- Enclosed Display Cabinets with Glass Doors:
- Floating Shelves with Clear Acrylic Panels:

In what ways might we store and organize things?

- Shelving:
- Cabinetry:
- Drawers:
- Bins and baskets:
- Hooks, Racks, & Pegboards:
- Modular and Custom Storage Systems:
- Trays and Organizers:
- Rolling carts and Trolleys:
- Floating shelves:
- Filing systems:
- Jewelry organizers:
- Kitchen organizers: Spice racks

In what ways might we reflect things?

- Mirrors:
- Prisms:
- Reflective Surfaces:
- Corner reflectors:
- Retroreflective Materials:
- Catadioptric Systems:
- Kaleidoscopes:
- Reflective optics in vehicles:

Figure 4.7 Brief Reframe

After answering the given questions, I began to reframe the brief. I did this by referring to the list of components and accompanying functions that I curated in figure 4.1:

- Mirror—reflection
- Legs—to support weight
- Drawers—holding things, sliding, organizing

I reframed the brief by asking, “In what ways might we *insert function*?” The questions along with their accompanying answers are as follows:

- **Mirror***: In what ways might we reflect things?*
- **Legs:** *In what ways might we support the weight of things?*
- **Drawers:** *In what ways might we store and organize things?*

While answering the research questions in figure 4.4, I found that solving the problem of not concealing the products generated a new one: dust build-up on unprotected products. Because of this, an additional question was added:

- *In what ways might we protect without concealing?*

The answers to the above questions are detailed in figure 4.6.

NATURE AS INSPIRATION

Reframe the questions you formulated and answered above to ask, "What in nature *insert function(s)* easily?" For example, when Leonardo Da Vinci designed the spiral staircase for the French king's chateau at Blois, he took inspiration from the 'twists' on the conch shells that he had gathered along the coast of Italy years before. When the telephone was invented, Alexander Graham Bell modeled it after the human ear. Upon inventing the pull tab on aluminum cans, the inventor asked himself, "What in nature opens easily?" His immediate thought was a banana, which led to his next question, "How can the design of a banana serve as a model for the task at hand?" (Gelb, 2018) If you have multiple functions within a single question, it might be beneficial to simplify the question into various parts to gain more insight.

What in nature protects without concealing easily?

- Waxy Cuticles:
- Thick Bark:
- Fur and Feathers:
- Mucus and Oils:
- Rock Formations:
- Burrows and Dens:
- Natural Canopies:
- Tough Outer Coverings: Snail shells
- Rock Overhangs and Caves:
- Fruit trees:
- Understory plants:
- Berry Bushes:
- Crops in fields:
- Fruit on Vines or Creepers:
- Nuts in Forests:
- Seeds in seed pods:

What in nature stores easily?

- Honeybee Hives:
- Animal Food Caches:
- Bird Nests:
- Plant Seeds:
- Fruit Trees:
- Squirrel Nests:
- Spider Webs:
- Coral Reefs:
- Animal Pouches:
- Plant Structures:
- Fungi Mycelium:
- Tree Hollows:
- Animal Dens and Burrows:
- Nests and Roosts
- Animal Mouths:
- Nesting Materials: :

What in nature supports weight easily?

- Tree Trunks and Branches:
- Rock Formations:
- Bone Structure in Animals:
- Exoskeletons in Insects and Crustaceans:
- Coral Reefs:
- Spider Silk:
- Fungal Mycelium:
- Root Systems in Plants:
- Sand and Sediments:

What in nature reflects easily?

- Water Surfaces:
- Ice and Snow:
- Metallic Minerals:
- Insect Wings:
- Animal Eyes:
- Feathers:
- Fish Scales:
- Insect Exoskeletons:
- Mineral Crystals:

Additional Inspiration/ Information:

TECHNICAL	EMOTIONAL

Figure 4.8 Nature

Next, in figure 4.7, utilizing the questions I formulated in figure 4.6, I reframed the questions in a way to ask, “What in nature *insert function(s)* easily?”

- *In what ways might we reflect things?* to… *What in nature reflects easily?*
- *In what ways might we support the weight of things?* To… *What in nature supports weight easily?*
- *In what ways might we store and organize things?* to… *What in nature stores things easily?*
- *In what ways might we protect without concealing?* To… *What in nature protects without concealing easily?*

The answers to the above questions can be seen in figure 4.7.

4.2 Define

REFRAME BRIEF:

Instead of asking how we might design a better vanity, you should ask, "In what ways might we *insert function(s) of product*: Could these functions contribute to your design goals? How do these mechanisms work? What are they typically used for?

In what ways might we support the weight of things?

- **Solid Structures:**
- **Foundations:**
- Frames:
- **Trusses:**
- **Arches:**
- **Cantilevers:**
- Suspension Systems:
- Hydraulic Systems:
- Pneumatic systems:
- Magnetic Levitation:
- Counterweights:
- Ball bearings:
- Rollers and bearings:

In what ways can we protect without concealing?

- Open Shelving with Dust Covers:
- **Display Cases with Transparent Panels:**
- Storage Bins with Ventilated Lids:
- Hanging Storage with Dust Curtains:
- Vacuum-Sealed Bags:
- Clear Plastic Containers with Sealed Lids:
- Stackable Storage Boxes with Dust Flaps:
- Wall-Mounted Shelves with Transparent Covers:
- **Enclosed Display Cabinets with Glass Doors:**
- Floating Shelves with Clear Acrylic Panels:

In what ways might we store and organize things?

- **Shelving:**
- Cabinetry:
- Drawers:
- Bins and baskets:
- **Hooks, Racks, & Pegboards:**
- Modular and Custom Storage Systems:
- **Trays and Organizers:**
- Rolling carts and Trolleys:
- **Floating shelves:**
- Filing systems:
- **Jewelry organizers:**
- **Kitchen organizers: Spice racks**

In what ways might we reflect things?

- **Mirrors:**
- Prisms:
- Reflective Surfaces:
- Corner reflectors:
- Retroreflective Materials:
- Catadioptric Systems:
- Kaleidoscopes:
- Reflective optics in vehicles:

Figure 4.9 Define Preparation 1

NATURE AS INSPIRATION

Reframe the questions you formulated and answered above to ask, "What in nature *insert function(s)* easily?" For example, when Leonardo Da Vinci designed the spiral staircase for the French king's chateau at Blois, he took inspiration from the 'twists' on the conch shells that he had gathered along the coast of Italy years before. When the telephone was invented, Alexander Graham Bell modeled it after the human ear. Upon inventing the pull tab on aluminum cans, the inventor asked himself, "What in nature opens easily?" His immediate thought was a banana, which led to his next question, "How can the design of a banana serve as a model for the task at hand?" (Gelb, 2018) If you have multiple functions within a single question, it might be beneficial to simplify the question into various parts to gain more insight.

What in nature protects without concealing easily?

- Waxy Cuticles:
- Thick Bark:
- Fur and Feathers:
- Mucus and Oils:
- **Rock Formations:**
- Burrows and Dens:
- Natural Canopies:
- **Tough Outer Coverings: Snail shells**
- **Rock Overhangs and Caves:**
- Fruit trees:
- Understory plants:
- Berry Bushes:
- Crops in fields:
- Fruit on Vines or Creepers:
- Nuts in Forests:
- **Seeds in seed pods:**

What in nature stores easily?

- **Honeybee Hives:**
- Animal Food Caches:
- Bird Nests:
- Plant Seeds:
- Fruit Trees:
- Squirrel Nests:
- Spider Webs:
- Coral Reefs:
- Animal Pouches:
- Plant Structures:
- Fungi Mycelium:
- **Tree Hollows:**
- **Animal Dens and Burrows:**
- Nests and Roosts
- Animal Mouths:
- Nesting Materials: :

What in nature supports weight easily?

- **Tree Trunks and Branches:**
- **Rock Formations:**
- Bone Structure in Animals:
- **Exoskeletons in Insects and Crustaceans:**
- **Coral Reefs:**
- Spider Silk:
- Fungal Mycelium:
- Root Systems in Plants:
- Sand and Sediments:

What in nature reflects easily?

- **Water Surfaces:**
- Ice and Snow:
- Metallic Minerals:
- Insect Wings:
- **Animal Eyes:**
- Feathers:
- Fish Scales:
- Insect Exoskeletons:
- **Mineral Crystals:**

Additional Inspiration/ Information:

TECHNICAL	EMOTIONAL

Figure 4.10 Define Preparation 2

After reframing the brief in figure 4.6 and utilizing nature as inspiration in figure 4.7, I researched the answers that I compiled via traditional research methods. After researching, I revisited page 6, figure 4.6, and page 7, figure 4.7 of the transdisciplinary workbook to evaluate which topics I could utilize as *possible* source material for ideation as seen in figure 4.9 to prepare for compiling the information together in figure 4.11.

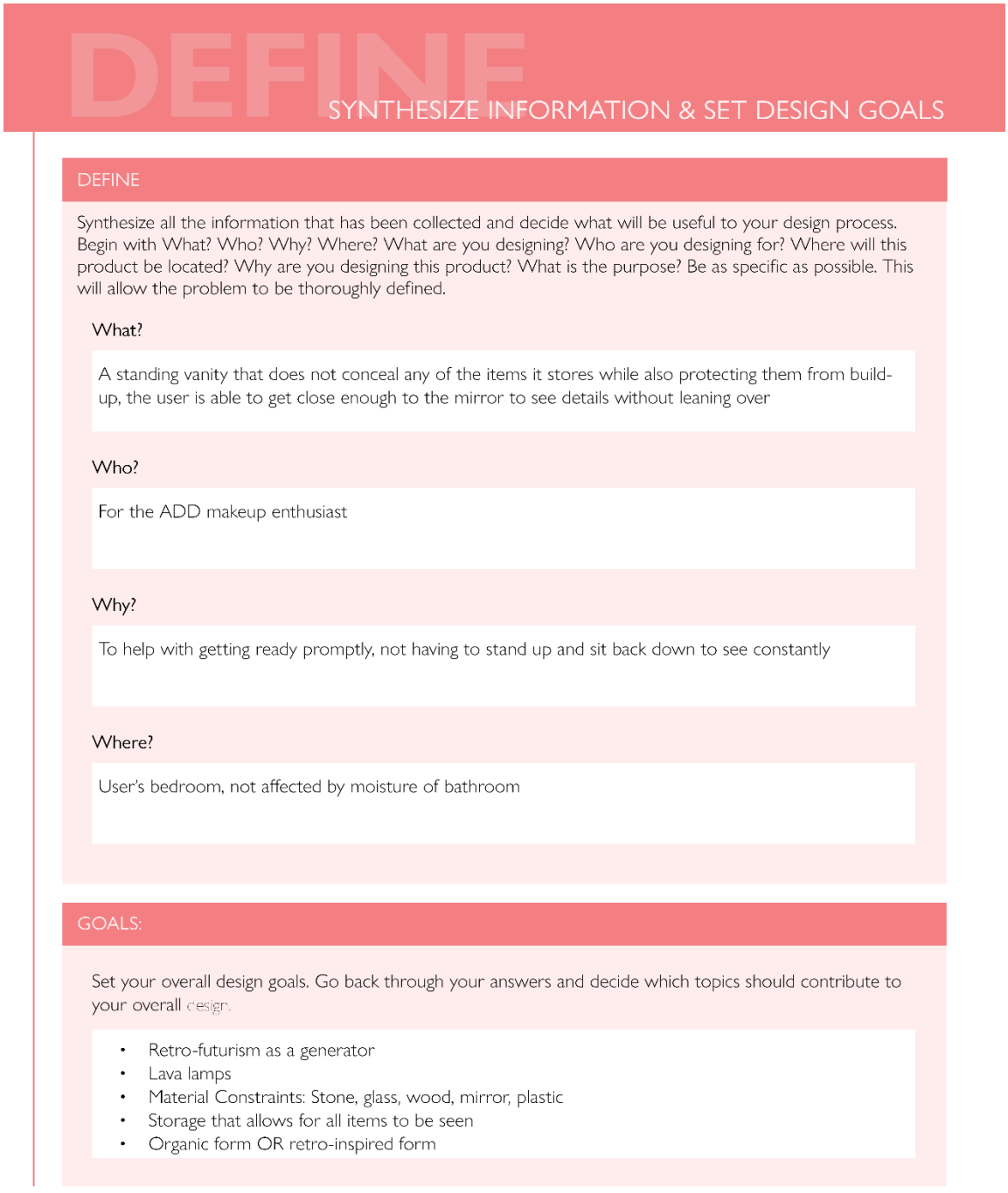


Figure 4.10 Design Goals

POTENTIAL INSPIRATION

Compile all potential inspiration and information you have found during your research in the white space below. Worry less about if it *will be* useful, and more about if it *could* be useful. This can include inspiration for function, form, or for the overall theme(s) and/ or emotion(s) you would like to express through your design. The inspiration does not have to be limited to the research that has been conducted in this workbook, external forms of personal inspiration are encouraged.

Storing and Organizing:

Technical:
- Shelving
- Hooks
- Racks
- Pegboards
- Trays
- Floating shelves
- Jewelry organizers
- Kitchen organizers (spice racks)

Nature:
- Animal burrows
- Dens
- Honeybee hives
- Coral reefs
- Tree hollows

Themes/ Generators:

Retro-Futurism:
- Warm colors reminiscent of vintage sci-fi covers
- Patterns of sea shell
- Lava lamps

Protecting Without Concealing:

Technical:
- Display cases with transparent panels
- Enclosed display cabinets with glass doors

Nature:
- Rock formations
- Burrows and dens
- Natural canopies (protects understory plants)
- Tough outer coverings (snail shells)
- Rock overhangs and caves
- Fruit trees (protect fruit until ripe)
- Seeds in seed pods

Supporting Weight:

Technical:
- Solid structures
- Foundations
- Frames
- Trusses
- Arches
- Cantilevers

Nature:
- Tree trunks
- Branches
- Rock formations
- Root systems in plants
- Sand and sediments

Reflecting:

Technical:
- Mirror

Nature:
- Water surfaces
- Animal eyes

Figure 4.11 Define

To consolidate all the findings, insights, and inspiration that were collected throughout the discovery phase, I recorded all the information I deemed would be of significance in the ideation phase. I began with defining the overall:

- *What I am designing:* A standing vanity that does not conceal any items it stores, while also protecting these items from dust build-up. The user can get close enough to the mirror to see details without leaning over.
- *Who I am designing for*: The ADD makeup enthusiast
- *Why I am designing it:* To help the user get ready promptly and not have to repeatedly stand up and sit back down to see details
- *Where the design will be located:* User's bedroom, not affected by natural elements or moisture of the bathroom

Next, I identified my overall design goals and vision, or generators:

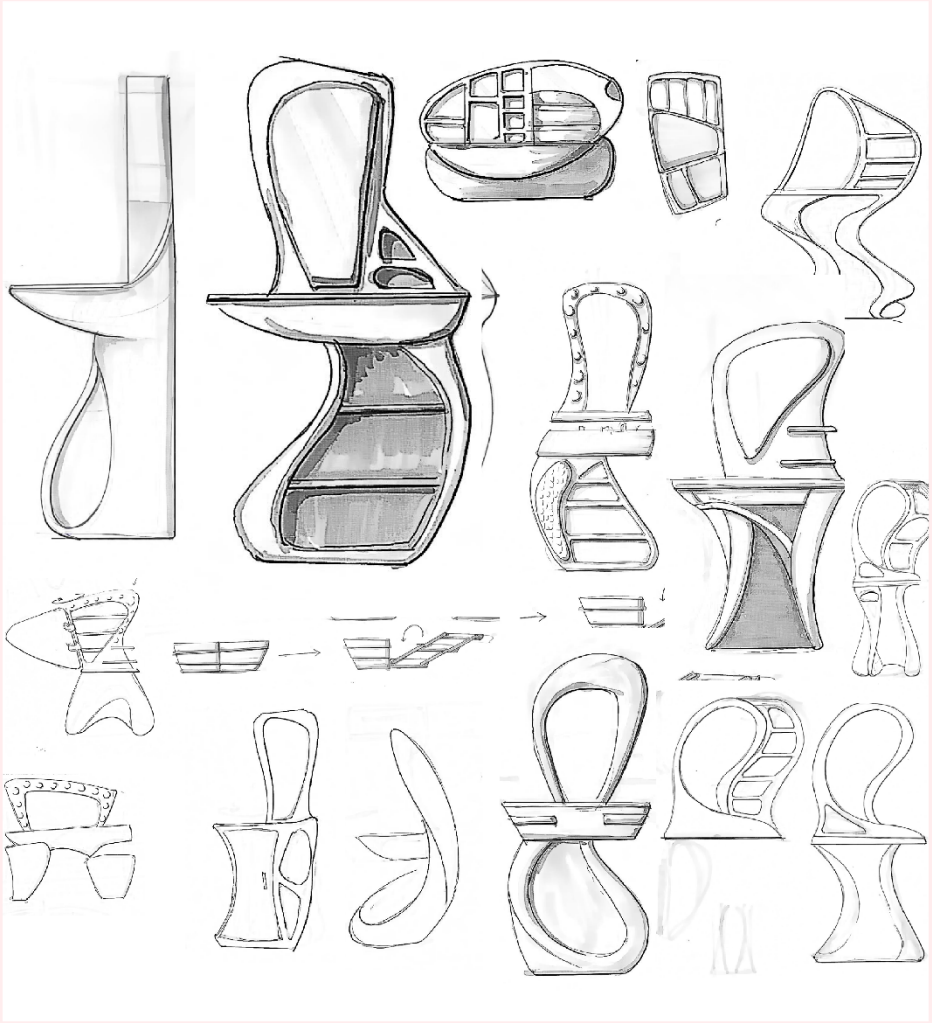
- Retro-futurism
- Lava lamps
- *Material constraints:* Stone, glass, wood, mirror, plastic
- Organic or retro-inspired form

4.3 Develop

DEVELOP
IDEATION & EVALUATION

IDEATE

Utilizing all of the information and inspiration you have compiled and organized in the first two sections, begin ideating. You may sketch in the white space below or sketch on your own piece of paper.



10

Figure 4.12 Ideate

Following the define phase of the transdisciplinary framework, I began ideating utilizing all the information and inspiration that I deemed useful to concept creation. To better illustrate how I utilized these topics as inspiration during the ideation phase, the following figures visualize the ideation process.

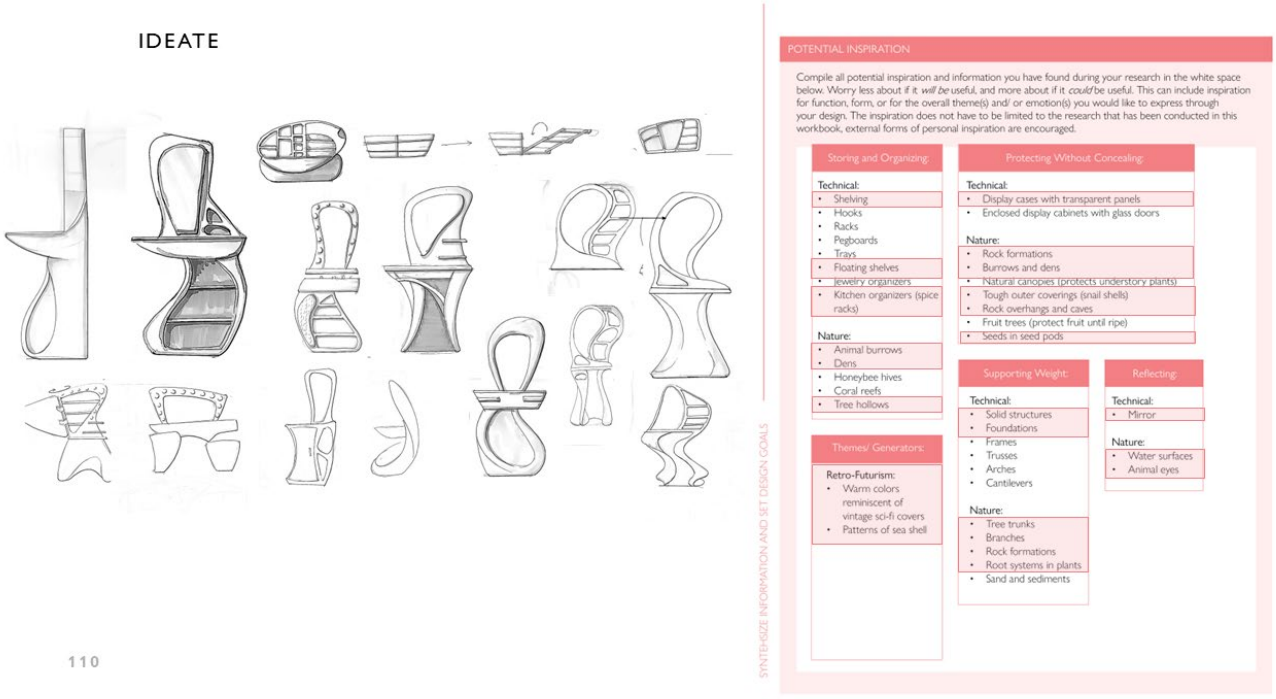


Figure 4.13 Visualize 1

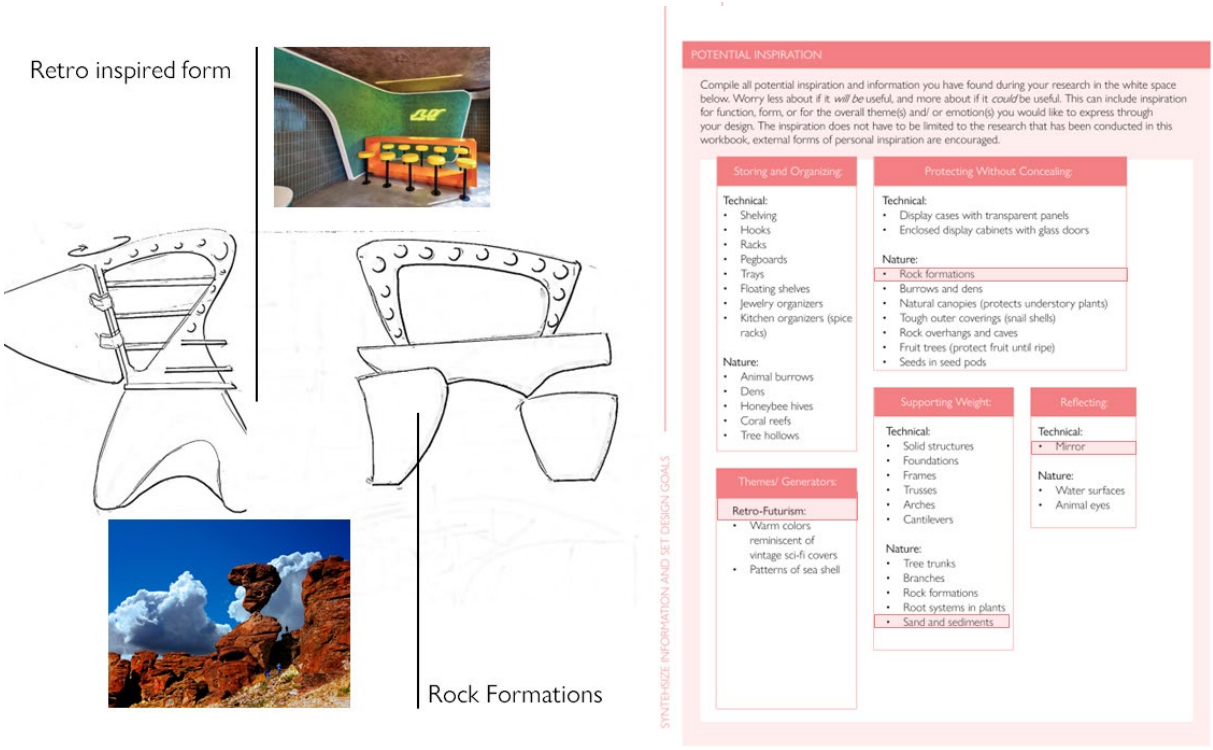


Figure 4.14 Visualize 2

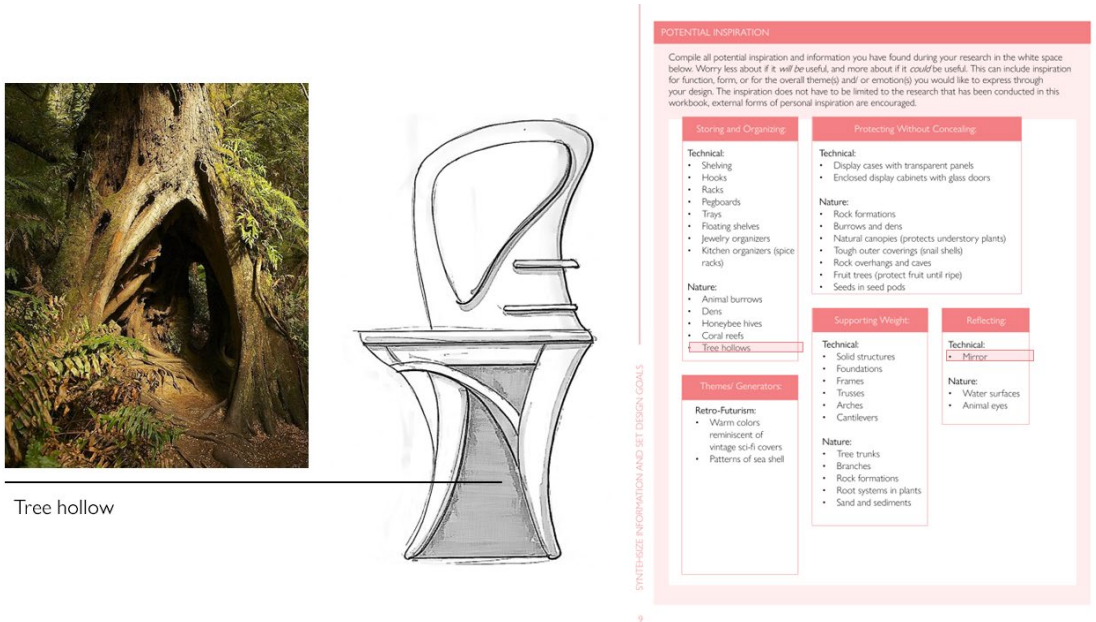


Figure 4.15 Visualize 3

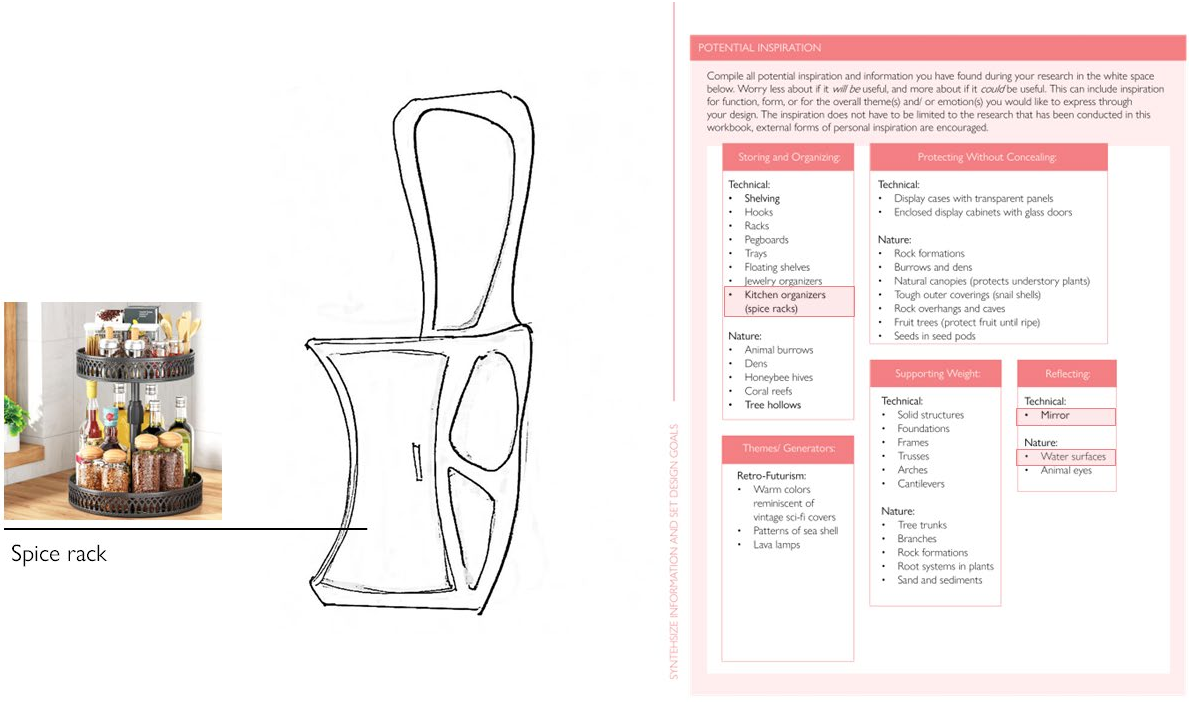


Figure 4.16 Visualize 4

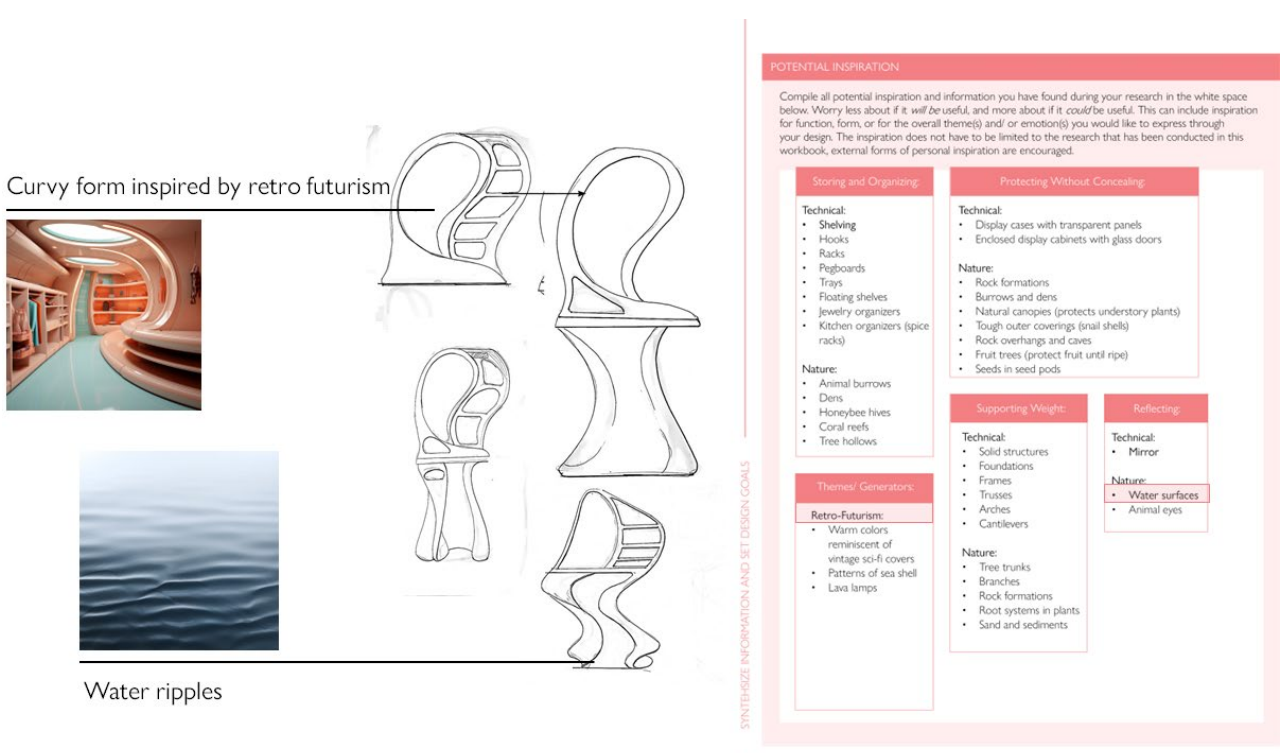
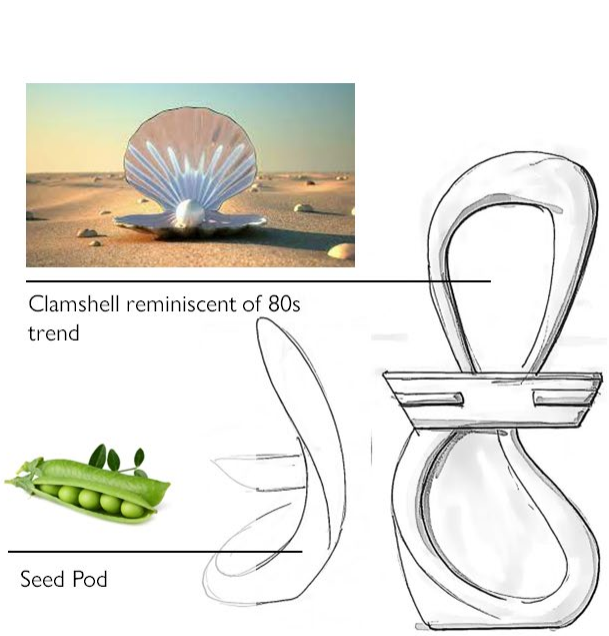


Figure 4.17 Visualize 5



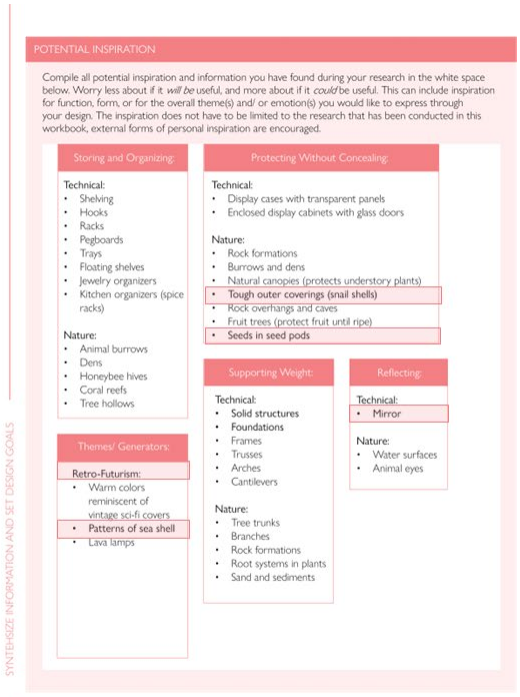
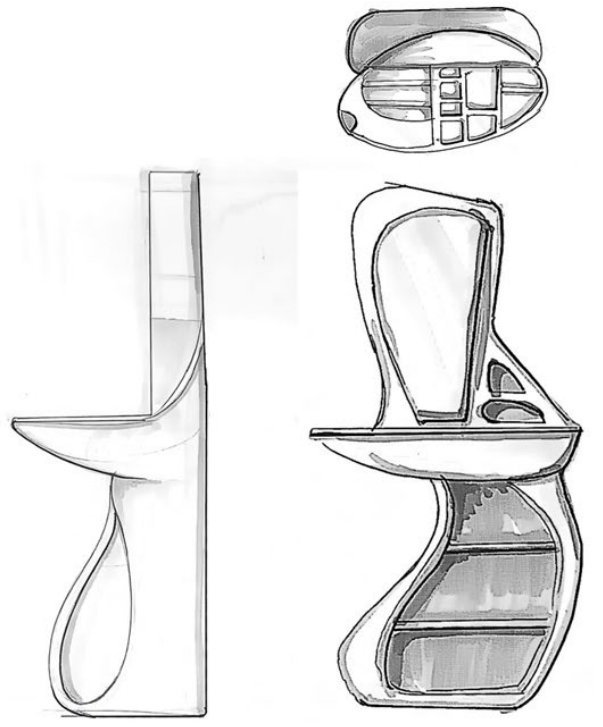


Figure 4.18 Visualize 6



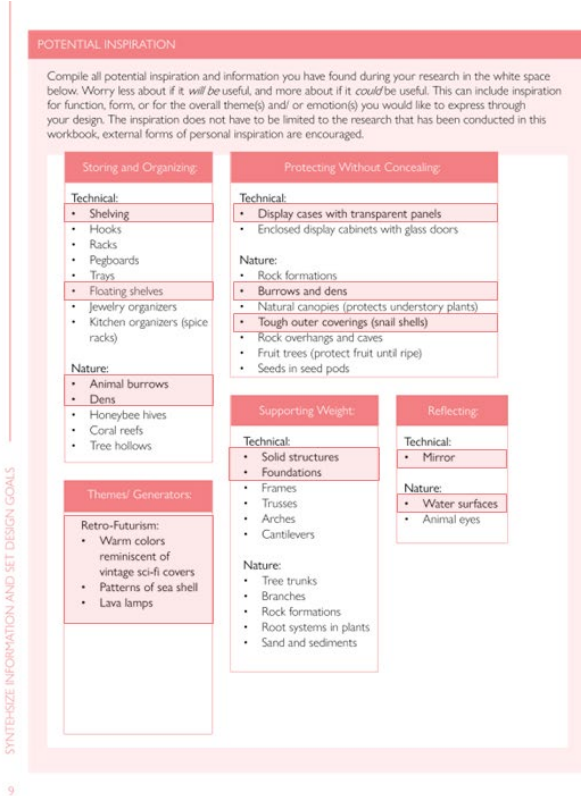


Figure 4.19 Visualize Final 1

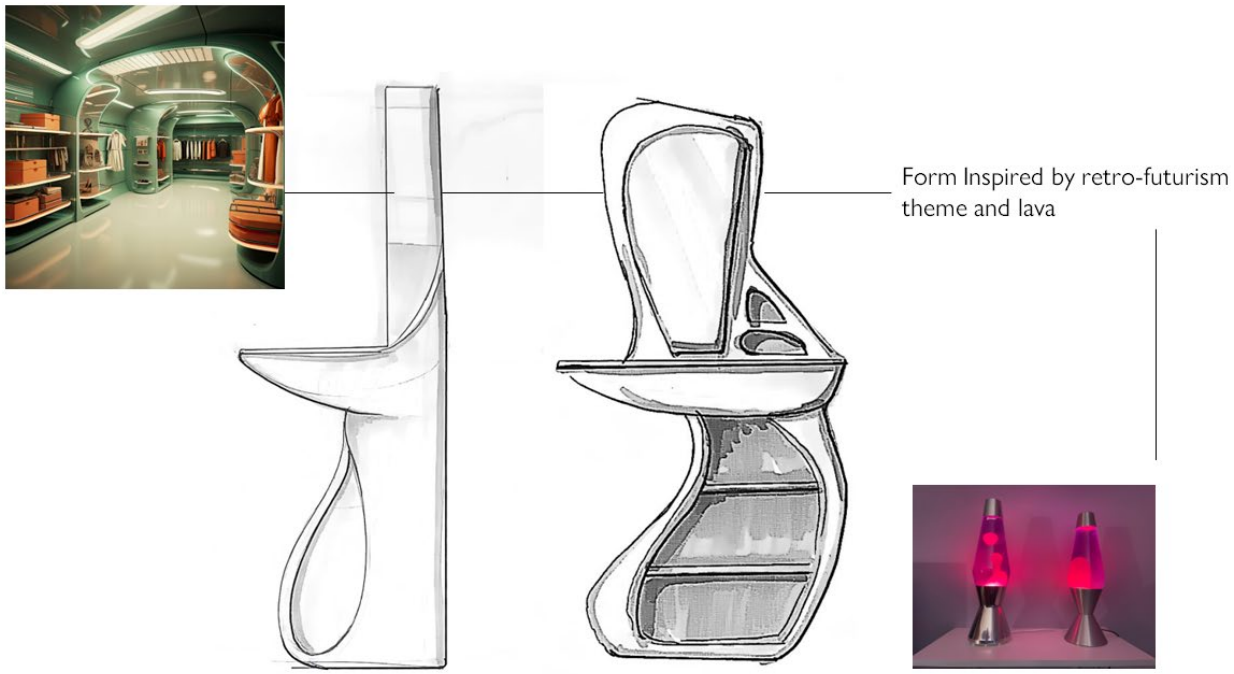


Figure 11 Visualize Final 2

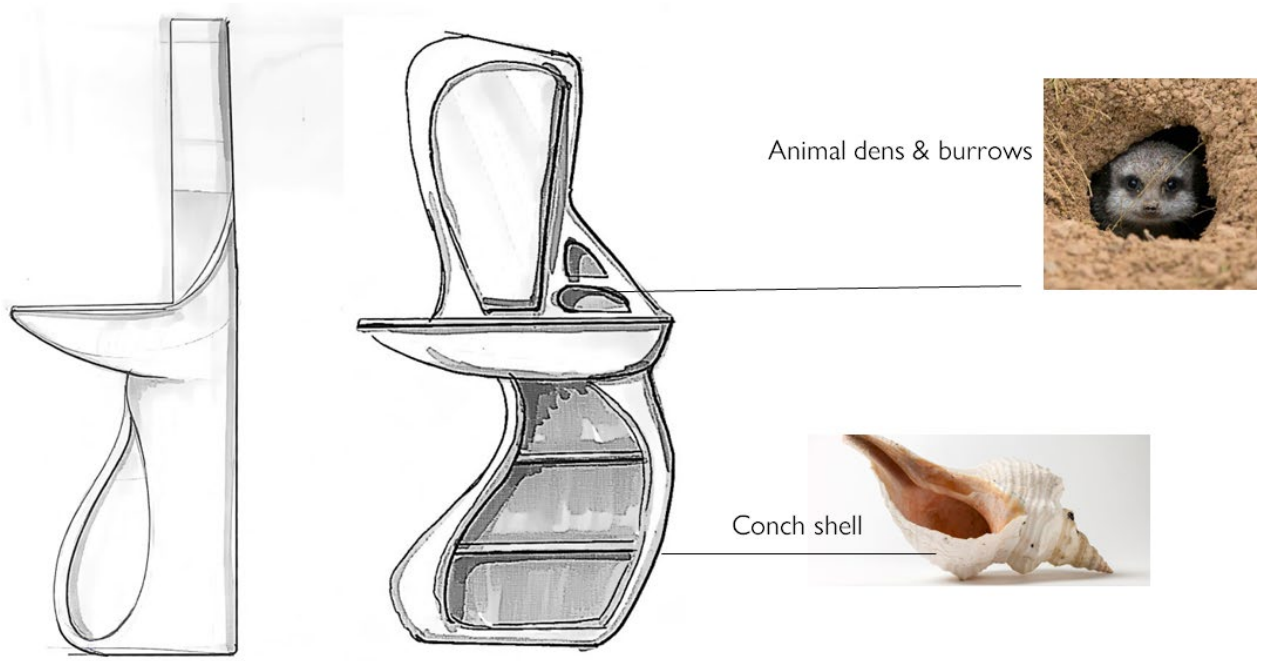


Figure 4.21 Visualize Final 3

4.4 Deliver

DELIVER

CONVERSATION WITH WORK & DELAYED CLOSURE

Many artists claim that their pieces 'pose questions to them' as they are working on them. This is similar to the iterative nature of design; however, artists are more likley to linger in this iterative nature. Although it is recommended to do this during the delivery phase, any of the artistic problem-finding strategies can be utilized at any time throughout the transdisciplinary framework.. Many artists will continue working until it 'feels' right to them. Trust your intuition. This strategy will consist primarily of 'What If?" questions. Some examples could be, "What if I shrunk it?" "What if a took a component away?" What if I switched two components? It is experimenting with what is already there.

From Ideation to Modelmaking: Use the white space below to sketch, ask questions, etc., about your concepts or models.

After modelmaking, you can repeat this process by returning to the 'Conversation With Work' strategy or return to ideation if you are unsatisfied with and would like to abandon your current concept.

CONVERSATION WITH WORK

11

Figure 4.22 Deliver

Following ideation, I began by asking questions about the concepts I created and how I could improve them or utilize them differently. For example, utilizing the concept sketch in the upper right-hand corner of figure 4.13, another concept was generated simply by turning the sketch upside-down and tweaking it accordingly.

After choosing a concept to move forward with, and I was pleased with the overall form, I began to ask questions such as:

- What if the mirror could move?
- What if it acted as a sliding door?
- What if the desk was clear and it could open?
- What if I shrunk it?

Upon generating the first question, the remaining questions began to form. During this phase of the transdisciplinary process, the designer can return to the ideation stage; however, I was satisfied with my final move forward with my concept. The final concept can be seen in figures 4.14-17.

Figure 4.23 Final Product 1

Figure 4.24 Final Product 2

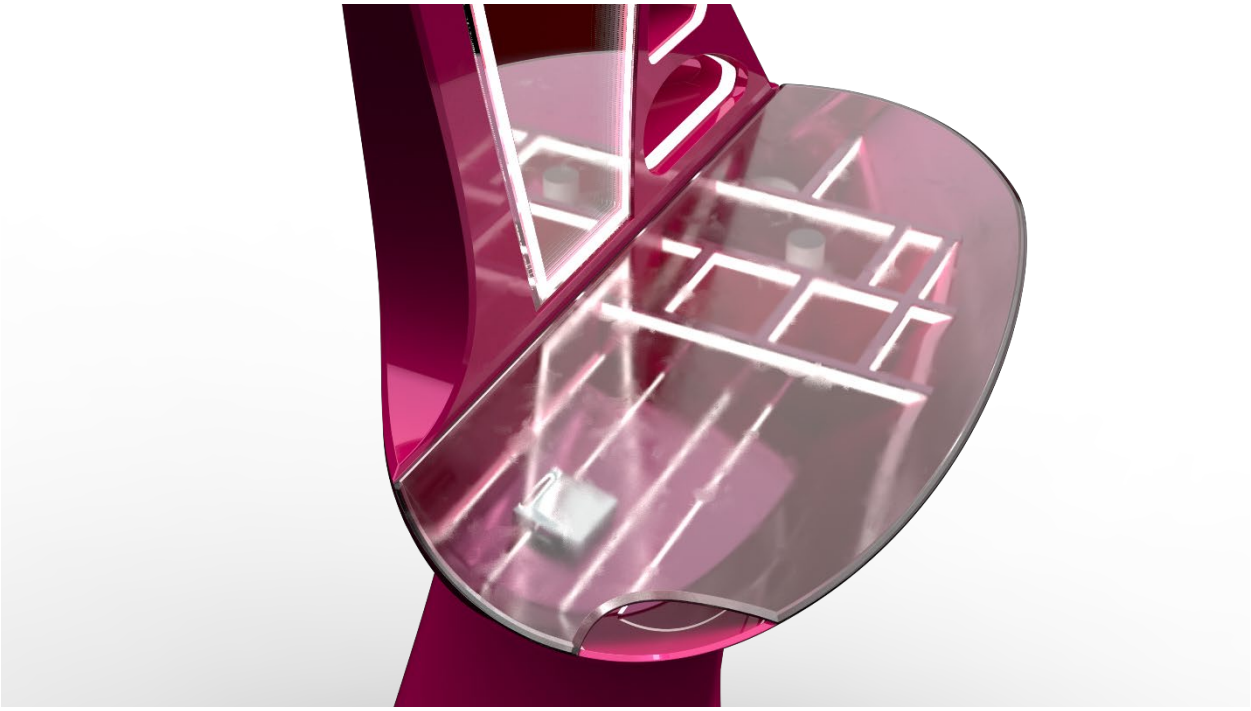


Figure 4.25 Final Product 3

Figure 4.26 Final Solution

4.5 Deliberation

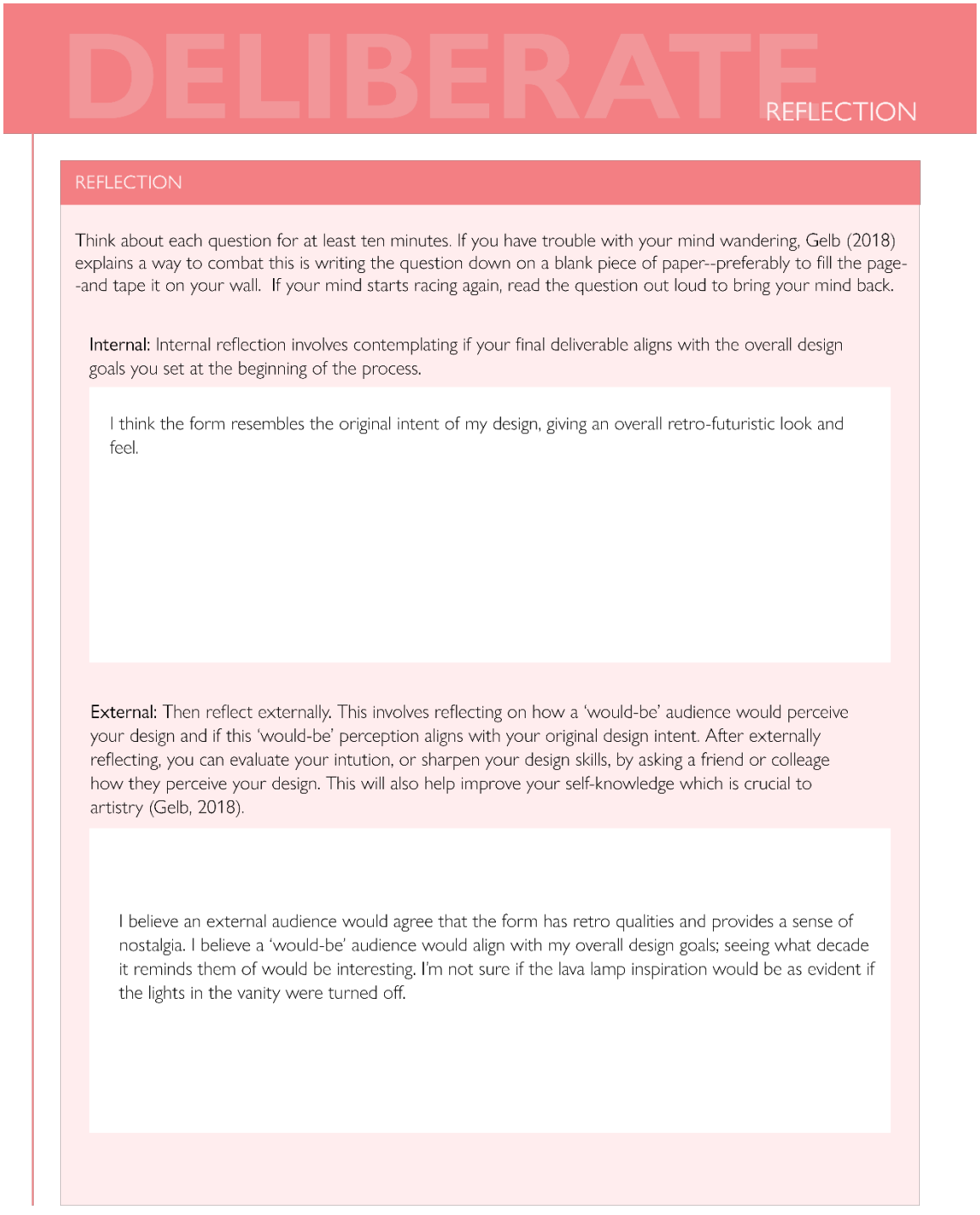


Figure 4.27 Deliberate

The fifth and final phase of the transdisciplinary approach is the deliberation phase or the reflection phase. My findings were as follows:

- *Internal Reflection:* After reflection, I believe the overall form, aesthetic, and function align with the original generators and design goals I set in place.
- *External Reflection:* Upon reflecting as objectively as possible, I do believe an external audience would concur that the form of the final product provides a sense of nostalgia. It would be interesting to see what decade a 'would-be' audience would claim the final product is reminiscent of. I am unsure if the lava lamp aesthetic would be as prominent when the lights in the vanity are turned off.

Chapter 5
Conclusion

The goal of this thesis was to develop a transdisciplinary approach to integrate art thinking into the design process for industrial designers to use. Emotion is a key factor in influencing purchasing decisions and could be beneficial to industrial design as a profession.

The developed approach allows for designers to find the right problem rather than merely solving the original one and allows for the designer to create “meaning” within their work.

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