Exploring Text-based Support for Designing Weave Drafts

by

Chehak Nayar
M.Sc., University of Victoria, 2024

A Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of

MASTER OF SCIENCE

in the Department of Computer Science

We acknowledge and respect the lək̓ʷəŋən (Songhees and Esquimalt) Peoples on whose territory the university stands, and the lək̓ʷəŋən and W̱SÁNEĆ Peoples whose historical relationships with the land continue to this day.

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ABSTRACT

We present the design and evaluation of *Textere* — a tool that helps weavers use text inputs to design weave drafts for weaving. Our research lies at the intersection of two areas of research: (i) text-based design tools, and (ii) design tools in weaving.

Text-based design tools have been explored by researchers in various domains like garment design, 3D modeling, and data visualization, showing benefits for expanding creative possibilities, enabling rapid prototyping, and making design processes more accessible for a broader range of users. Motivated by such benefits, in our research we explore how text-based tools can help with designing weave drafts.

Weaving is a design and production activity, wherein weavers map ideas, inspiration, or client requirements to visual elements like pattern, color, and weave structures to design a weave draft. The drafts are then physically produced using a loom. Weave drafts are designed before production, to convey what the appearance of the final product will look like. Design tools in weaving use different modalities, like audio and tactile, to make the design process more accessible, creative, and efficient—benefits that design tools in other domains have achieved using text support. Several text-based scenarios in weaving, require interpretation of words from text inputs. Yet, current text-based techniques and design tools in weaving are limited to mapping individual alphabets to specific weaving elements, or incorporating text as is in the weave draft. We extend this research space by exploring how weave drafts can be designed using meaning or interpretations of words.

We developed *Textere*, a text-based tool for designing weave drafts using the open source AdaCAD weaving platform. Using *Textere*, weavers can map text inputs to visual elements such as color, weave structure, and patterns based on meanings and interpretations. We curated the text-to-visual mappings used in our system from existing user studies in research, that describe how people associate words to visual elements. To evaluate *Textere*, we first used the evaluation-by-demonstration method, to produce four physical woven samples designed using our tool. Further, we conducted a qualitative study with 12 weavers to evaluate opportunities and limitations of using *Textere*, by comparing workflows to the tool we extended, AdaCAD, with no explicit text-to-visual support.

From our study we learned about the strengths and limitations of *Textere*. Informed by our results, we further discuss how text-based design tools like *Textere* can enable reflective decision making, generation and broadening of ideas, gaining different perspectives on what visual elements represent, and contribute to an ecosystem of tools for designing weave drafts. This thesis makes three contributions: i) a novel tool for designing weave drafts using text inputs, ii) empirical findings on the benefits and limitations of text-based interactions for designing weave drafts, and iii) a set of design implications for future text-based design technologies.

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ACKNOWLEDGEMENTS

I would like to express my deepest gratitude to the following individuals, whose support and contributions have been invaluable throughout this journey:

My supervisor Dr. Sowmya Somanath, for her invaluable guidance and continuous support, which were crucial in shaping this thesis.

My thesis committee, Dr. Lora Oehlberg and Dr. Charles Perin , for their insightful feedback and suggestions that helped improve the quality of my work.

My lab professors and fellow lab members, for their iterative feedback and encouragement throughout my research process.

Ruth Scheuing, for weaving physical samples of designs made using *Textere*, helping us validate its feasibility.

My family and friends, for being an unwavering source of support and encouragement through all the highs and lows of this journey.

Chapter 1

Introduction

1.1 Context

Design tools are increasingly incorporating text-based features to support their design processes, as text is an intuitive medium for expressing ideas, describing concepts, and communicating design intentions [116, 29, 21]. Researchers have explored the use of text-based design tools with users from different backgrounds like fashion, cinema, art, data visualization, and 3D modeling to help in converting ideas to visuals [72, 51, 29, 80], describing and gaining insights [116, 24], and choosing visual elements or properties for creating the design [21, 112], and serving as an additional modality for brainstorming [96]. For example, DiCTI [72] allows designers to visualize garment designs based on textual descriptions, while Articulate [116] uses text prompts to give insights about the data visualizations created. Tools like AttribIt [21] leverage relative text-based attributes like “less scary to more scary” to choose visual elements like face options for a 3D characters’ design and DesignPrompt [96] uses text as an additional modality — alongside images and color— to create custom prompts for generating visual outcomes. Designers in various fields have found text support to help expand creative possibilities [112, 24, 70], enabling rapid prototyping [72, 29, 80, 30], and making design processes more accessible for a broader range of users [21, 69, 29, 51]. As a result, text-based design tools are being developed and leveraged to design digital and tangible products. We explore text-based support for design processes in the domain of weaving.

Weaving is a process of creating tangible products, which involves designing a weave draft— a grid-like structure used by designers to convey what the appearance of the final woven cloth will look like [91, 27]. A weave draft is designed by translating ideas or inspiration into a combination of visual elements like pattern, color, and weave structures, which is then produced by interlacing threads or yarns to form a fabric output [111]. Weaving is supported by digital or physical tools that help weavers to achieve tasks, like designing and producing fabric outputs [37, 57, 33, 114]. Weaving design tools help in designing the weave draft before the production stage [37, 50] or in making improvisational changes to the weaving [130, 114].

Some weavers are part of weaving communities called guilds, [19] where they exchange ideas and weave projects based on personal interests, client requests, or themes [8] provided by the guild. These products are for personal use, gift-giving, or commission orders for specific customers, and sold through independent practice[25, 92, 43, 105, 39, 94, 87], art and craft festivals, and exhibitions hosted by guilds [19] or submitted to weaving magazines like Handwoven [4] and Little Looms [6] for recognition. Weavers encounter scenarios where they need to weave based on text inputs while making projects for weaving magazines, interacting with clients for commission work, creating personal projects, or attempting weaving challenges in guilds. These are discussed further in the next sub-section.

1.2 Motivation

In my thesis, we explored how text-based tools can be integrated to support design processes in weaving, based on three motivating reasons :

1. Weaving design tools are expanding into different modalities like audio [50, 136], tactile [50], computational inputs [57, 37, 114], and text [15]

2. Existing text-based scenarios encountered by weavers require them to map text inputs like words or descriptions to design weave drafts [9, 8]

3. Current text-based design tools and techniques in weaving do not support mapping of words to design weave drafts

Research in design tools for weaving has expanded into new modalities for designing weave drafts allowing weavers to explore different approaches to design weave drafts. Modalities like audio and tactile have been researched for specific user groups, for example using sound and touch to aid visually impaired weavers [50], or using music [13, 136], algorithms [56, 48] and game narratives [114] as input to enable users with cross-domain interests to design weave drafts (discussed in Section 2). The use of text as a modality is an emerging field in design tools for weaving, and offers a way to support design processes for weavers who wish to use text to design weave drafts [15]. Our work furthers research in text-based design tools for weaving and supports current text-based scenarios in weaving.

Weavers encounter different text-based scenarios when designing weave drafts. Theme weaving is a prevalent practice where weavers design a weave draft based on a theme or topic provided to them. Weaving groups and guilds host monthly, seasonal, and yearly meetups centered around a theme expressed using words and phrases. For example, Peterborough Weavers' and Spinners' Guild [9], Edmonton Weavers' Guild [7], Crocus Country Fibre Arts Guild [2] and design groups like Design Justice Network [8] provide themes such as "*Fragile Forest*" [9], "*Renewal, Regeneration and Reimagining Shared Reality: A Year of Interconnection and Community*" [8] and "*landscape*" [2] to their weavers to design weave drafts. Further, weaving magazines like Handwoven [4] and Little Looms [6], used by weavers as a source of inspiration and learning for over four decades, choose quarterly themes for each magazine issue and call for theme-based submissions from weavers. These themes, like "*Dazzling Downtown*", "*Hip to Be Square*", "*A Walk in the Woods*", "*Flora and Fauna*" are open to interpretation by weavers who draw from personal experiences and expertise to choose visual elements and design weave drafts in different ways based on the theme. For example, for the theme "*Flora and Fauna*", two weavers chose to represent a birch tree branch in their design, with one weaver using delicate stripes in the pattern to depict the elegance of a birch tree, while another focusing on the irregularity of the birch in their pattern [77]. For the same theme, another weaver chose a clover-shaped pattern representing the flora part of the theme [78] and opted for colors pink and dark blue based on other factors like personal preference, visual contrast, and so on. In another example, for the theme "*Hip to Be Square*", some weavers used the theme to inform their patterns and created simple square patterns, some interpreted "*square*" as game boards with square-like patterns (e.g, checkers) to inform colors and others used the theme for weave-structure techniques to create illusions of overlapping squares in their design. Weavers have reported how weaving based on text-based themes helps them expand their design skills, and gain inspiration to approach designing weave drafts in a new way [79]. Such theme-weaving examples show how weavers associate words to visual elements in various ways to design weave drafts. Hence, a tool that enables weavers to utilize text for designing weave drafts, and viewing different interpretations of elements can further support such theme-weaving scenarios, which have not been explored by any weaving design tools yet.

Further, weavers create weaving designs based on text-based descriptions and details in both commission-based and personal weaving projects. Commission weavers who weave custom pieces for clients based on their specific requirements initiate the design process with clients using text-based inputs. Many independent weavers and weaving studios share the design process used to collect design briefs from clients. Customers are asked to send an email with the idea proposal [25, 39, 94], fill a survey or form, with details and description of the idea [92, 105], or answer a questionnaire with questions like "*why the scene is meaningful to you*", "*how you want to feel when you look at the finished art*" [87] or share a personal, family or community story [25] that can be represented in the weaving. Even in video calls or face-to-face meetings, weavers mention "*asking meaningful questions, preferences, and background stories*" before proposing potential design options [94, 87]. Weavers have also shared examples of abstract topics given by customers e.g. *contemplation and digestion*, *pop the space*, *making it come alive*[43] to describe their ideas for the design. The above-mentioned text-based scenarios require weavers to interpret words or phrases to design weave drafts, which we aim to support. Similarly, weavers weaving personal projects use text-based descriptions of photographs and personal experiences to inform their designs. For example, a weaver associated with GistyYarn [**?**]– a company aiming to inspire the weaver community to use high-quality resources, shared their experience of using a sunset experience and its description with their cousins in the weave design –

> The photo was taken in Bay Ridge, Brooklyn, New York—a place that I grew up around and one that has been such a constant part of my life. Growing up, my cousins and I would walk from Sunset Park to Bay Ridge in order to go to the pier nearby. We'd spend hours walking along the bay, talking about life, school and staring at the sunset. As an adult, I decided to move to this area because I would be closer to those cousins and a pier that I grew up around. This past summer and fall I would walk to the pier and stay on the phone with a friend, talking about life and getting advice.

The weaver chose colors like indigo for water, two shades of yellow for the sunset and black for city shadows of New york. For pattern, they integrated a complex and simple pattern to contrast the "complex flow of water" and with the "simplified horizon" to give the viewer a break from the complexity of the water. Hence, exploring text-based design for weaving can support such existing scenarios where weavers interpret abstract or descriptive pieces of text to inform their designs.

Current tools and approaches only use individual alphabets of word(s) to design weave drafts [15, 5] or inscribe the word as is, into the weave design. This is discussed in detail in Section 2.1. Designing weave drafts where words and phrases can be interpreted by weavers in different ways and associated with visual elements like patterns, color, and weave structures is yet to be explored. Our research seeks to fill this gap, examining how weave drafts can be designed based on the meaning of words in the input text.

1.3 Problem Statement and Objectives

Given that text-based tools can potentially benefit the design process in weaving, our goal was to identify use cases, explore opportunities, and examine considerations for integrating text-based features into the design workflow. Hence, the problem we attempted to tackle in this thesis is as follows.

Problem Statement: How might we utilize text to support weavers in designing weave drafts? To address the problem, we had two main objectives:

1. Design and develop *Textere* - a text-based tool that supports designing weave drafts by enabling users to
   (a) view multiple visual element options (patterns, colors and weave structures) based on text (e.g. design brief, personal stories, themes),
   (b) have a way to trace the visual outcome options back to input text, and
   (c) view different interpretations or word associations of visual elements, allowing for more informed design decisions
2. Evaluate potential opportunities, limitations, and feasibility of designing weave drafts using text. This includes identifying potential opportunities for text-based design tools, determining if weavers find it useful for their design process, and verifying whether the resulting designs can be feasibly produced as physical woven products.

1.4 Methodology

We used user-centered design [127] methodology for this research, reviewed weaving concepts and past literature, developed a text-based tool, and evaluated it to explore insights about opportunities and limitations of text-based design tools in weaving.

Informed by insights from current literature and text-based scenarios for weaving, we designed *Textere* iteratively [90] by adding features to an existing open-source design tool for weaving, AdaCAD [37]. We created low-fidelity sketches, and experimented with different ideas to integrate text-based features into the tool, and developed a prototype demonstrating how text support could be used in the design process of weaving. We also referenced literature from interdisciplinary research to develop the underlying mapping database for the tool, discussed further in Chapter 3.

Given the physical nature of weaving, our research required evaluating the benefits and limitations of the tool, and its validity for producing physical outcomes. We evaluated *Textere*, using two evaluation strategies - evaluation by demonstration and user evaluation with potential users [73]. First, we demonstrated three user scenarios for designing weave drafts using *Textere*, then produced physical samples of the weave drafts designed. Secondly, we involved the potential users of *Textere*— weavers, in the process of evaluating the benefits and limitations of the tool in designing weave drafts. We conducted user interviews [73] to understand users' experiences and preferences, using thematic analysis [11, 26] to identify patterns in the data. Following a user-centered design process [127], we utilized their feedback to identify key areas where future tools like *Textere* can support the weaving design process as well as identifying potential considerations for future technologies.

1.5 Contributions

This thesis contributes to the research area of text-based design tools for weaving. It explores how text-based tools can leverage the meaning of text inputs to inform the design of weave drafts. The contributions of this thesis are threefold:

i) a novel tool *Textere*, for designing weave drafts using text inputs,

ii) empirical findings on the benefits and limitations of text-based interactions for designing weave drafts, and

iii) a set of design implications for future technologies and research directions in text-based tools for supporting design processes in weaving.

1.6 Thesis Overview

The remainder of this thesis is organized as follows:

- In *Chapter Two*, we discuss previous works in related domains and how our work learns from or furthers research in those areas.
- In *Chapter Three*, we discuss the process of designing *Textere*, and outline the implementation details of our work.
- In *Chapter Four*, we evaluate the opportunities, limitations, and feasibility of *Textere* using evaluation by demonstration and a user evaluation study.
- In *Chapter Five*, we discuss insights from our results and implications for future technologies in text-based design tools for weaving, as well as for broader the domain of text-based design tools.
- In *Chapter Six*, we revisit our research objectives to determine the extent to which we have succeeded in fulfilling our research goals and underline some promising directions that future researchers could pursue.

Chapter 2

Related Work

This thesis is situated at the intersection of two research areas: text-based design tools, and design tools in weaving (Figure 2.1). In this chapter, we discuss related work in both these areas.

We begin by reviewing the state-of-the-art literature from design tools with text-based support, highlighting how text is utilized in the design process and how our work on *Textere* learns from and furthers research in this domain. Next, we provide a background on weaving, followed by a discussion of previous design tools in weaving that motivated the idea of *Textere*. Finally, we discuss the intersection of these fields - text in weaving and gaps that exist which inspired our work in exploring the potential of designing text-based tool for designing weave drafts.

2.1 Text-based Design Tools

Design processes typically consist of multiple stages— finding inspiration, conceptualizing, exploring, refinement, modeling, and production [17]. Text-based tools have been found to be useful for different design activities [96, 24, 116, 21, 29]. For example, in an interview conducted by Ko et al., visual artists that design tangible outcomes (like sculptures, furniture, and 3D objects), and digital outcomes (like graphics, webtoons, and posters) expressed appreciation for the availability of text-based tools for automating the creation process, expanding their ideas, and facilitating communication between users, clients, and artists [68]. Design tools supporting users like visual artists, use text to support a variety of scenarios.

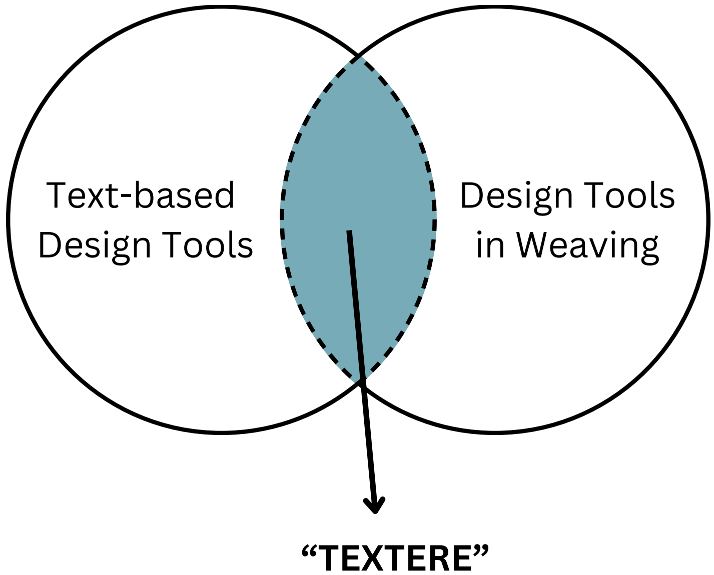


Figure 2.1: Situating our work in current research areas

2.1.1 Using Descriptive and Abstract Text Inputs to Obtain Visuals

Some design tools use descriptive text inputs to help users express their ideas using specific descriptions of the intended outcome, which are then converted to visual outcomes. For example, in garment design tools like DiCTI [72], designers can provide specific textual descriptions like "white cotton blouse with frilly short sleeves, purple dress pants" to generate a design that matches the description as closely as possible. Similarly DressCode [51] generates sewing pattern outcomes based on descriptive text prompts, allowing users to visualize their ideas or experiment with different outcomes. In interior design, NALIG [16] uses high-level descriptions of spatial scenes to create sketches to inform interior design, while text-to-scene tools like WordsEye [29], enable users to create 3D scenes from spatial text descriptions like "The dinosaur is in front of the horse". In cinema, Text2Cinemagraph [80] converts descriptions of intended visual and artistic styles into cinemagraphs. In web design, GenLine and GenForm [58] utilize text-based inputs such as, "make an okay button", to create web elements. In these cases, tools use text as a medium of expression to translate their descriptive ideas into visual outcomes.

Other design tools use text inputs to enable users to represent an abstract piece of text as a visual, even if they don't have specific descriptions for the intended outcome. Such users have an idea of *what* they want the visual to represent but do not provide descriptive details about *how* the intended outcome should look like. For example, domain-specific tools like Objektivisering [70] enable users to convert a variety of text inputs like abstract words and excerpts from books, into 3D-printable designs. Similarly, story picture engines like the one proposed by Joshi et. al [59] use excerpts from a story text to obtain a set of accompanying pictures, facilitating the visualization of complex narratives, while Text2Viz [30] automatically creates infographics from statistical statements like "*40 percent of USA freshwater is for agriculture*", based on predefined layouts, streamlining the process of visual communication. In these tools, the input is abstract text and does not specifically describe what the intended visual outcome should look like.

2.1.2 Using Text to Convert Visual Ideas into Words

In cases where users have design ideas in other modalities like images, some design tools use text support to extract keywords from the images and convert them into text prompts. For example, CreativeConnect [24] helps users explore the recombination of reference images using text. The tool extracts keywords describing details like subjects and actions from a set of reference images provided by the user and recombines the keywords selected by the user into a text prompt to generate new visual inspirations (e.g. sketches). Similarly, DesignPrompt [96] supports prompt engineering by converting multimodal inputs from the user—such as images and colors—into textual keywords and creates custom prompts using keywords selected to generate new visual outcomes. In both tools, keywords are used to help users translate their vague visual ideas into text and provide sense-making capabilities.

Many tools in 2.1.1 and 2.1.2 generate a single overall visual outcome based on the text inputs. If the outcome does not match the users' intentions, it can lead to frustration [96]. While users can try to refine or alter their text prompts, in most tools they are unsure about how changes in their input text affect the outcome, leading to a feeling of lack of control [100, 96].

2.1.3 Using Text for Better Control of Overall Visual Outcome

One approach to offer greater control to users is by allowing them to modify the overall visual outcome. For example, WorldSmith [31] and Plantography [53] allow users to create fictional scenes using text descriptions and iteratively edit them using follow-up text prompts. Similarly, Articulate [116] allows users to create and manipulate data visualizations using natural language queries.

Another approach to offer users greater control is allowing them to choose or modify individual parts or properties used to make the overall visual outcome. For example AttribIt [21] uses text-based attributes on a relative scale, for example, "less pointed" vs. "more pointed" to let users choose parts of the visual outcome like face options for a 3D characters' design. Similarly, emotiveModeler [88] shows how text commands such as "more scary" and "joy" can be used to modify parts of 3D models. In art design, emoPaint [112] utilizes emotive words like "happy", "sad" to guide the selection of individual art elements like patterns, colors, and shapes, allowing artists to convey specific moods and emotions through their creations.

While these tools provide better control of the outcome, they often have a one-to-one mapping between visuals and text [112, 21]. For example, patterns in EmoPaint are mapped to only a single emotive word each, or visual elements in Attribit [21] are mapped to only one descriptive word each. The tools do not provide insights about what other text or keywords could be associated with the visual obtained, limited flexibility in exploring alternative interpretations. For instance, a pattern mapped under the text attribute "happy" in EmoPaint [112], does not consider that the same pattern might also evoke other emotions like "nostalgia" or "calmness".

2.1.4 Summary

Overall, text is used in design tools as a descriptive or abstract input to obtain visuals, to convert visual ideas into words, or to choose and modify individual elements or properties of the visual. Our work is inspired by insights from all the above tools in 2.1.1, 2.1.2 and 2.1.3, like the importance of having multiple options to choose from, the ability to map different text inputs (descriptions or abstract text), having traceable outcomes and flexibility for multiple interpretations. *Textere* explores the scope of text in the domain of weaving, while ensuring users have multiple options to choose from and a way to trace back visual elements to the input text. Further, while some prior tools either support users with specific descriptive ideas, or offer a way to convert abstract text input to a visual in the absence of explicit design intent, *Textere* aims to accommodate both types of users, similar to Objektiversing [70], and build a tool that supports users who may or may not have well-formed design ideas yet. For example, as mentioned in Chapter 1, weavers can input text from a client or weaving guild, a literary text like excerpts from a poem, book, or journal or design ideas and *Textere* maps it to visual element options. Additionally, while other tools provide a single or linear mapping between visuals and text (e.g., one visual is obtained from one keyword), *Textere* shows multiple possible interpretations for the same visual element, considering the subjective nature of mappings. This offers diverse perspectives, including a range of similar or contradictory interpretations, and lets the users decide which interpretation makes the most sense to them.

2.2 Background on Weaving

Weaving is a traditional craft practice that produces woven artifacts such as rugs, tea towels, and other such fabric-related outputs and has been in practice for about five millennia [64].

It is a method of textile production in which two distinct sets of yarns (warp and weft) are interlaced at right angles to form a fabric using a frame-like structure called a loom [27, 111] (Figure 2.2). Warp is the set of lengthwise yarns fixed to the loom, while the weft is the traverse set of yarn that goes up over or down under the warp to create the output. The designer conveys what the appearance of the final woven design will look like using a diagram called a weave draft, weave diagram, or draft [27, 91]. As shown in Figure 2.3, the weave draft is represented using a grid-like structure, where the columns represent the warps, the rows represent the wefts and each square represents an intersection of the warp and weft. Each time a weft passes "over" the warp, the square is filled in or marked 1 or X depending on the style of draft, and each time the weft passes "under" the warp, the square is left blank, or marked 0.

The two fundamental steps of weaving are designing a weave draft, and producing the actual product using the loom. The visual design elements in any weaving project are pattern, color, and weaves (weave structure). **Patterns** can be described as repetitive decorative pieces [111], arrangements of geometric shapes, [45], motifs or an overall image, depending on the type of weaving [108, 47]. **Color** is a visual perception property and weaving uses two or more colors with different arrangements

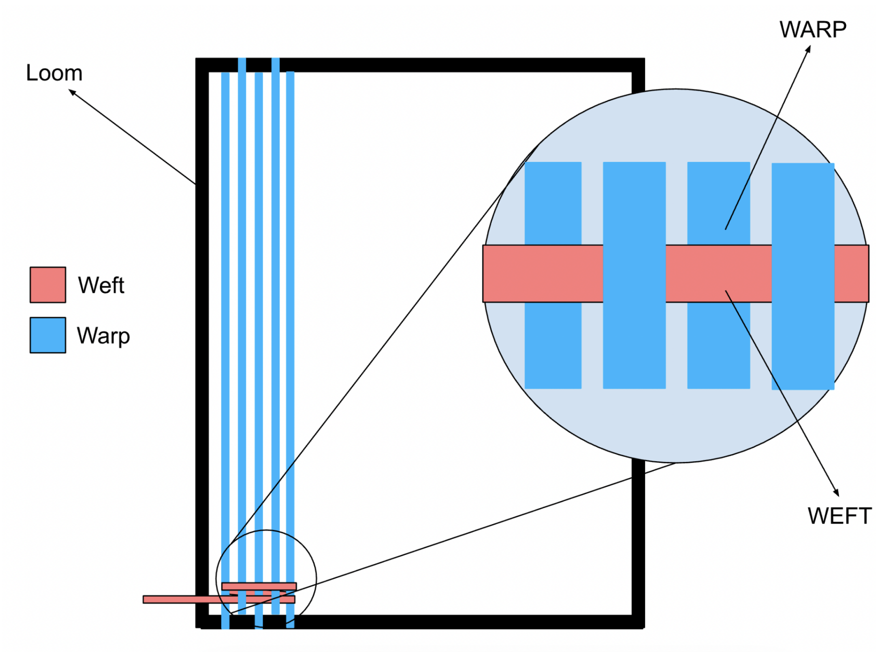


Figure 2.2: Basics of weaving : warp and weft

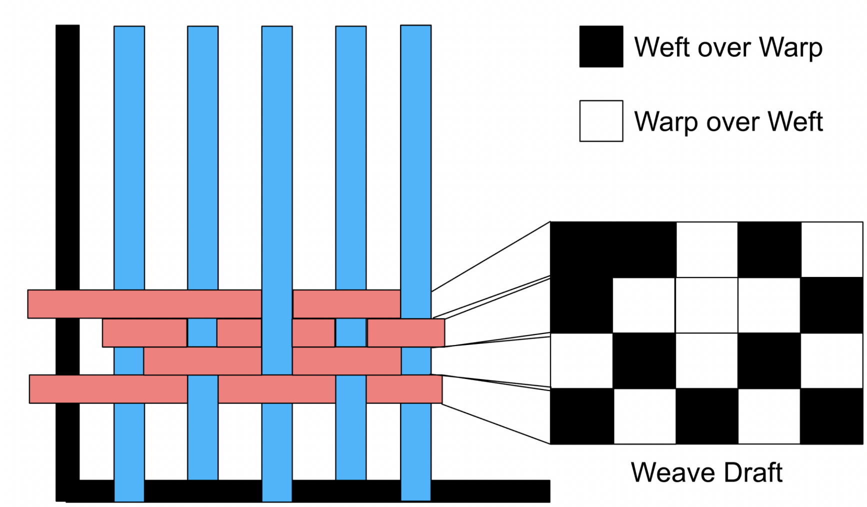


Figure 2.3: Grid-like structure of a weave draft, where each black square is where the weft passes over the warp

to create diverse outcomes [91]. **Weave structure** is the way warp and weft yarns interlace with each other to obtain the pattern chosen, for example, the same pattern can be woven differently based on chosen weave structure [91], as shown in Figure 2.4.

Historically, weave drafts were designed manually using a graph paper and pen

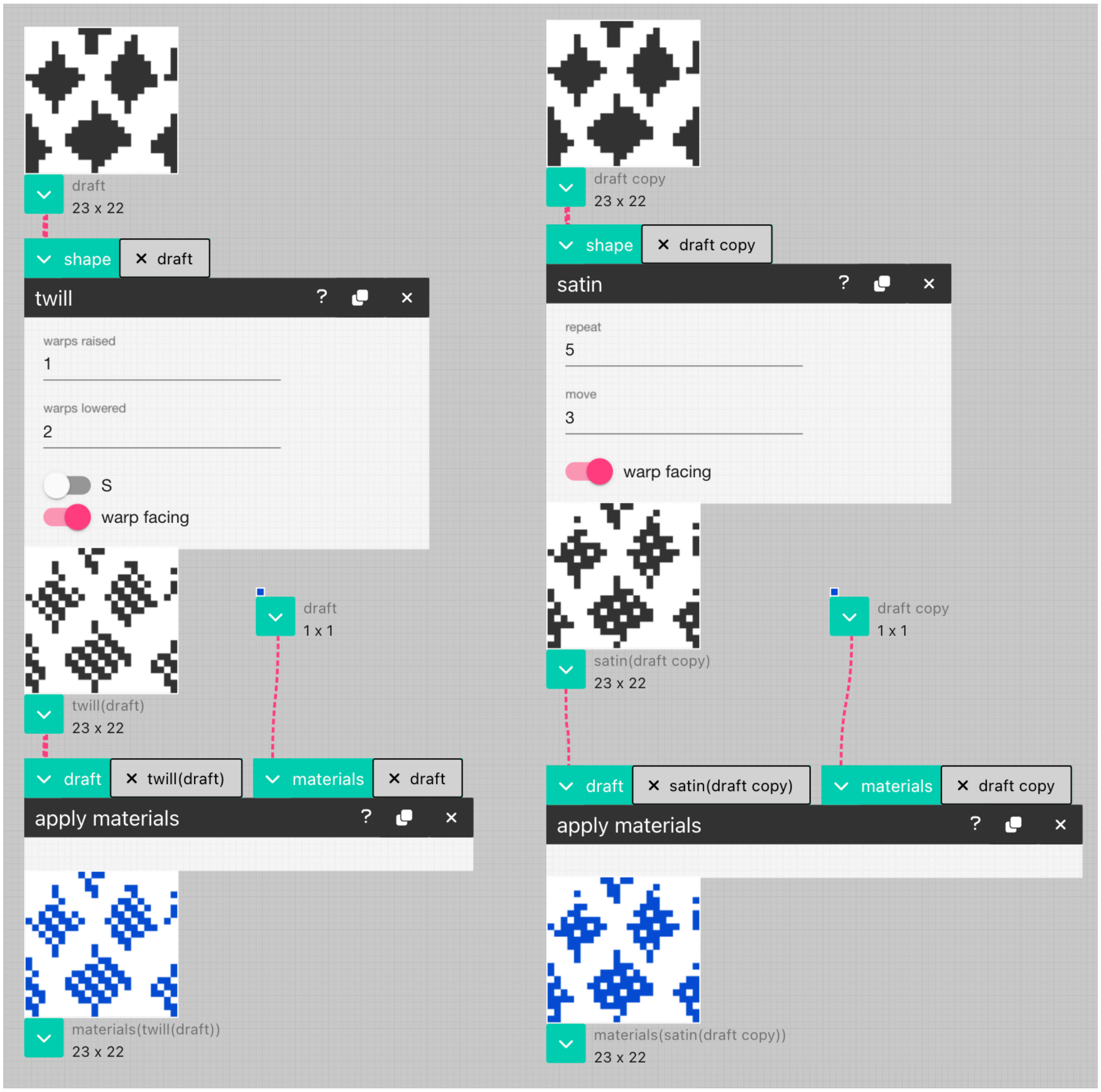


Figure 2.4: Different weave structures (*twill* and *satin*) for same pattern and color, result in different weave draft designs

to create the weave diagram grid [41, 107]. With the introduction of digital design tools, the design process became digital. One of the earliest tools Lilly [40], helped designers to design weave drafts using algorithmic functions. For color, initial design systems offered users a list of colors to choose from using radio buttons, to apply to the warp and weft [111].

Today, computer-aided design tools [91] that support the design of weave drafts follow some common features, including a color library with a collection of predefined and user generated colors, a weave library containing a collection of pre-made patterns ready to be used, options to import and edit images as patterns, make-from-scratch options using direct manipulation and several modules based on the type of loom used (eg. jacquard, dobby) [14, 1, 10, 97, 37].

The domain of weaving is in constant pursuit of investigating different types of technologies to support the exploration of new designs. In the next section, we discuss digital tools that have explored new modalities for weave draft design.

2.3 Design Tools and Techniques in Weaving

Research in design tools for weaving, like other fields, aims to make the process more intuitive, accessible [57, 50, 136] and encourage creative exploration [66, 114]. Design tools in weaving can be broadly categorized into two types: those that support the design of the woven product during its actual production on the loom, and those that assist in designing weave drafts before production.

2.3.1 Designing During Production

Tools like EscapeLoom [33], LoomPedals [130] and Loominary [114] experiment with different ways to design a woven artifact during the production process on the loom. For example, EscapeLoom [33] supports new weave designs by producing different 3D printable design in the shape of objects like a chair, to be used as custom looms to create a woven object in those shapes. LoomPedals [130] attempts to incorporate improvisational changes in the weave design as it is being produced, by customizing the loom, and Loominary [114] experiments with using a rigid heddle loom as a game controller which weaves a product based on players' choices in the game. These tools steer away from traditional weave practices. We chose not to pursue such experimental routes with *Textere* as we wanted to integrate text into the existing workflow followed by weavers without significantly altering the foundational processes of weaving.

2.3.2 Designing Before Production

Many tools help design weave drafts before the production of the actual woven product, using different input modalities. In accessibility research, Simphony [50] explores an audio-tactile system to aid visually impaired users in creating and perceiving weave drafts. Audio cues, such as musical notes and spoken words, are used to convey information about the weave drafts, while tactile elements, like raised surfaces or grids, enable users to physically interact with the design. Similarly, researchers have explored new designs for weaving using the similarity between music notation and weaving patterns [136, 13].

Another approach to designing weave drafts uses algorithms, programming, and computational parameters. For example, Jacobs et al., enables users to specify dimensions of elements and colors in a pattern using algorithmic inputs and run a function to generate a unique design [57]. Similarly, Grundler et al. use an evolution algorithm to design aesthetic patterns [48], while Jackson and Nilan use algorithms that introduce random disruptions and modifications to traditional weaving patterns [56]. AdaCAD [37] enables craftspeople and HCI researchers to design weave drafts using parametric inputs associated with weaving elements to influence outputs. Research has also explored novel weave designs influenced by geometric shapes [66], existing artwork [76], and personal data [44].

The above tools in 2.3.2 and 2.3.1 help us understand how weaving design tools are moving beyond traditional input styles by introducing new modalities like audio, tactile, or computational inputs to explore different ways to design weave drafts and woven outcomes. Our work contributes to this expansion of modalities by exploring text for designing weave drafts. In the next section, we discuss different approaches that currently exist in using text for weave draft design.

2.3.3 Text in Weaving

Weaving designs based on text is an existing practice. The current motivation for using text to design weave drafts is threefold - trying to create unique designs [15, 98, 126], streamlining the weave design process to make it easier [126], and as memorabilia [34, 120].

Lettering is a technique where weavers directly inscribe text in the pattern, such as adding the makers' names onto woven belts [34], and weaving handwritten text [120] onto garments for remembrance. This technique is achievable through some

Letters	Shaft
ABCDEFG	1
HIJKLMN	2
OPQRSTU	3
VWXYZ	4

Table 1

Letters	Shaft
ABCDEFG	1,2
HIJKLMN	2,3
OPQRSTU	3,4
VWXYZ	4,1

Table 2

Letters	Shaft
EIR	1,2
TNDUF	2,3
ASLMGPV	3,4
OHCWYBKJXQZ	4,4

Table 3

Figure 2.5: Mapping table examples for code drafting on a 4-shaft loom

online tools like FiberWorks [63] and used to add messages to the weaving project.

Code drafting [98] is another for designing weave drafts using text. In this method, alphabets, numbers, and special characters from a word or phrase are mapped to loom shafts (mechanical part of a loom used to raise warp threads while weaving) based on predefined tables, to create a weave draft. Several such tables exist and weavers usually try different table mappings to see which one provides the most feasible design. For example, for a 4-shaft loom, alphabets are grouped into 4 sets, each mapped to one or more shafts (See Figure 2.5). Depending on the type of input text, this method is known as name drafting (for names), or commemorate drafting (for meaningful words). For structural stability and visual aesthetic, shafts need to be balanced [99], i.e. used a similar number of times in the weaving process. However, the randomness of letters can lead to uneven shaft use, so strategies like using letter frequency tables or mapping each letter to its own shafts are used. Despite these efforts, achieving the perfect balance is challenging and mixes up alphabet sequences, leading to meaning of the word being lost [98]. This technique is supported by some commercial tools [63] that allow users to enter a word and choose a mapping table to create a corresponding weave draft for the entered word. Researchers have also explored a similar process of designing a weave draft, which involves mapping alphabets to different rows (weft threads) of a weave draft [15] between 1 to 9 (for e.g., A corresponds to 1 and B to 2) to create a pattern for the weaving draft. While this approach retains the order of alphabets, it still faces similar problems when a particular weft thread that has no alphabet mapped to it leading to a defective fabric. Moreover, when the length of the input text increases, multiple alphabets are mapped to the same weft thread, leading to words being mixed and loss of meaning. Hence, while structure-based mappings encode text into weave drafts, they are unable to retain the “meaning” into the weave draft.

Additionally, mapping alphabets to the color of yarn has also been explored. For example, particular alphabets have been mapped to a color starting with that alphabet, (for example the alphabet “r” mapped to the color “red”) or a predefined symbol (for e.g. hashtag) in the weaving draft [34].

Another approach involves the use of prompt engineering to design weave drafts [126]. Researchers have explored the possibility of designing weave drafts by conducting operations on existing weave structure arrays (consisting of 0’s and 1’s) using prompt engineering. By creating text-based variables for arrays representing weave structures, researchers perform operations to create new weave designs using prompts like “plain weave + satin weave”.

These works highlight how embedding text or encoding its meaning has been an ongoing practice in weaving. While existing tools break down words and sentences into alphabets for mapping, none of them focus on using the meaning of the entire word to map to weaving elements like pattern images, colors or weave structures. Hence, *Textere* attempts to fill this gap by designing weave drafts based on meaning and interpretations of words.

2.3.4 Summary

Overall, previous design tools in weaving support design processes either during or before the production. *Textere*, supports designing before the production process. While existing design tools in this domain have explored modalities like audio, video, and programming, *Textere* extends research by investigating the use of text as a modality—which has limited design tools in weaving. While existing text-based design tools and techniques in weaving primarily focus on splitting words to map letters or symbols to weaving elements, none of the tools map the meaning of the entire word. *Textere* fills this gap by mapping the meaning of words to patterns, colors, and weave structures, providing a novel approach to design in weave drafts using text inputs.

Chapter 3

System Design and Implementation

3.1 System Design

In this section we discuss the design of *Textere* and the basis of our design choices. We developed *Textere* using the open-source AdaCAD codebase [37]. AdaCAD is a design tool for weave drafts, developed by a group of HCI researchers. Leveraging this tool gave us a starting point for developing *Textere* using existing design workflows for weaving. Additionally, AdaCAD's workflows were developed iteratively with feedback from weavers— our potential users, grounding it in real-world usage and making it a strong foundation for further development and evaluation.

Moreover, prior studies in weaving have highlighted the importance of making weaving techniques more accessible by utilizing freely available tools to facilitate weave draft design [76]. As AdaCAD is an open-source tool, we were able to access the code base, add text-based features to it and contribute to the open-source community, making text-based weaving design techniques more accessible to a broader audience.

3.1.1 Design Goals

Our design goals are informed by previous literature discussed in Chapter 2. From previous text-based design tools, we learned that if tools provide a single outcome based on the text input, it can result in frustrated users— if the result does not match their intentions [96, 70, 72]. Hence, to increase possibility for the user to find a visual outcome that matches their intentions, our first design goal is to

- **Design Goal 1 (DG1)**: Enable users to view multiple visual element options based on text.

Secondly, we learned that if users are unsure how modifying the input text affects the visual outcome, it can lead to a sense of lost control [96]. Hence, to ensure users know which visual outcome is obtained from which word in the input, our second design goal was to

- **Design Goal 2 (DG2):** Enable users to have a way to trace the visual outcome options back to input text.

Previous tools addressed challenges around users' feeling of lack of control and frustration in obtaining visual outcomes by either allowing them to modify the overall visual created as per their preferences or choose individual elements that eventually combine to create the overall outcomes [21, 112, 53, 31]. The design process in weaving inherently consists of different visual elements that are combined to design a weave draft (See Background in Chapter 2), hence our design goals, DG1 and DG2 focussed on exploring these elements individually, rather than providing users a combined final outcome.

Finally, we observed that current design tools presenting multiple visual options to choose from, often show users a single or linear mapping between visuals and text (e.g., one visual was obtained from one keyword)— leading to limited exploration of possibilities. Hence, our third design goal was to

- **Design Goal 3 (DG3)**: Enable users to view different interpretations of visual elements, allowing for more informed design decisions.

These design goals, along with insights from related work, and AdaCAD's general workflow informed our design decisions. We used the design concepts and workflows part of AdaCAD, to enable users to obtain the three visual elements: color, pattern, and a weave structure.

3.1.2 Design of Text-to-Visual Mappings

To implement text-to-visual mappings, we referenced literature that establishes an association between text and visuals. Previous tools use different approaches to obtain text-to-visual mapping data, such as AI-generation, volunteer or crowdsourcing contributions and online repositories. For instance, CreativeConnect [24] and WorldSmith [31] utilize underlying AI models, rules or algorithms, while Wordeye [29] uses a large licensed database of 3D models modified by adding text-based attributes. Similarly, Objektivisering [70] and DesignPrompt [96] utilize online repositories from websites like Thingiverse [?] and Unsplash [?] which return models and images respectively based on text input. Other tools like Coloring with Words [18] and work by Mihalcea et al. [85] rely on manually curated data from a community websites or through volunteer contributions.

Inspired by such approaches, in *Textere*, we manually curated data from previous literature like research papers, books and articles [121, 125, 124, 110, 117, 23, 36]. The text-to-visual mappings we curated, consisted of visual elements associated to different types of words, such as abstract nouns, emotive words, objects and descriptors—which aligned with our design goal (DG2) of offering users multiple interpretations for visual elements. These mappings were backed by empirical evidence and insights from 33 user studies, surveys, qualitative studies and focus groups, with participants from various backgrounds (technology, design, finance, HR, engineering), age groups and nationalities.

3.1.2.1 Text-to-Pattern Mapping

To obtain text-to-pattern mappings, we considered research studies that present word associations to pattern images. We narrowed down to three research papers and one book in the domains of product design, visual art, architecture and engineering design. Researchers used various approaches like user studies, focus groups and surveys to obtain word associations for patterns from 580 participants from diverse backgrounds, (technology, finance, design, HR, engineering, students) across different age groups and nationalities.

We curated a dataset collection of 75 patterns. The patterns used in these research studies and the book were historic patterns from art [125], patterns curated by designers over multiple decades [101, 110], modifications of historic patterns using geometric shapes [121], and patterns created from user sketches [124]. The associated words included those that described geometric patterns and shapes [121, 110, 124], semantic and emotional meanings [125], and tactile qualities [121]. These were relevant for designing weave drafts because, patterns in weaving are made from arrangements of geometric shapes (See Chapter 2), and draw inspiration from abstract themes (See Chapter 1), or personal experiences and emotions [83, 114, 136]. These different types of interpretations also aligned with *Textere's* design goal (DG3) to allow users to explore multiple interpretations of visual elements. Figure 3.1 shows some examples of the text-to-pattern mappings curated and used in *Textere*.

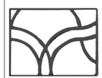
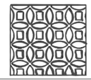
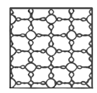
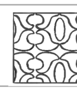
Pattern Image	Keywords/Tags		Keywords/Tags
	Trust, Excitement, Interest, Anticipation		Serenity, Love, Joy, Affection
	Trust, Acceptance, Optimism, Serenity		Trust, Happiness, Connection, Optimism, Joy and Love
	Serenity, Ecstasy, Love, Joy		Affection, Joy, Distraction
	Cream, Lollipop, Ice Cream, Motion, Drain, Wave, Dizziness, Helicopter, Whirlwind, Hypnosis, Video Card, Snail, Washing Machine, White, Red, Hectic, Dizzying, harmonic, Creative, Hypnotic, Food Industry, Automotive Industry, Electronics, Textile Industry, Decoration		Fence, Church, Window, Wrought Iron Fence, Decoration, Wallpaper, Candlestick, Wall, Window Grille, White, Elegant, Boring, Contradictory, Retro, Beautiful, Yellow, Interior Architecture, Exterior Architecture, Decoration
	Anger, Aggression, Nervousness, Uncertainty		Joy
	Joy, Excitement, Love, Affection		Vigilance, Trust, Serenity
	Smooth, Swelling, Sliding		Falling, Pessimistic, Defeated, Depressed

Figure 3.1: Examples of text-to-pattern mapping in *Textere*; consolidated and redrawn from [121, 125, 124, 110].

3.1.2.2 Text-to-Color Mapping

To obtain text-to-color mappings, we referred to studies that explored word associations with color. A majority of literature in this domain mapped colors to semantic interpretations of people [49, 119, 86]. We found a set of mappings by Surov et al [117] which consisted of text-to-color associations consolidated from results if 28 qualitative studies. The consolidated mappings included colors and word associations that appeared repetitively across different languages and cultures, and were the most diverse set of interpretations (DG3) with supporting empirical evidence that we found for colors. It contained emotive words and descriptors— used while describing a design intent, and also included abstract nouns and names of objects— that could appear in a theme-based weaving scenarios. Figure 3.2 shows text-to-color mappings curated and used in *Textere*.

3.1.2.3 Text-to-Weave Structure Mapping

We found no existing studies that explicitly showed how text can be mapped to weave structures. As such, we developed some mappings through indirect information sources like general research papers on weaving [36], weaving magazines and newsletters

Color	Keywords/Tags	Color	Keywords/Tags
Blue	Surprise, interest, Anxiety, startle, fear, Water, coolness, calmness, passivity, freedom, clarity, Logos, wisdom, intelligence, discretion, separation, alienation, distance	Red	Passion, bravery, zeal, Anger, fury, rage, Fire, blood, power, action, heat, expansion, energy, force, attraction, Eros, danger, fight, aggression, stress
White	Light, clarity, purity, goodness, divinity, sincerity, emptiness, consciousness, future, life	Grey	Indifference, ignorance, non-involvement, neutrality, mediocrity, closeness, weakness, inertia, lethargy
Magenta	Inspiration, ambition, Irritation, stress	Orange	Warmth, Warm
Violet	Mystery, magic, transformation, ceremony, luxury, richness, royalty, majesty, dignity, individuality, will	Black	Evil, negation, protest, badness, darkness, chaos, night, unknown, destruction, dirt, oppression, death
Yellow	Acceptance, delight, Disappointment, disgust, Sun, shine, glow, radiance, happiness, kindness, divinity, lightness, optimism, openness, feces, pus, vomit, apple juice, pineapple, and sunflowers	Green	Joy, contentment, rapture, Sadness, grief, despair, Vegetation, harmony, balance, stability, Nature, patience, peace, equanimity, rest, respect, satisfaction, defense
Cyan	Calmness, Serenity, Bliss, Depression, Shame, Guilt		

Figure 3.2: Text-to-color mappings in *Textere* based on the summary provided by Surov et al [117].

[23, 107]. Informed by the the visual characteristics of a weave structure (such as it's orientation), and mood lines used in text-to-pattern mapping, we added some visual mappings. For example, because the visual appearance of "twill" weave structure (diagonal lines moving downwards) matches the visual appearance of a pattern from text-to-pattern mapping in *Textere*, we associated its words to twill as well. (See Figure 3.4).

Weave Structure	Keywords/Tags
Waffle	Diamond, Ridges and Depressions
Tabby	Low-contrast
Twill	High-contrast, Falling, Pessimistic, Defeated, Depressed

Figure 3.3: Shows how weave structure can be mapped to from [101, 36, 107]

We also referred to articles written by weavers, and research papers about weaving which describe weave structures using words that highlight their visual and physical nature. For example, "twill" weave structure was described as having a high-contrast structure [23], plain weave was described as low-contrast, and waffle is described as a diamond-shaped weave [36]. We thus used such information to create an initial dataset as shown in Figure 3.3. These mappings while limited, are sourced from resources written and referred by researchers or weavers— our target user, but is an area for future research.

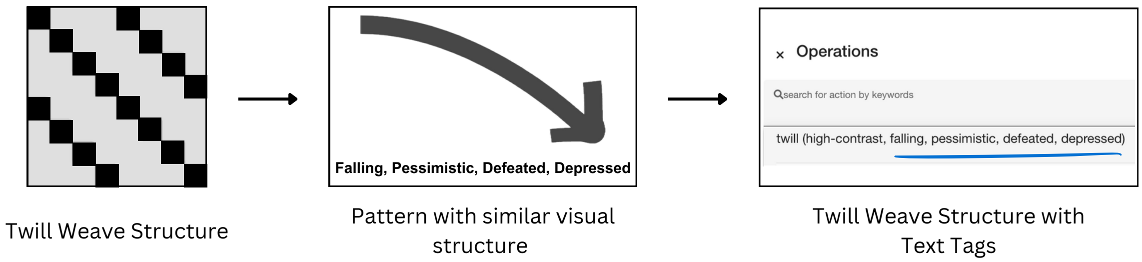


Figure 3.4: Mapping *twill* weave structure to text tags using visual characteristics

3.1.3 Design of System Features

We added two features in *Textere* to obtain pattern, color, and weave structure using text support. First, we introduced a text-based keyword search to help users find various visual elements using text inputs (DG1). Second, we added text tags to each visual option to offer diverse interpretations for each option (DG3). We also used text tags to help user trace visual options back to input text (DG2).

3.1.3.1 Text-based Search

Previous design tools like Objektivisering [70] and DesignPrompt [96] use input text from users as search queries to retrieve visuals from an underlying set of mappings. Objektivisering allows more variety of text inputs than DesignPrompt, ranging from abstract words to excerpts from books. Similar to these tools, we added a text-based search feature in *Textere* to allow weavers to input text, like themes, ideas, and descriptions to view different visual element options. *Textere's* keyword-based search splits the text input into keywords, and uses each keyword as a search query to retrieve visual elements— patterns, colors or weave structures from the text-to-visual mappings curated in 3.1.2. The keyword search method retrieves all possible matches from the set of mappings, providing users with multiple options to choose from (DG1).

3.1.3.2 Text Tags

Previous design tools like CreativeConnect [24], SemanticCollage [69] and DesignPrompt [96] extract words (referred to as semantic tags or keywords) from visuals to describe their different aspects. Inspired by these tools, *Textere* uses a set of words (text tags) that are displayed with each visual option in the text-based search results. While inspired by semantic tags used in previous tools [24, 96, 69], the use of text tags differs in purpose, and method of mapping. While semantic tags or keywords are generated using semantic labeling algorithms or AI models, text tags in *Textere* are obtained from manually curated mappings from literature (See 3.1.2). Further, previous tools use semantic tags to help convert *user's* vague visual ideas into words [24, 69], while *Textere* uses text tags to help convert *system-provided* visual options into diverse interpretations, and enable users to make informed choices (DG3) amongst the options.

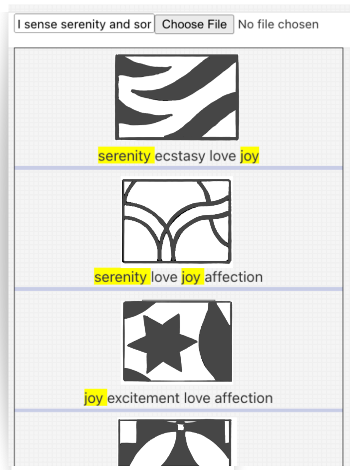
In addition to providing multiple interpretations, *Textere* also uses text tags to help users trace visual options back to the input text (DG2). This is implemented in various ways for all three visual elements - pattern, color, and weave structure, and covered in more detail in the next section. *Textere* also ensures that in case the input text does not match any text tags, the user is presented with a default set of visual options. This ensures, users are never presented with a blank slate, and always have a starting point.

3.1.4 Summary

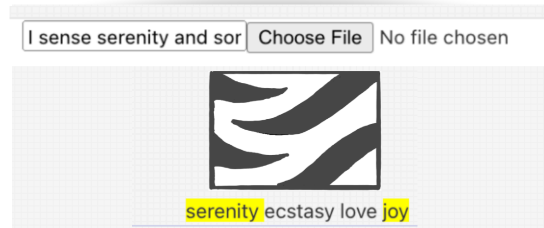
Overall, text-to-visual mappings are curated from previous user studies, focus groups, survey, and other literature. The mappings are utilised to support two features in *Textere*— text-based search and text tags. Text-based search splits input text into keywords and uses each keyword to iterate through text-to-visual mappings. When a keyword matches the text associated with a visual element, that visual element is retrieved. Text tags, are the text associated with each visual element in the text-to-visual mappings, and are displayed alongside the visual to provide diverse interpretations and word associations of the visual element to users.

3.2 Implementation

Textere is developed by extending the open-source AdaCAD environment which is hosted on GitHub, and uses the Angular framework, which is based on Javascript and CSS. To implement *Textere* we cloned the code repository to our local system and used the existing workflows of AdaCAD to add the text-based search and text tag features in

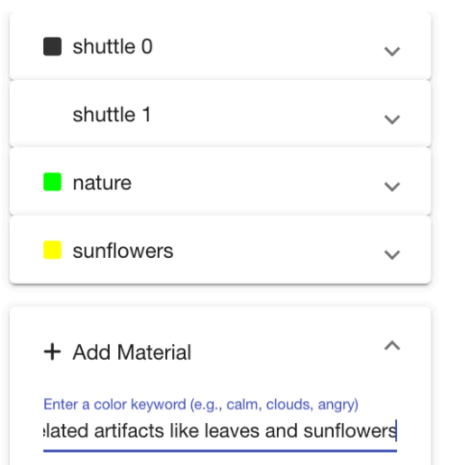


(i) Using text input from user, *Textere* displays matched patterns in decreasing order of matched keywords.

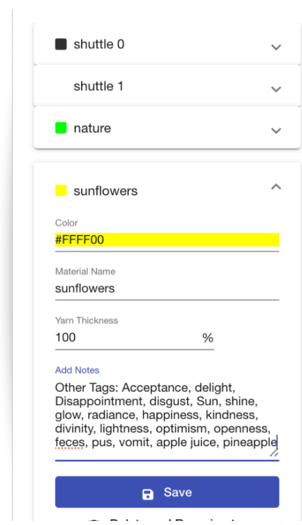


(ii)The matched text tags *serenity* and *joy are* highlighted,

Figure 3.5: Text support for patterns



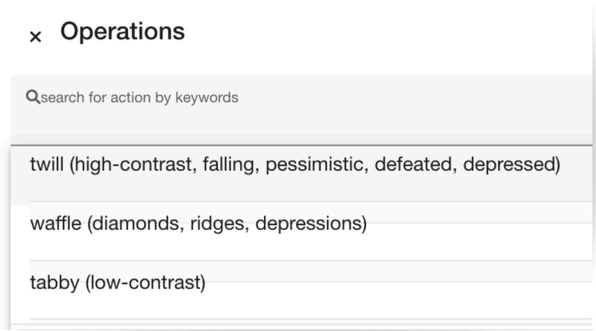
(i) Using text-input from user, *Textere* maps keyword *sunflower* to yellow



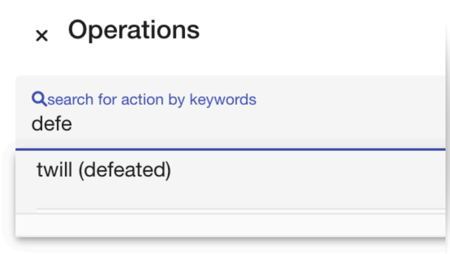
(ii) Clicking on yellow, reveals all text tags; the color is named after the matched keyword *sunflower*

Figure 3.6: Text support for color

appropriate places in the workflow. As the workflows in AdaCAD are different for pattern, color, and weave structure, the user interface and implementation vary between



(i) All weave structures with their text tags



(ii) Using text-input from user, *Textere* maps keyword *defeated* to a text tag in *twill* weave structure

Figure 3.7: Text support for weave structure

pattern, color, and weave structure. Nevertheless, the core concept and purpose of text-based search and text tags remain constant. Further, to enable these features to work, we added the text-to-pattern, text-to-color, and text-to-weave structure mappings to appropriate components in the code base.

3.2.1 Pattern

In AdaCAD, there are two ways to obtain a pattern— making it from scratch and importing an image. As our text-to-pattern mappings also contain images, we decided to add our text-based features, to AdaCAD's existing pattern image import feature. We developed a **pattern library** interface consisting of the text-based search bar and the set of patterns sourced from the text-to-pattern mappings. We integrated the text-to-pattern mappings to the AdaCAD code base by creating an array of objects, each with the pattern image and its corresponding text tags. For example,

```
[{
    filename: 'pattern1.png',          #pattern image
    tags: ['serenity', 'joy', ...],    #text tags
 },{
        filename: 'pattern2.png',      #pattern image
```

```
        tags: ['wave', 'cream', ...],     #text tags
} ...]
```

On entering user input into the search bar of the pattern library, the system splits it into keywords. For each keyword, *Textere* iterates through each pattern's text tags to see if any keywords match the text tags. The tool keeps track of a number of matched text tags and displays the search results in descending order of matched text tags. This means that patterns with maximum matched keywords appear first, followed by patterns with lesser matched keywords in decreasing order, followed by all other patterns in the library.

When the input text matches the text tag of a pattern, it is highlighted in the pattern library search results. For example, in Figure 3.5, consider that the first pattern (P1) is mapped to the words "*serenity, ecstasy, love, joy*" in the text-to-pattern mapping. These words are shown alongside P1 in the pattern library as its text tags. If a user inputs a text like "*I sense serenity and some joy*", which matches P1's text tags "*joy, serenity*", the matched text tags are highlighted. The highlight allows users to see which keywords from their input text matched the text tags, enabling them to build a connection between their input text and the visual element option (DG2). If users want to adjust their input text to explore alternative design directions or modify outcomes matched, they know which word to alter in the input text. In cases where there are no patterns with matched keywords, the patterns in the library are still visible to the user to pick a pattern based on personal preference, but without any highlighted text tags.

3.2.2 Color

In AdaCAD, color is added using the materials library, which we refer to as the **color library** in the thesis. In AdaCAD's existing workflow, users use a color picker to choose any color as per their preference, which is then added to the color library. Each color has editable attributes like a name, a notes section, and yarn properties. To add *Textere's* text features, we added a text-based search bar to the color picker module and integrated it into the text-to-color mapping. We created an array of objects with the name of the color and corresponding text tags. For example,

```
[{
   color: 'blue',                                #Color Name
   tags: ['surprise', 'calmness', ...]           #Text tags
 },{
```

```
        color: 'green',                          # Color Name
        tags: ['vegetation', 'nature', ...]  #Text tags
}, ...]
```

As the text-to-color mappings use the ”name” of the color, and not the exact hex or rgb value, while displaying the color to the user, the system converts the name of the color, for example, “*blue*” to its hex value “*#0000FF*” using the predefined color to hex mapping functions available in CSS.

On entering an input text, the system splits it into keywords. For every keyword, *Textere* iterates through text tags of each color, and on matching, adds the color to the color library. The color saved only acts as a starting point and its hue or shade can be modified if the user wants. The other set of tags for the color is also added to the ”notes” section of the color interface, providing multiple interpretations and word associations for the color (DG3). If the text does not match any color, the default color picker is still available (DG1) to the users to pick a color based on personal preference.

When the input text matches a text tag of a color, *Textere* saves the color with the name of the text tag that matched with the input text. For example, if the color yellow is associated with the words “*sunflower, delight, kindness....*”, (See Figure 3.6) and a user inputs text containing the word “*sunflower*”, yellow is saved with the name of the matched text tag—“*sunflow*er”. This helps the user trace the color back to the input text without relying on their memory (DG2).

3.2.3 Weave Structure

In AdaCAD, weave structures are available as part of a larger operations library. As we only use the weave structures in the library, we refer to it as the **weave structure library** in the thesis. The weave structure library already contains a search bar which functions based on the names of weave structures i.e. typing *twill* would find the twill weave structure. To add text features, we modified this search bar to work as a text-based search bar, meaning now users could enter any text and it would match text tags of the weave structure instead of the name of the weave structure. We integrated the text-based search bar to text-to-weave structure mapping. In AdaCAD, each weave structure (called operations in the AdaCAD database) is already implemented as an object with multiple attributes, hence we added text tags as an additional attribute. For example,

```
const waffle: Operation = {
```

```
    name: 'waffle',             #name of weave structure
    ...
    tags: ['diamonds', ...],    #text tags
}
```

When a user enters text, the system splits in into keywords. For each keyword, *Textere* iterates through text tags of different weave structures and as a user types, weave structures with matched text tags are shown in a drop-down menu. if the input text matches the text tags of a weave structure, the matched text tag is shown alongside the name of the weave structure (See Figure 3.7), so the user can trace the visual that is matched, back to the input text (DG2). If none of the tags match, the entire list of weave structures is shown with their set of tags (DG1).

Chapter 4

Evaluating Textere

In this chapter, we discuss the two evaluation methods we used to evaluate the opportunities, feasibility, and limitations of *Textere* — evaluation by demonstration and a user evaluation study.

4.1 Evaluation by Demonstration

To demonstrate and validate *Textere*, we used the evaluation-by-demonstration method [73]. We present a walk-through of three example scenarios, motivated by text-based scenarios that we identified (See Chapter 1) like theme-based weaving in guilds and commission-based weaving for clients. These scenarios highlight the opportunities that open up by using *Textere* for designing weave drafts using text-based inputs. We also show images of the corresponding physical woven outcome(s) for each walk-through scenario, which were produced by a professional weaver.

4.1.1 Scenario 1: Finding Inspiration for Pattern Designs and Weave Structure

The first scenario demonstrates how Deepa, a member of a weaving guild, uses *Textere* to get inspiration for her guild's theme-based monthly weaving challenge. As mentioned in Section 1, this scenario reflects theme weaving practice in the weaving community: designing based on word(s) or phrases like "*love*", "*vacation*", "*new beginnings*" and "*lovely lace and captivating containers*" provided by weaving guilds and magazines. Given the widespread use of theme-driven design challenges in both formal magazine publications and informal guild settings, this scenario offers a credible and relatable context for demonstrating *Textere* as a tool for weaving design. We chose text inputs similar to the previous open-ended themes used in weaving guilds and weaving magazines, both single word and a phrase, where weavers draw from personal experiences or interpret the theme to make design choices in patterns, colors, and weave structures. In our scenario, Deepa needs to weave two pieces for open-ended topics, first, for the topic "*youth*", and second, for the phrase "*Diamonds form only under pressure*".

For the first piece, she plans to use black and orange yarn, and practice a twill weave structure but is unsure which pattern can be used to represent an abstract concept like "youth", and hence turns to *Textere*. She searches *Textere's* pattern library using keywords like "youth", "joy", and "innocence". *Textere* shows her a series of black-and-white patterns and the text tags that matched keywords from the input text are highlighted as shown in Figure 4.1. As she adds more words, *Textere* sorts results in descending order of matched keywords. Deepa is drawn to one of the matched patterns, described with additional text tags like "gracefulness, innocence, youth," as these descriptions align well with her personal memories of youth. Thus, she chooses to incorporate that pattern in her design.

For the second piece, she has the sentence "*Diamonds form only under pressure*". She has chosen the color combination and pattern she wants to use, but is unsure which weave structure would help her design the outcome she wants. To represent the word "diamond", she wants to be able to create a 3-dimensional effect. *Textere* suggests the waffle weave (matches keyword *"diamond"*) for the sentence entered, as shown in Figure 4.2, and additional text tags ("ridges and depressions"). Knowing that the weave structure library uses the visual and physical characteristics of structures to classify them, she decides that waffle could be a good choice for her idea, and thus incorporates it.

In this scenario, for the first piece, the user was given a word and did not know how to convert it to a visual element (pattern). *Textere* served as a source of inspiration, allowing the weaver to explore options (rooted in literature) without relying solely on their knowledge or needing to conduct an open-ended search on the Internet. The longer list of text tags associated with each pattern also provided additional context for patterns and helped spark other ideas (for example, aligned with Deepa's personal experiences) to interpret the given text. For the second piece not only does *Textere* help Deepa explore meaning-based choices based on visual and physical characteristics of the weave structure, but also makes her more confident about explaining her work to her weaving group.

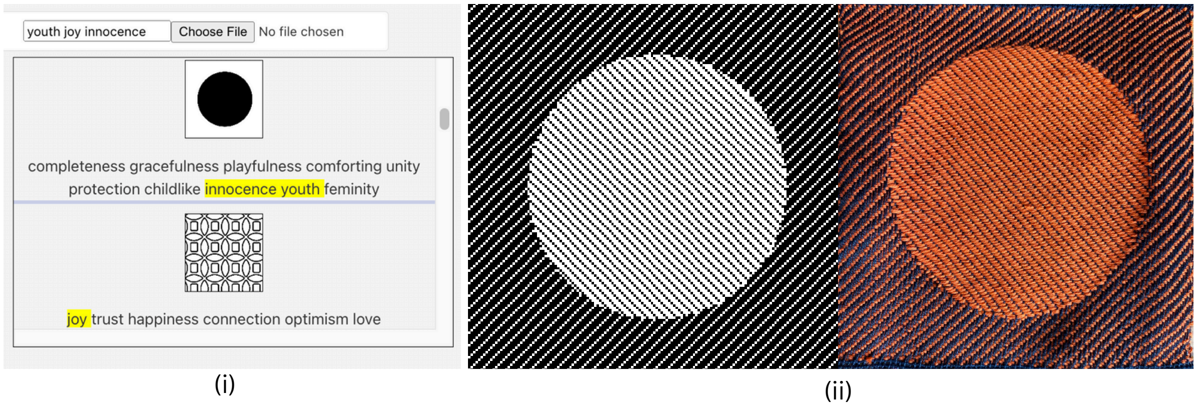


Figure 4.1: *Textere's* Pattern Library: (i) text tags matching users' text input are highlighted, (ii) weave draft designed, and final product woven

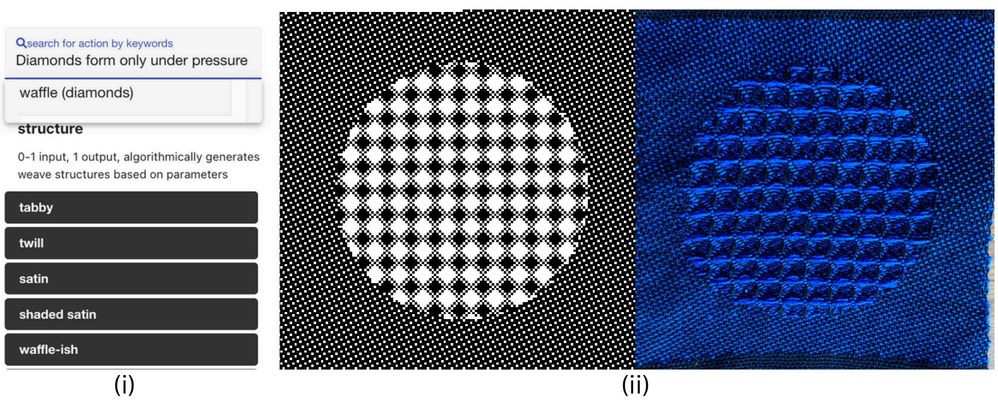


Figure 4.2: *Textere*'s Weave Structure Library: (i) as the user types, matching weave patterns shown through a dropdown interface; (ii) weave draft designed, and final product woven

4.1.2 Scenario 2: Exploring User Perspectives through Color Mapping

The second scenario showcases how Arnold, a commission weaver utilizes *Textere* to understand how color choices are interpreted by different people. In designing the second scenario for Textere, we aimed to reflect the real-world processes used by commission weavers when collecting design briefs and translating client inputs into visual elements, to strive to align our scenario to the typical challenges commission weavers might face when translating client feedback into visual representations. As discussed in Section 1, various independent weavers and studios use text-based interactions in the design process of making a custom piece for a client, where clients describe their desired outcome, and personal stories [25, 94, 87] and answer questions evoking emotions like "*how you want the design to make you feel*"[87]. Inspired by these examples, we developed a scenario where Arnold is asked to create a "happy" emotion for the design of a commission piece for a school lobby. While he personally associates "happy" to the greenery around him, he does not know how other people might interpret it. So he uses *Textere*, to view colors that might signify a "happy" tone to people as per user studies. Through the search process, Arnold does not find a direct match for the word happy, and thus expands his search string to include multiple words that might signify a happy emotion to people like "sun", "bright", "nature", and "blossom". After reviewing search results, associated text tags, and his personal preference, he realizes that while green may signify "happy" for him, it also carries connotations of grief. He thus decides that yellow is a more fitting "happy" color with a large number of positive text tags associated with it (Figure 4.3). In this scenario, the weaver knew what they wished to design, but as the target audience was not them, *Textere* helped them view how others might interpret their design decisions, allowing them to refine and adapt their choices.

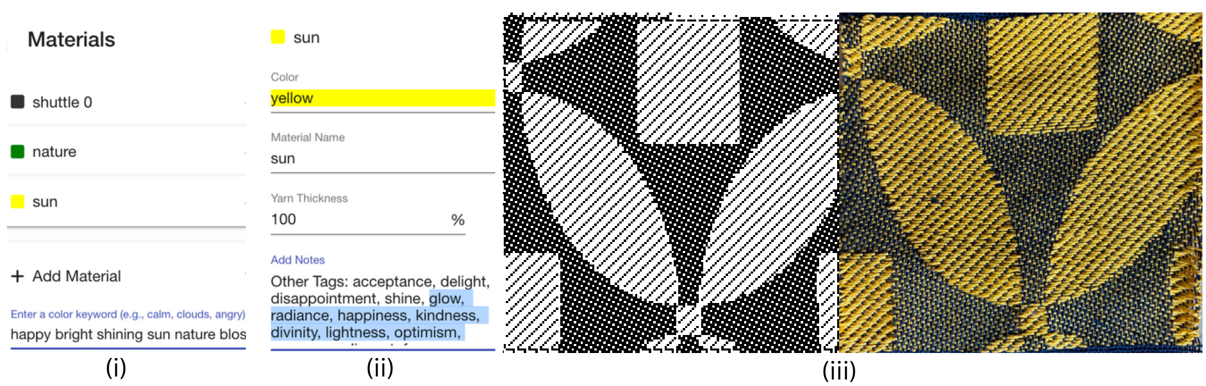
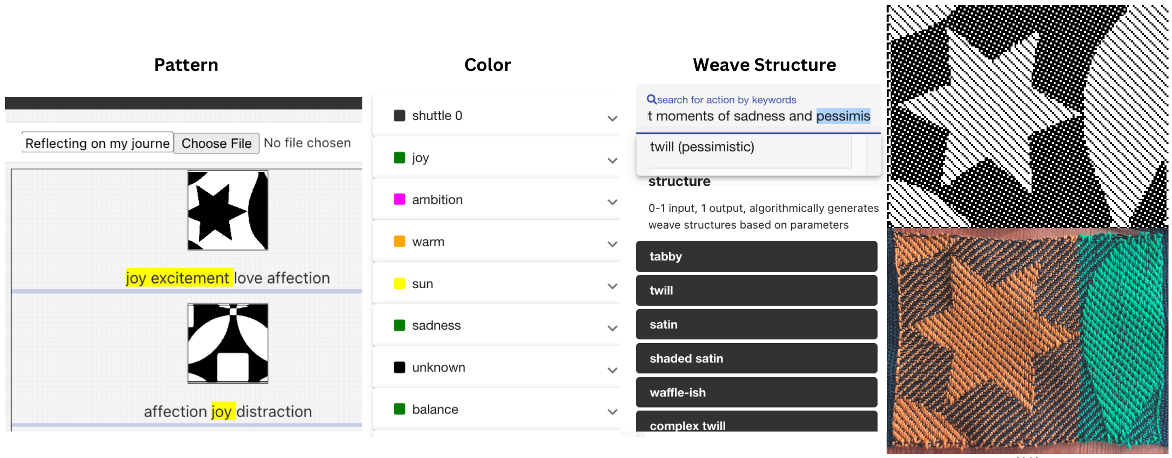


Figure 4.3: *Textere's* Color Library: (i) as user types, matched color are saved to library (ii) other text tags for a selected color are visible for the user to review, (iii) weave draft designed, and final product woven



(i) (ii)

Figure 4.4: Creating a weave draft using *Textere*: for a given input, viewing visual options for (i) pattern, color, and weave structure, (ii) weave draft designed, and final product woven

4.1.3 Scenario 3: Rapid Exploration

The third scenario is grounded in examples where weavers use descriptions of experiences and memorable moments to create a woven piece. For example, some weavers use memorabilia like a list of things the person likes, personality, or descriptions of memorable vacations to inform their designs. In commission work or personal projects too, weavers weave based on text inputs provided by clients describing photographs, outlining personal experiences [133], personality descriptions and likings [84], or narrating stories [25, 94, 87] to be represented in the weaving design. This scenario demonstrates how Olivia uses *Textere* for the rapid exploration of options while planning to design a woven piece for her friend. She decides to use a text message from her friend as her reference for creating the woven memorabilia piece:

> *"Reflecting on my journey, the hike was a mix of joy and excitement, driven by my ambition. The warm sun was comforting, but moments of sadness and pessimism also surfaced. I faced the challenge head-on, navigating through the unknown and finding balance. It was a true test of persistence, but reaching the summit was a rewarding feeling."*

To avoid needing to search for individual ideas on the Internet, Olivia uses *Textere* to engage in a rapid and more integrated exploration process (Figure 4.4). For pattern, *Textere* shows options linked to *"joy"* and *"excitement"*. Olivia selects a flower and leaf motif that matches the most words from the description and best reflects the description of her friend's hike. For color, Olivia chooses green for the leaves based on her personal preference. Based on *Textere's* suggestions, she picks orange for the flower and black for the background to symbolize the *"unknown"*. For weave structure, *Textere* matches *"pessimistic"* to twill. Olivia uses twill to represent the emotional lows of the hike.

In this scenario, *Textere* showed limited but relevant options for identifying ideas for color, pattern, and weave structure, helping the user to quickly explore and evaluate options without feeling overloaded by too many possibilities.

4.2 User Study

To validate the user scenarios in evaluation by demonstration and understand the kinds of opportunities and challenges text-based tools can introduce for weaving, we conducted a qualitative study with weavers. Our study was approved by our university ethics board. Each study session included a demonstration of the tool, followed by participants interacting with the tool to perform tasks, a post-study questionnaire, and semi-structured interview. We conducted two pilot studies to refine the study design and procedures before the main study. (See Appendix B)

Through our study, we aimed to answer the following questions:

1. In what scenarios do weavers currently use text inputs to choose visual elements like patterns, colors, and weave structures for their weave draft?
2. How do weavers interpret and map text-to-visual elements for designing weave drafts?
3. What are the key differences and similarities in weavers' approaches when using tools with and without explicit text-based support?
4. What opportunities do weavers see in text-based tools like *Textere*? What challenges do they face or anticipate in converting text into visual elements?

4.2.1 Study Setup

In our evaluation, we showed participants two tools *Textere* and AdaCAD. As AdaCAD was the tool that we extended, showing participants both these tools was useful as it would help participants better reflect upon the differences between using a tool that offers explicit text-based support for design versus one that functions without such support. Pragmatically too, it made sense for us to explain and show AdaCAD as *Textere* is built upon that environment.

We conducted the study remotely via Zoom (See Figure 4.5), and invited participants to interact with both the tools using their browser and sharing screen. Having a remote setup enabled us to involve a more diverse set of weavers from different weaving guilds across Canada. To make working with these tools easy, we set up an initial workspace for both tools which included task instructions, which the participants imported. To remove any potential bias due to the learning effect, the order of interaction was counterbalanced — half of the participants started with AdaCAD, while the other half began with *Textere*. For both tools, participants were provided with an overview of their functionalities. For AdaCAD, this involved showing how to design weave drafts using two methods for pattern — (a) making from scratch with direct manipulation of pixels or shapes, or (b) importing images from the Internet. Using the color picker feature for choosing colors, and selecting a weave structure from the available options within the tool was common for both options (a) and (b). For *Textere*, participants were introduced to how text-based inputs could be used to get potential options for patterns, colors, and weave structures. They used the text-based search feature within the tool to input text and obtained visual options for patterns, color, and weave structure, alongside their text tags (See Chapter 3).

4.2.2 Study Tasks

For both the tools, each participant performed two tasks. In **task 1**, participants were provided with 3 words and asked to select a pattern, color, and weave structure for each word respectively - *fence* to select a pattern, *kindness or calmness* to select a color, and *high contrast* to select a weave structure. Task 1 included words based on the available mappings, but also covered different types of words like objects, emotions, and descriptive words to cover various types of text inputs that weavers might experience. The input words represented weaving scenarios like theme-based weaving in guilds where a word or the phrase is provided without much context.

In **task 2**, participants were provided with a piece of text consisting of 2 sentences and asked to obtain a pattern, color, and weave structure to put together a weave draft that represents the piece of text. The sentences— "*The warm sun brought happiness to everyone outside. Love felt like a cozy fire, radiating heat and joy in their hearts.*"

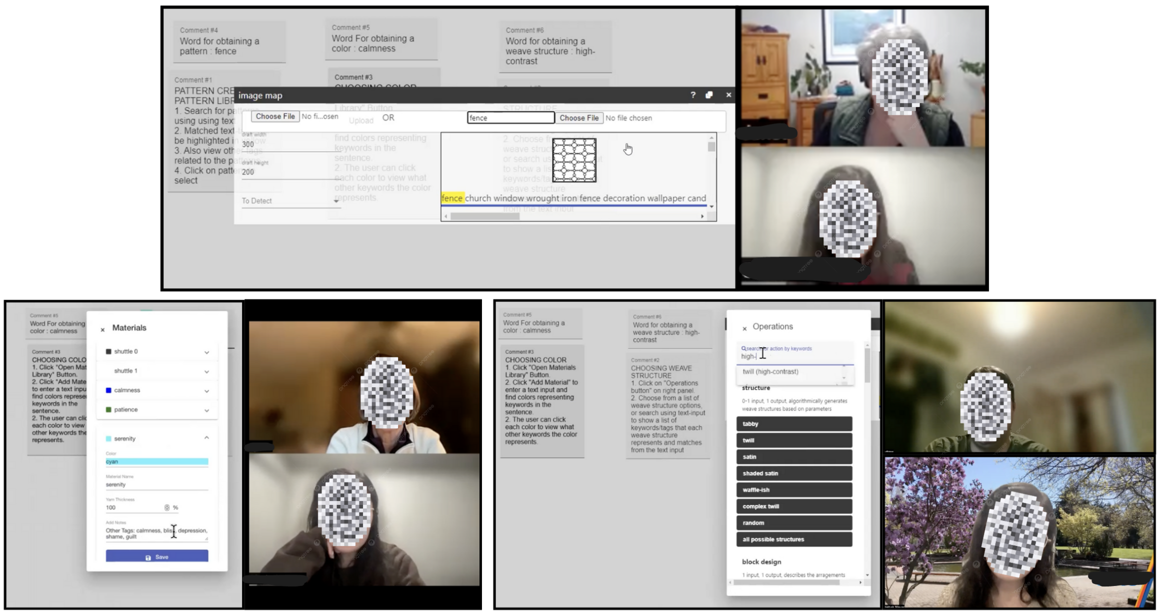


Figure 4.5: User evaluation study

represented a text input like a journal entry or story description provided by a client and consisted of a variety of words from the text-to-visual mappings like emotive words, concrete and abstract nouns, and descriptors.

Each task lasted 10 minutes, during which participants were encouraged to think aloud, and could ask for assistance if needed. Both tasks involved searching, iteration, and narrowing down to a final set of one or more visual elements. In both tasks and tools, the participants were free to use the given text as is to explore visual elements or create new search strings that built upon the given input text and were reminded of this if they were stuck. This was done to create a more realistic environment for weavers where they would not be restricted about what they can or cannot search for. We audio and video recorded the interaction sessions for posterior data analysis.

4.2.3 Data Sources and Analysis

In addition to using both the tools, participants completed a pre-study questionnaire (See Appendix A), consisting of questions about demographics, and previous experience with weaving preference of express ideas using different mediums. They also filled a post-study questionnaire (See Appendix A) to evaluate their experiences while mapping text to visual elements. A follow-up semi-structured interview (See Appendix A) was conducted to gather detailed feedback on participants' experiences. Interview questions addressed the overall experience of using text to explore visual elements, previous use cases of using text-based inputs for design in weaving, helpful features and challenges from interaction with *Textere*, and suggestions for improving the tool. From the interviews and system interactions, we gathered about 15 hours of data, which we transcribed and analyzed using thematic coding [11]. Initially, two researchers independently open-coded one transcript and then discussed their codes to discuss and resolve any disagreements in the identified codes. Then one researcher iteratively coded the remaining transcripts, and the resulting codebook was discussed by the two researchers. Our analysis identified 43 codes related to *Textere* or text-based design processes in general, such as "Getting started", 'Brainstorming" and "Text-to-visual mappings are subjective"'. These codes were then categorized into 9 broader themes, such as "Thoughts on text-to-visual" and "Potential considerations" through iterative discussion between the two researchers.

4.2.4 Participants

We advertised our study to several weaving guilds using their publicly available contacts. We recruited 12 participants (10 women, 1 man, 1 queer) from these weaving guilds on a first-come-first-serve basis. Participants were compensated with $20 for their time. We had 3 participants who were between 35 to 44 years, 5 between 55 to 64 years, 2 between 65 to 74 years, and 2 were over 75 years. From our pre-study questionnaire, we learned that of the twelve participants, eight practiced weaving regularly, three were occasional hobbyists and one was a professional weaver. Five participants had over twenty years of experience, one had at least 11 years of experience, five had at least 4 years of experience, and one participant had at least 1 year of experience. Ten participants identified as intermediate weavers, one as a beginner, and one as an expert. All participants had used manual looms, with one also having experience with automatic looms. To design weave drafts, participants used one or more methods — seven used pre-made drafts, seven used software, and four used manual methods like grid paper. Figure 4.6 summarizes previous experiences of how participants felt about expressing their ideas using color palettes, shapes, symbols, images, and text.

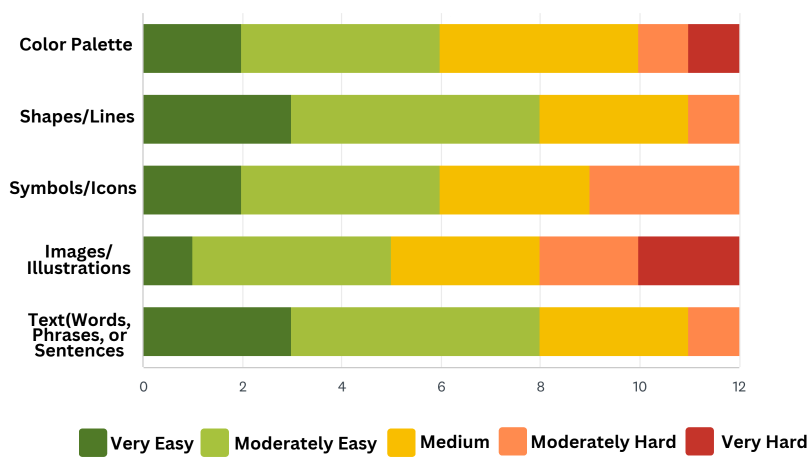


Figure 4.6: Previous experiences of expressing ideas using color palettes, shapes, symbols, images, and text

4.2.5 Results

4.2.5.1 Current Usage of Text-Based Inputs for Designing Weave Draft Elements

Participants in our study shared a variety of scenarios where they currently use text-based inputs to generate aspects of a weave draft. Five participants mentioned being part of challenges in study groups, weaving groups, and guilds where weavers were given text-based monthly themes to visualize in their weaving. For example, P7 mentioned interpreting the theme “home” as “eggs on toast”, using a square pattern, orange color yarn, and overshot (a twill-based weaving structure). Similarly, P2 recalled using the words “gothic” and “renaissance architecture” to come up with pattern, color, and weave structure using Mercerized cotton. Additionally, three participants mentioned instances of creating commission pieces and gifts based on text-based inputs. For example, P9 wove a piece for a customer who provided a personality description of a loved one, and P7 recalled weaving a table runner with her children’s names and using icy blue colors and twill weave to design a dress for a “winter” theme. P6 also described weaving techniques where text-based input is used and shared how weavers they knew assigned letters to shafts or pedals, converted words into Morse code or signals, or interpreted words like “Love” into specific weave structures or colors. The variety of scenarios shared by participants underscores the prevalence of text-to-visual weaving in the current workflow, and shows support for the type of scenarios we envisioned *Textere* could be used for (see 4.1).

4.2.5.2 Mapping Text to Pattern

Participants used both tools, AdaCAD and *Textere*, to map a given text input to patterns for their weave drafts. For single word text input “fence”, in AdaCAD, a majority of the participants (10 of 12) preferred to import an existing pattern from the Internet, over creating the pattern from scratch (2 of 12). For sentence-based input, in AdaCAD, 6 of 12 participants preferred making the pattern themselves, and either created the pattern from scratch (4 of 6) or described what they wanted to make (2 of 6). Further, 4 of 12 wanted to import a pattern image from the Internet, of which only 1 found an image to import, while the others described what they would look for but did not find an image to import. Two participants could not complete task 2 due to lack of time or technical difficulties.

Participants who opted to make a pattern from scratch for the given text input in AdaCAD, shared insights about what they wished to create. P7 expressed her overall pattern idea of a picture of a "*sun coming up out of the Horizon*". P4 talked about the different types of fences she could think of *picket fence*, *chain link*, and chose to make a chain link fence calling it more *tileable* than a picket fence which is more of a *border* element. P10 explained, "*I'd want to do a campfire right in the middle of the draft*". The entire process of ideation, considering options, and narrowing to a pattern was done verbally, followed by drawing out their intended pattern.

In *Textere*, for single word input "*fence*", 9 participants selected an image from the tool's suggestion, 2 were unsure if they wanted to use an image from the suggestions, and 1 did not complete task 1 due to technical difficulties. For sentence-based input, 9 selected an image from the tool's suggestion, and the remaining did not finalize a pattern. The patterns selected by the participants for a given input, "fence", are summarized in Figure 4.7. Comparing the participants' outcomes with each other, more variation of patterns was seen in AdaCAD than in *Textere* as can be seen from Figure 4.7.

We focus the remainder of this section on how people searched for patterns on the Internet to import into AdaCAD, and used the pattern library in *Textere*. We do not include the results related to the "making from scratch" feature in AdaCAD, as we view that as an entirely different type of operation, and one that does not have a corresponding feature in the current implementation of *Textere*. However, we do believe it is an important option, given our participant's enthusiasm for using it, and consider it to be part of the ecosystem of tools that can be available to weavers (See Chapter 5).

To search for patterns, the general workflow participants followed in both tools was similar and included the following steps: receiving input text, generating a search string, obtaining search results, and narrowing down to one pattern option. In both *Textere* and AdaCAD, participants entered multiple search strings to find patterns for the given input text, but their approaches were different. Figure 4.8 shows an example of the search strings used by the participants to find a pattern for the input "fence". In *Textere*, 11 out of 12 participants used the provided input text for their search, of which 6 used additional words to find their pattern. In AdaCAD, the more common approach was modifying the given text by adding words that provided more context e.g., "image of", "fancy", or described styles and sources e.g., "clipart", and "google images" or adding descriptors like "fancy", "gate" or "chain link".

Through participant's thinking aloud, we learned that in *Textere*, at least three participants were trying to find patterns that mapped the visual attributes of the object

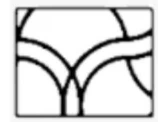
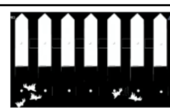
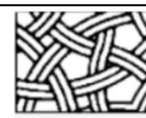
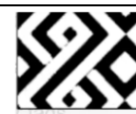
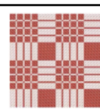
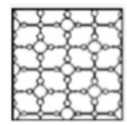
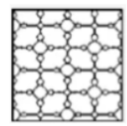
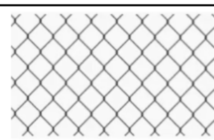
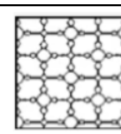
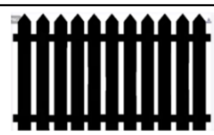
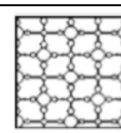
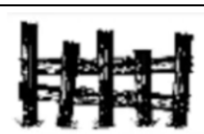
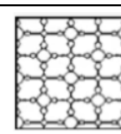
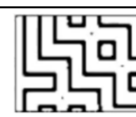
Participant	ADACAD	TEXTERE
P1		Couldn't perform pattern mapping due to technical issues with her screen and mouse
P2		
P3		
P4	Made pattern from scratch 	
P5	 or  or 	
P6		
P7		
P8		Explained vision but did not select pattern
P9		
P10		
P11		
P12	Wanted to make from scratch but did not make the pattern	Searched but did not select pattern

Figure 4.7: The final patterns selected or created for the word *fence* in AdaCAD and *Textere*.

being described by the input text. For example, P8 shared she was looking for *“vertical bars if it is a picket fence, horizontal bars if it is a split rail fence, checkered if it is a deer fence, diamonds if it is a chain link fence*”. Similarly, P6 said, *“A grid or vertical lines for a fence, and then I would like pattern library to prompt me for other shapes etc*”. For AdaCAD, none of the participants shared any insights about the types of patterns they were looking for on the Internet before beginning their search.

Input Text = fence	
ADaCAD	**Textere**
P1 *fence image*	**P1<*Technical Issues*>**
P2 *Fence drawing, gate*	**P2** *fence, calm, serenity;*
P3 clipart images**,** *fence, google images fence*	**P3** *fence,*
P4 ***opted for ``make from scratch”***	**P4** *fence;*
P5 *fence*	**P5** *balance, structure, fence;*
P6 *fence gate*	**P6** *fence, wrought iron fence,*
P7 *chain link fence*	**P7** *fence, wall;*
P8 *fence*	**P8** *fence, joy,*
P9 *Image of fence;*	**P9** *fence;*
P10 *Images of fences free;clipart*	**P10** *fence*
P11 *fence, fence png, fancy fence*	**P11** *fence, isolate, uncertain,*
P12 ***opted for ``make from scratch”***	**P12** *fence*

Figure 4.8: Search strings for the given input text *fence*.

When narrowing down their selection process, in both AdaCAD and *Textere*, participants scrolled through search results using visual appeal and personal preferences to match patterns to the input text or search string. Additionally, in *Textere*, participants also considered the suggestions from the tool’s text tags feature to narrow down their choices and select the final pattern image. Participants either selected a pattern that matched keywords from their input text (e.g., P2 selected a pattern because its text tag *“excitement*” aligned with their vision of the keyword *“radiating heat*” from the input text) or eliminated some choices based on the text tags (e.g., P7 eliminated patterns that contained negative text tags such as *“rage, grief, disturbance, uncertainty*’ as it didn’t align with their design intent). Some participants, P4 and P5, said that the association between the text tags and images did not match what they had in mind and so selected patterns based on personal choice. As to be expected with producing a draft, participants mentioned other factors they considered while choosing a pattern, including the feasibility of weaving that pattern using the loom they have. For example, P4 mentioned that her interpretation of words had less to do with patterns and more to do with the process of weaving. Although *Textere* does not currently offer direct support for checking the feasibility of production, and assumes that the weavers would have the relevant knowledge, incorporating such considerations is key to having a useful system (see Discussion section).

4.2.5.3 Mapping Text to Color

While mapping text to colors, participants had to pick a color(s) from the color picker tool, without the assistance of text tagging in AdaCAD, and with that assistance in *Textere*. The color(s) selected by the participants for inputs such as, *"kindness"* in AdaCAD, and *"calmness"* in *Textere*, are summarized in Figure 4.9. For a single word, all participants picked a color in AdaCAD, and 11 of 12 participants picked a color using *Textere*. One participant did not complete the task in *Textere* due to technical issues with their computer. For sentences, in AdaCAD, 5 chose a color, and 7 explained what they wanted but did not pick a color from the picker. In *Textere*, 11 participants picked a color from the suggestions, and 1 did not select a color.

In AdaCAD, for a given input, we saw more diversity in the colors chosen as participants had full freedom in how they interpreted the given input. Six participants instantaneously knew what color they wanted and chose green (P1), yellow (P3, P7, P9, P12), and pink (P6) to represent "kindness". Whereas others, mentioned their intended color choice using attributes such as *softer, paler, gentler, too medical*, or using hues, such as *pinky range, and blue-ish purples*.

In contrast, in *Textere*, we saw similar colors being picked by participants for a given input. This was largely driven by participants selecting colors based on the tool's suggestion. To find the colors, participants would either use the given text (e.g., calmness), use modified text (e.g., *calmness* of the sea after a storm (P5)) to find additional colors, and or use alternate text (e.g., peace, serenity (P9)) to find more colors. Through the search process, eight participants engaged critically with the text tags, expressing surprise or questioning the appropriateness of some tags, while eventually agreeing with some of the tags, and picking those colors. Six participants selected a suggested color, but also adjusted the hue and saturation to match their preference or to align better with input text.

In both tools, participants mentioned other factors they considered while choosing a color. These included color theory and consideration of the pattern or weave structure chosen. For example, P5, P2, and P8 added complementary or analogous colors

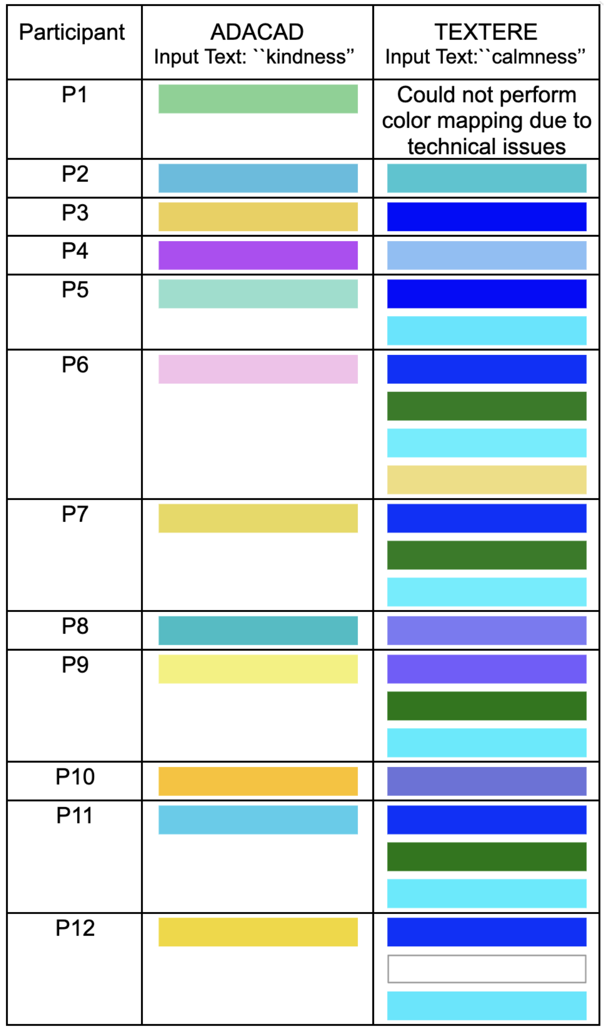


Figure 4.9: Colors selected for the input word *kindness* in AdaCAD, and *calmness* in *Textere*.

to ensure visual clarity in the final draft, and P2 and P11 mentioned considering the placement of colors or the amount of a color to be used before making a decision, while P6, P7, P9, P11, considered the pattern or weave structure previously chosen.

4.2.5.4 Mapping Text to Weave Structure

In AdaCAD participants searched through the available weave structure options to choose one for the given input text, while in *Textere*, participants used the search feature to obtain suggestions and then selected one. For single word inputs, in AdaCAD, 11 participants picked a weave structure from the available list. One participant did not think it made sense to pick a weave structure separately from the pattern, and so did not select any options. In *Textere*, 8 participants picked a weave structure, 2 discussed the suggested options but did not pick one, 1 person found the database very limiting, and 1 had technical difficulties and did not complete the sub-task. For sentence input, in AdaCAD, 4 selected a pattern from the list, 1 explained their vision, but did not select a weave structure, and 7 did not complete the sub-task due to lack of time. In *Textere,* 3 participants selected a weave structure based on the suggestions, 5 described what they wanted but did not select a structure due to various reasons (database was limited, did not want to choose weave structure independently from other visual elements), and 4 did not complete this sub-task because of limited time. Figure 4.10 shows a summary of weave structures chosen by the 12 participants for the input, "*high contrast*" in AdaCAD and *Textere*.

Similar to the other mappings described previously, in AdaCAD, participants approached the process of selecting weave structures based on instinct, and personal preference. In *Textere*, participants looked at the suggestions by the tool, and while some accepted the suggestions, others modified or overrode the suggestion based on personal preferences or specific needs.

Participant	ADACAD	TEXTERE
P1	Twill	Could not perform weave structure mapping due to technical issues
P2	Shaded satin	Explained ideas but did not select one
P3	Satin	Twill
P4	Waffle-ish	Twill
P5	Did not think task made sense	Twill
P6	All possible structures	Twill
P7	Twill	Did not attempt due to limited database
P8	Twill	Explained ideas but did not select one
P9	Tabby	Waffle
P10	Twill	Twill
P11	Tabby	Twill
P12	Rose Path	Searched but did not select one

Figure 4.10: Weave structures selected for the input *high contrast* in AdaCAD and *Textere*.

In AdaCAD, participants either instinctively chose a weave structure from the list (e.g., P1 chose twill and P3 chose satin), or iterated through the available weave structures before choosing one based on personal preference (e.g., P4 clicked on different weave structures and changed its properties) or based on the patterns they had chosen previously (e.g., P4 finalized a waffle pattern as it complemented her chain link fence pattern). P2 considered using input text for the other visual elements, like color, and pattern, only, but did not want to use the text input for finding a weave structure. P8 expressed wanting a weave structure that would help her implement her chosen circle pattern and could not find that from the tool.

In *Textere*, participants used a combination of direct text, modified text, and alternate text to find a weave structure. Participants found the text tags useful for their search. For example, P3 went through text tags and agreed with some such as "high contrast" and "falling" for twill, but were surprised by tags like "pessimistic," "defeated," or "depressed," noting that twill represented their "happy place". Six participants chose the suggested weave structure, based on the text tags that matched their input, and wanted to sometimes make minor adjustments (e.g., to refine properties (P10) or to find a specific type of structure like twill broken and turn (P4, P8)). Two participants ignored the suggestion from the tool, and selected another structure (e.g., P5 sought a structure to replicate sushi-like movements in his pattern). When for a given input *Textere* was unable to suggest a matching result, participants like P2, P3, and P6 found text tags useful to iterate upon the available options.

Other considerations in choosing a weave structure included more practical factors like the type of loom or weaving (P4, P5, P8, P11), yarn thickness or fabric drape (P3, P8, P12), weavers' skill level with a particular weave structure (P2, P3, P6, P7, P8), and the final product they wished to create (P2, P4, P12).

4.2.5.5 Opportunities, Challenges, and Suggestions for *Textere*

From our study, we also gathered feedback about potential opportunities, challenges, and suggestions for improving *Textere*. Nine out of twelve participants said they would be extremely (6) or mostly (3) willing to use a text-based approach like in *Textere*, to convert a textual idea to a visual weaving draft.

Opportunities: Overall, 8 out of 12 participants found the concept of using text to obtain visual elements for weaving drafts mostly (7) or completely (1) *practical*, and 8 out of 12 participants found it mostly (1) or completely (8) *appealing*. Participants described the text-to-visual process as *"interesting"* (P7, P2, P11), *"intriguing"* (P11), *"novel"* (P9), *"useful"* (P1), and *"practical"* (P6). Six participants (P1, P2, P5, P9, P11, P12) highlighted their liking of text-to-color mappings, agreeing that text associations exist for color in emotions and cultural festivals, thus stating that it made *"sense"* (P11, P12), or could serve as a *"launching pad"* (P11). Three participants appreciated the text-to-pattern search, stating that it made sense (P5), would be beneficial for finding simple repetitive motifs or seasonal ideas (P8), and that it provided good variety and selection (P11). For weave structure, three participants found that if weave structure could be integrated into the pattern or color results, it would be more meaningful. Independently, text-to-weave structure was considered challenging, with P5 stating that it *"does not lend itself well to adjective like words"*, because a weave structure is typically a mathematical operation and co-dependent on other elements like equipment available, color, and pattern.

Participants identified several scenarios where *Textere* could be particularly useful. For example, in weaving groups and guilds, P1 noted that *Textere* could help generate ideas for open-ended themes like *"prairie"*. Two participants saw *Textere's* potential in commission work by helping interpret a piece of poetry or photograph descriptions (P7) and design *"concept drawings or concept proposals"* (P9). For personal projects, P12 highlighted that *Textere* could convert descriptions of memories or journal entries to bridge the gap between text descriptions and visual representations. P5 and P7 also mentioned that *Textere* could help in creating thoughtful gifts by providing starting points for color palettes and patterns based on personality descriptions.

Participants also envisioned that *Textere* could be useful to accomplish specific goals such as generating and broadening ideas. 9 of 12 participants agreed (7) or strongly agreed (2) that the use of text as a starting point for idea generation or expression made it easier for them to articulate weave draft ideas. For example, 8 participants (P1, P2, P5, P6, P7, P8, P11, P12) found *Textere* useful as a starting point stating that it helps with the *"creative side of things"* (P1), acts as the *"starting point for creativity"* (P5), or could *"unleash creativity"* (P7). P2 noted that it *"gives you something to start with"* when facing a blank canvas as a beginner weaver. Further, six participants (P1, P2, P4, P6, P7) highlighted *Textere's* potential for broadening ideas, iterative thinking, and modifying existing projects. P1 saw potential of *Textere* in broadening ideas, mentioning how you could *"play around to see if you could come up with something that you might not come up with on your own"*, while P2 appreciated how *Textere* could use a *"text sentence as a trigger"* to present a range of visual options, and *"expand on it as much as you want"*. P6 valued how *Textere* helps with iterative thinking of *"what's next"*, enhancing the brainstorming process by prompting new directions. Giving an example of how *Textere* could help in a current project, P11 expressed how she could start with words that describe her current colors and then add words that are similar to change it to a new palette.

Eight participants (P1, P2, P5, P6, P8, P9, P10, P11) found value in *Textere* for gaining new perspectives and insights. P1 appreciated the tool for offering a fresh perspective: *"It's interesting to see what other people might associate with those words."* P2 was surprised by the range of connotations for colors, *"I didn't realize that there were so many connotations for one color"'*. P8 mentioned how *Textere's* suggestions made her reflect: *"I guess the words make me think... why did that person think this (pattern) was Joy?"* P9 found it useful for understanding cultural appropriateness in commission work, such as selecting colors for Chinese New Year or other significant events. P10 and P11 highlighted the importance of grasping others' perceptions to effectively convey emotions or ensure satisfaction with their designs, especially in woven pieces made intended for another person or as a gift or in commission. By gaining new insights about visual elements, 9 of 12 participants found *Textere*'s text-based search and text tags moderately (3) or extremely (6) useful for choosing element options closer to their intended vision.

Seven participants (P1, P2, P6, P7, P8, P10, P11) found *Textere* to be a useful addition to the existing ecosystem of tools (*"another tool in the toolbox."* (P2)). P1 and P6 appreciated *Textere's* integration of text prompts with AdaCAD's drawing capabilities, and said, *"combining the two would be perfect for me... really super useful..I would definitely use something like that"* (P6), and that *Textere* could be a starting point for shapes or patterns, facilitating easier image handling before moving on to options like importing or drawing (P1). P10 called the integration *"amazing"* for visualizing designs: *"Loading in my colors...attaching some words...or upload an image...all kinds of things you could do that way...could be very useful"*.

In the post-study questionnaire, 8 out of 12 participants found efficiency to be an important factor that would motivate their use of *Textere*. Two participants (P5, P10) noted that *Textere* could significantly enhance efficiency, convenience, and ease in their design processes. P5 highlighted that going through the vast number of existing weave drafts available online can be difficult and *Textere* could simplify the search by narrowing down options, thus making the process less daunting and more manageable. This efficiency also extends to speeding up the design process, as P5 mentioned that *Textere* could accelerate overall workflow by filtering through potential designs more quickly. P10 emphasized how *Textere* could help in focusing and streamlining ideas, reducing the overwhelm of numerous concepts and aiding in maintaining discipline to complete projects.

Lastly, two participants (P7, P10) also recognized *Textere's* potential beyond weaving, suggesting its applicability across various design domains. P7 envisioned the tool's utility for needlepoint and embroidery designs, while P10 saw potential for *Textere* in her jewelry design, specifically in wire work and silver smithing, saying that it would help *"come up with something of my own"*.

Challenges and Suggestions: Participants had some reservations about the tool and it's underlying concepts. Six participants (P3, P4, P6, P7, P11, P12) mentioned that text inputs were not in line with their usual thought process. Out of these participants, five said that they could see that it would work if they think about it, and were open to exploring the idea (e.g., P12 said, *"I haven't used words. But as I said, I could think about it and I can, I can understand it."*). One participant (P3) found the concept quite challenging and unfamiliar, as it diverged significantly from their usual approach to weaving (*"It's kind of opposite to any way I've thought about this before, so. I'm not sure [...] I found this pretty difficult."* (P3)). Another consideration mentioned by three participants (P1, P6, P9) was the dependence on language proficiency to use a text-based system, and coming up with alternative prompts.

Participants also gave many suggestions for improvement. Rather than needing to come up with a user-defined text input for outputs like color, four participants (P3, P8, P10, P9) suggested the option to upload or input existing stain or yarn colors to obtain words or descriptors associated with them. Two participants suggested features for personalizing and customizing the tool. For instance, P8 and P11 suggested the ability to add or delete tags and upload new images to keep them as part of a personal library. Additionally, P9 proposed adding a feature to assign letters or numbers to colors, to facilitate the quick creation of personal tartans or patterns based on text. To enhance the process of incorporating text into the process of designing weave drafts, P4 suggested interpreting text into the process of weaving in addition to visual elements. For example for the word *uncertainty*, assigning random numbers to yarn color causes uncertainty in the design obtained. P4 also expressed interest in incorporating shadow weaving-based patterns in the pattern library, and P7 proposed creating a decision tree for generating more nuanced creative statements by starting with a single word, getting users to expand it into phrases and sentences, and building towards a complete idea, to cater to varying levels of comfort with creativity and generating visual elements at each stage.

Six participants highlighted the importance of trust and quality in the text tags, P8 mentioning that *"effectiveness of the tool depends on the quality and trustworthiness of the words used"*. Providing suggestions that tools can include credible sources for text tags, including mentioning if they come from experts (P8), a large, cross-cultural sample (P5), information from paint manufacturers such as descriptive names for colors, and art critics' descriptions (P7). To make the text-to-visual associations more transparent, P10 suggested displaying the percentage of people who associate a color with specific meanings and filtering out less common associations. P2 suggested using word bubbles to visually represent the prominence of different elements within a sentence, highlighting which words or themes have more potential of having text-to-visual associations, based on frequency or relevance.

Chapter 5

Discussion and Future Work

In this chapter, we discuss the key insights and opportunities uncovered, highlighting how text-based design tools can support the weaving design process. We also discuss implications for future design of technologies. While some findings from our evaluation were specific to weaving, others had broader implications for the use of text-based tools in design. Lastly, we acknowledge the limitations of our work and how addressing them can open new possibilities for exploring text-based design tools in weaving.

5.1 Complex Relationship of Visual Elements in Weaving

Inspired by text-based design tools thar allow users to control specific parts of the overall visual outcome [21, 112], *Textere* enabled users to design a weave draft using three distinct workflows for mapping text inputs to pattern, color, and weave structure. Results from our user study provided insights into the correlation between different visual elements and the role it plays in design decisions for weaving. This was evident from repeated references to previously chosen visual elements by 9 out of 12 participants, considering the pattern (P4, P5, P8, P9, P12) and color (P3, P5, P7, P8) while picking a weave structure, and considering colors chosen while looking for patterns (P2, P6, P7, P8, P9, P11). As a first step towards text-based design in weaving, *Textere* supported independent search workflows, but more thought needs to be given to support aspects of correlation in the mapping process. Participants suggested options like having a common text-based search to show all three visual element options side by side and compare outcomes in all three for the same input text. Another suggestion involved being able to view visual options in the form of combinations of visual elements, for example, pattern and color, pattern and weave structure. Leveraging such features, future text-based design tools for weaving can also explore the opportunities of using text to support more complex weave designs that involve a closer interplay of multiple visual elements, like color-and-weave [129].

On the contrary, some participants like P7 appreciated having pattern and color search separately to ensure their pattern choices were unbiased. This was important to her as from previous experience, having color in pattern options impacted the clarity of the pattern. The choice of color used in the pattern option would either enhance the pattern or *muddy* it, making it harder to identify motifs and elements in the pattern. She also recalled making biased decisions by skipping over patterns if she didn't like its color. P7's preference also aligns with weavers in previous studies who also prefer black and white patterns to choose from [45]. Moreover, despite the correlation between elements, participants had different approaches to search and finalize pattern, color, and weave structure. Participants chose patterns based on visual properties like shapes and visual structure, colors instinctively, or based on mood and emotion, and considered functional or tactile properties to choose a weave structure.

These contradicting observations and feedback highlight how intertwined weaving elements are, yet they might benefit from the personalized workflow in some cases. This raises questions about how text-based design tools can better support this complex relationship. In future iterations, the trade-offs between distinct and integrated workflows to obtain visual elements using text can be explored. This balance would be valuable to weavers as they navigate the complexities of decision-making for designing a weave draft. Such considerations about correlated visual elements can also be utilized in the broader research on design tools supporting tangible crafts like knitting and crocheting [62, 113, 61] which also create designs through an interplay of pattern and color.

5.2 Working with Existing Weaving Resources

Our study results revealed that many weavers begin weaving projects using resources they already own. For example, four participants mentioned using the existing color of the yarn they own, due to the convenience of using a yarn pre-loaded onto the loom and the expenses of buying new yarn. This could have implications on how text-based mapping for colors works in designing weave drafts. *Textere*'s broad color categories like "red" instead of specific shades of red, worked well in these cases, and weavers were given a general direction, but were free to choose the exact shade of color. However, this raises questions about what the appropriate level of detail for color mappings is for text-based design tools in weaving— overly specific shade mappings could become impractical. An approach that retains the meaning of text while offering flexible color choices could better serve weavers. For example, showing how the variation in the shade of a color impacts its perceived meanings and interpretations can help them decide between using what they have vs acquiring new yarn. Another suggestion offered by participants to work better with existing elements was adding features to input their existing colors or patterns in *Textere* to understand diverse perspectives on those elements as well. This would help them assess if their chosen visuals in *Textere* align with their current resources. Moreover, participants considered the existing loom they own, or the type of weaving they prefer (e.g., loom weaving or tapestry weaving), and their current skill level while choosing weave structure., which can be incorporated as feasibility filters in the next iterations of *Textere*. These approaches of including existing weaving resources and skills weavers currently have, with new elements they choose using *Textere* and providing diverse perspectives on both, can be an interesting research direction. It aligns with the overall theme of personalization and customization of design tools [60, 123], while focusing on maintaining a diversity of perspectives.

5.3 Offering Diverse Perspectives for Visual Elements

Textere utilized text tags to present participants with multiple perspectives and word associations of visual outcomes. While in most previous tools, text labels are AI-generated or keywords extracted [24, 96, 69], in *Textere* all text tags were based on previous user studies or books, and participants were made aware of that during the evaluation study. This led to eight out of twelve participants considering tags as opinions. This was evident in various comments made by them while going through text tags "I'm thinking why did that person think this was Joy?" (P8), and "It's interesting to see what other people might associate with those words."(P1). This shift in perspective, from viewing text tags as computer-generated words to seeing them as actual people's opinions, impacted how participants acknowledged and interacted with the text tags. As compared to internet search, where users looked through options until they found a visual element that matched their original vision, in *Textere* most users saw text tags as different opinions of the visual outcome. So, if the visual outcome *Textere* mapped for their text input did not align with their intention, they still considered it, tried to find reasons behind the associated text tags, compared it to their own reasoning, and then made a decision. These observations echo findings from previous studies where users prefer advice they believe comes from human sources, particularly in emotional or personal contexts, and computer-generated suggestions when speed, efficiency or objectivity is important [54].

In the context of weaving, these insights can be utilized to think about scenarios where human or computer generated suggestions and tags can be useful and giving the weavers autonomy to switch between different sources as needed.

5.4 Sparking Creativity

Researchers have emphasized the need for strategies to spark ideas and overcome creative block [118, 122] . Participants in our study found *Textere* to be useful as a starting point for finding visual outcomes or to overcome creative block. Especially for longer sentences with more words, participants like P7 were blank while searching for visual elements using AdaCAD, but found a starting point while working with *Textere*. This can be attributed to two design decisions in *Textere* - always having some visual options available to users as a starting point, regardless if their input text maps to a visual outcome or not, and the presence of text tags alongside visual outcomes. Hence, in the absence of ideas, many users copy-pasted the text (especially the longer text) into *Textere*, and obtained a few visual outcomes to start with, and used text tags to come up with new search strings. These benefits of visual and textual stimuli reiterate previous research which considers textual stimuli a useful part of the design process to foster creativity and enhance imagination when presented alone or as a combination with visual stimulus [46, 95]. Future design tools could investigate how varying the types of text stimuli or adding interactive components where text tags are clickable, might enhance creative ideation in text-based design tools.

Further, while *Textere* provided a process that is close to the vision of systematic creativity [22, 104]— offering a systematic framework, encouraging user input, and facilitating iterative exploration, participants designed more unique and diverse outcomes with AdaCAD. This could be attributed to the limited database that *Textere* currently has, where text inputs sometimes have limited visual mappings, leading to similar overall outcomes, and the study design that did not allow users to interact with other features of AdaCAD to tweak the visual options chosen using *Textere*. It would be interesting to test if a combination of expanding the database using more user studies and allowing modification using the underlying tool, helps improve the diversity of outcomes produced.

5.5 A Reflective Approach to Design

Reflection is an important aspect for supporting the development of design practices [12, 109, 115]. Tangible crafts like weaving and knitting have been used as a way of expressing narratives, emotions, and messages which require thought and reflection [102, 34, 120]. Participants in our study also mentioned several weaving use cases they previously encountered that involved a reflective approach, such as designing a gift for a loved one, representing an abstract text-based theme using visuals, or a personal weaving project. The participant interactions described in the results sections show that *Textere* facilitated a reflective design process where despite getting suggestions from the tool, participants often deliberated on what to select for their drafts. For example, *breakdown* is a type of reflection that occurs when a "person's actions map to outcomes against their intuitions", prompting re-evaluation of decisions [42]. In *Textere*, when participants found that the suggested patterns, colors, or weave structure did not match their initial ideas, that made them stop and reflect. This is unlike user responses in previous tools where when outcomes did not match their intent and users expressed frustration and lack of control [96]. Based on viewing visual outcomes and corresponding text tags, many participants came up with alternate search strings for a given input to search for corresponding outcomes (e.g., using *"balance"* and *"boundaries"* as additional words for input *"fence"*. This engagement is similar to a form of reflection, termed *inquiry* [42], wherein ideas are revised based on new information.

In contrast to *Textere*'s in-tool search, when people imported images from the Internet, we did not explicitly observe much reflection take place. This might be caused by a phenomena called "choice overload" [106] which can in many cases lead to a decrease in motivation to choose, and overwhelm cognitive resources, resulting in superficial engagement rather than thoughtful consideration [106]. Relative to the open-ended search enabled by the Internet, *Textere* can be viewed as a tool that added a *"design friction"* [82], wherein participants had to pause and look at the text tags to make a decision. Research shows that introducing such design frictions can enable mindful interactions [28]. Future tools in weaving could benefit from exploring other possible design frictions for tools like *Textere*. For example, asking a reflective question when a user makes a design choice could maintain engagement while encouraging reflective thinking without becoming overwhelming [20, 35]. Additionally, it would be valuable to study how different types of friction can impact weavers with different expertise levels, cognitive styles, or cultural backgrounds, to design more effective tools [28, 32].

5.6 Designing For Trust

Previous research underscores the importance of building trust with users, and its benefits in improving user satisfaction and engagement [71, 103]. Our study uncovered insights about users' mindset while making design decisions based on their preferences and given text-based suggestions. Participants enquired about the expertise of those who contributed to text tags used for mappings, the statistics of which text mappings were more popular than others, and the reliability of text associations presented to them. Participants mentioned that if the tags came from expert groups like graphic designers and artists, they were more likely to trust the tags. This aligns with previous research indicating that trust in recommendations significantly impacts users' acceptance or rejection of suggestions and trust improves if the expertise of the recommendation source and its *"similarity with the target user"* is revealed [71]. Additionally, users trust recommendation systems more when they perceive the recommendations to be credible, accepting them as "advice-givers" [55]. Hence, future iterations of *Textere* can explore options to add cues that reveal sources for the text tags for example, and indicate who generated them to make the process of designing weave drafts more reliable.

Another way to establish trust in systems that provide suggestions is to be transparent in explaining the system behavior [75, 65]. Previous tools discussed in Chapter 2 also mentioned users' experience of a feeling of lack of control over outcomes [96], because they were not aware of how changing the text inputs would affect the visual outcomes. To improve this lack of transparency, *Textere* included features like highlighting the matched keywords in visual elements to allow users to create an association between which word in the text input is mapped to which visual outcome. Users provided suggestions to add more transparency during and even before they begin searching for visual outcomes. Participants in our study suggested methods to enhance transparency in system behavior such as displaying which parts of the text are more likely to have more visual outcomes using word clouds, and showing the percentage of users who prefer certain text tags in the search results. These suggestions align with findings in recommendation systems, where transparency cues, such as the presentation of algorithmic processes or user preferences, have been shown to promote trust [67, 74]. These insights are also a reminder of how important trust and transparency are in design tools. Hence, a better understanding of transparency and trust can allow tools like *Textere* to align with best practices observed in related fields and incorporate them in the process of designing weave drafts.

5.7 Envisioning an Ecosystem of Tools

Textere is built using the open-source AdaCAD platform [37]. The basic building blocks of *Textere* are similar to those used by other drafting softwares, that is, colors, weave structure, and pattern. Working with *Textere*, therefore, continues to help people to think within the framework of weaving principles, and can offer some continuity for those who may want to transfer from *Textere* to other more advanced tools for weaving. In real-world interaction scenarios, we envision that *Textere* would not operate in isolation but rather in conjunction with a broader ecosystem of tools. In our study, participants pointed out how text was not in line with their usual style of thinking about weave design, but that they could envision it after interacting with *Textere*. This raises questions about whether a smoother transition to text-based approaches is needed. As weavers gain inspiration from a variety of sources like using photographic inspirations [133], sketching their inspirations [134] and also use tools with other modalities like audio-tactile [50], *Textere* could be integrated with these more familiar modalities like images, sketches [135], audio-tactile [50] to enhance the overall design experience. Previous research shows the positive impacts of using such an ecosystem of design tools in enhancing user reflection [38], increased efficiency in exploration [89], fostering ideation and improved design decisions [128], opening up creative opportunities [96], and exploring connections between inspirations [96]. Integrating *Textere* with other design tools for weaving could also mitigate the challenges around having a limited database that is built on empirical insights that continue to be gathered over time. Because of our integration with a platform like AdaCAD, when users cannot find relevant mappings for their text-based input, they can continue to develop their drafts through other means such as importing images from the Internet or creating new designs from scratch. As part of future work, it would thus be interesting to explore how weavers might use tools like *Textere* in practice including when they switch to other weaving tools, and how their learning from one tool informs their use of other tools for furthering their creativity while designing weave drafts.

5.8 Textere's approach vs AI-tools

While *Textere* and AI tools like DALL·E [3] both enable text-to-visual generation, they serve distinct purposes and employ different methodologies. *Textere* focuses on supporting the design of weave drafts through a smaller, research-backed dataset, ensuring that visual elements are traceable and grounded in real-world user scenarios. In contrast, AI tools like DALL·E leverage vast datasets and advanced machine learning algorithms to generate diverse images from text, often without clear mappings between text inputs and visual outcomes. *Textere* allows users to choose individual visual elements, which when combined, create the final design. In contrast, AI tools like DALL·E generate a complete visual outcome based on a text prompt, and modifications are made using subsequent text prompts [93]. The interpretation of these prompts can vary, as AI models may not always produce the desired changes or fully capture the user's intent [131, 52]. Each visual element option in *Textere* is associated with multiple text tags, allowing users to make informed decisions based on specific words from the input text, which is mapped to visual element options shown, and associated text tags displayed. This makes the process more transparent and reflective, especially when users know that the tags are sourced from human inputs. In contrast, AI tools do not consider multiple interpretations that might be associated with the resulting visual generated using the text prompt, and the mapping process from text to visual is largely hidden [52]. Despite these advantages, *Textere's* smaller, research-backed dataset, while offering control and traceability, also limits the diversity of possible visual outcomes. In comparison, AI tools like DALL·E produce a wider variety of results for text-inputs. Moreover, *Textere's* reliance on human-sourced tags and curated data sets can restrict the range of interpretations, making it less scalable for large-scale or highly creative explorations, which generative AI excels at.

In the future, we can explore how the strengths of both *Textere's* controlled, research-driven approach and generative AI capabilities can be combined. For example, by adopting rule-based [81], explainable AI models [132], *Textere* can maintain the transparency that users value while also benefiting from the creative variety and scalability that AI tools offer. *Textere* could explore integration of AI-generated tags alongside human-sourced tags, allowing weavers to compare multiple interpretations of a text input. This would enhance creativity while retaining the reflective, trust-building aspects of human-generated tags. Weavers could also be given greater control by allowing a choice between human-generated tags, AI-generated visuals, or a combination of both, tailoring the design process to their needs. This integrated approach can also be used to compare if weavers are as accepting and open to AI-generated suggestions as they were to human-generated tags, further refining the role of text-based support in the weaving design process.

5.9 Limitations

In this section, we discuss the limitations of our current work. We also mention how addressing these limitations or adopting alternative approaches can create new opportunities in text-based design tools for weaving design.

Text is a complex input type and while *Textere* takes the first step towards text support for weaving, there are several avenues we did not explore in our work. For example, conditional statements like ”if..else”, negation statements like “not”, and relationships or context between words, were not considered in our current implementation. Incorporating these additional factors can open up opportunities to map the overall meanings of sentences to visual elements. It can also enable more accurate mapping of individual words, with better context. For example currently, *Textere* would not be able to differentiate between the input text “I am happy” and ‘I am not happy‘”. Moreover, to understand if text-based input is helpful in the weave design process, we only explored text-based search inputs using typed or copied text in our work. We did not explore different ways in which text can be input into the system, for example, by uploading text files, transcription from videos, text from audio recordings, and direct speech input. These different text inputs can help add nuances in output, for example, translating speech could enable incorporating additional factors like tone, intonation, and broader context into a weave draft, which can enable new forms of in-situ craft creation processes. Further, *Textere* currently operates as a single-user system, which restricts opportunities for collaborative design. Exploring how text-based inputs could enable collaborative workflows in multi-user environments, such as student projects or creative teams, could further extend *Textere's* applications. Lastly, the tool currently is a prototype and has a limited database supporting its search functionality. Further studies with weavers can help create a more comprehensive text-to-visual database, especially for domain-specific visual elements like weave structure. A more comprehensive database could offer more mapping options for each text input, and would likely lead to more diverse outcomes, which were harder to achieve in our study.

Chapter 6

Conclusion

In this thesis, we explored how text inputs could be used to support the design of weave drafts. By developing and evaluating a prototype tool, we investigated potential opportunities and challenges of using text-based design processes in weaving.

Our first research objective was to *design and develop Textere - a text-based tool that supports designing weave drafts by enabling users to (i) view multiple visual element options based on the given text (ii) have a way to trace the visual outcome options back to input text, and (iii) view differentinterpretations of visual elements, allowing for more informed design decisions.* Informed by previous literature and existing weave design workflows, we developed *Textere*, and offered two features to support designing of weave drafts—text-based search inputs and text tags. *Textere* enabled users to view multiple options for their text input using a text-to-mapping database curated from previous literature. Using text tags, *Textere* enabled users to see a connection between the matched visual outcomes and their input text, while viewing multiple interpretations or word associations of visual elements. While *Textere's* current features are a step towards text-based support in designing weave drafts, there is scope to explore more in the design process. As weave draft design requires thinking of three different visual elements that must be composed together, considering the relationship between visual elements, and working towards more comprehensive mappings to offer multiple options for the given text input can be a good next future work direction. Additionally, as weave drafts are designed for a physical outcome, incorporating existing weaving resources and feasibility options in the text-based features would ensure the tool aligns with practical constraints. This would enhance *Textere*'s utility in real-world weaving projects, where both conceptual inspiration and physical feasibility are critical. Finally, while mapping meanings of independent words is a starting point, developing features to support context-based mapping of words, and eventually introducing options to map entire sentences would take us closer to the objective of *text* support, which is currently limited to words.

Our second research objective was to *evaluate potential opportunities, limitations and feasibility of designing weave drafts using text.* Through our two evaluations (evaluation-through-demonstration, and study with weavers), we learned that multiple text-based scenarios exist in weaving where weavers consider a tool like *Textere* to be useful. These included scenarios where weavers would want to reflect, generate or broaden ideas, overcome creative block, and gain inspiration and insights about visual elements by translating abstract concepts into visual designs. However, there were also limitations with using text-based support. For instance, text-based thinking was not the usual way how some weavers think, and while *Textere* was well-received as a tool for generating initial design ideas, and participants were open to exploring the approach, they expressed different ways *Textere* could be improved by adding customization options, more transparency in the process, and more approaches for reflective decision making. Based on our findings and insights, we discussed future work directions for tools like *Textere*, such as finding ways to encourage exploration through more nuanced text-to-visual mappings, enabling reflective design practices, improving weaver's trust in the system, and finally situating single tools within a broader ecosystem of digital tools for weaving.

Overall, text-based design tools hold potential in supporting design processes in weaving, but require collaboration with weavers to address key considerations at each stage of tool development. Our thesis is a step towards demonstrating a novel approach to design meaning-based weave drafts using text. Through the design, development, and evaluation of *Textere*, we propose future directions for design tools in weaving where textual ideas, artifacts, and themes can be used to design weave drafts, by enabling the weaver to take reflective, deliberate and informed design decisions.

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Appendix A

User Evaluation Questionnaires and Interview Questions

Textere: Pre-Study Questionnaire

Demographic Details

* 1. What is your age?

- ◯ 18 to 24
- ◯ 25 to 34
- ◯ 35 to 44
- ◯ 45 to 54
- ◯ 55 to 64
- ◯ 65 to 74
- ◯ 75 or older

* 2. What is the highest level of education you have completed?

- ◯ High school diploma or equivalent
- ◯ College or vocational training
- ◯ Bachelor's degree
- ◯ Master's degree
- ◯ Graduated from college
- ◯ Doctorate or other advanced professional degree
- ◯ Prefer not to say

* 3. What is your gender identity?

- ◯ Woman
- ◯ Man
- ◯ Genderqueer or non-binary
- ◯ Agender
- ◯ Not specified above, please specify

[ ]

* 4. Which of the following best describes your current occupation?

- ◯ Management Occupations
- ◯ Business and Financial Operations Occupations
- ◯ Computer and Mathematical Occupations
- ◯ Architecture and Engineering Occupations
- ◯ Life, Physical, and Social Science Occupations
- ◯ Community and Social Service Occupations
- ◯ Legal Occupations
- ◯ Education, Training, and Library Occupations
- ◯ Arts, Design, Entertainment, Sports, and Media Occupations
- ◯ Healthcare Practitioners and Technical Occupations
- ◯ Healthcare Support Occupations
- ◯ Protective Service Occupations
- ◯ Food Preparation and Serving Related Occupations
- ◯ Building and Grounds Cleaning and Maintenance Occupations
- ◯ Personal Care and Service Occupations
- ◯ Sales and Related Occupations
- ◯ Office and Administrative Support Occupations
- ◯ Farming, Fishing, and Forestry Occupations
- ◯ Construction and Extraction Occupations
- ◯ Installation, Maintenance, and Repair Occupations
- ◯ Production Occupations
- ◯ Transportation and Materials Moving Occupations
- ◯ Other (please specify)

[ ]

* 5. What is your educational major or field of study?

- ☐ Arts and Humanities
- ☐ Science, Technology, Engineering, and Mathematics (STEM)
- ☐ Social Sciences
- ☐ Business and Economics
- ☐ Health and Medicine
- ☐ Education
- ☐ Agriculture and Environmental Sciences

Other (please specify)

[ ]

6. Current province of stay

- ◯ Alberta
- ◯ British Columbia
- ◯ Manitoba
- ◯ New Brunswick
- ◯ Newfoundland and Labrador
- ◯ Nova Scotia
- ◯ Ontario
- ◯ Prince Edward Island
- ◯ Quebec
- ◯ Saskatchewan
- ◯ Northwest Territories
- ◯ Nunavut
- ◯ Yukon

Textere: Pre-Study Questionnaire

Weaving

* 7. How would you rate your level of weaving expertise?

- ◯ Beginner
- ◯ Intermediate
- ◯ Expert

* 8. Approximately how long have you been actively involved in weaving?

- ◯ Less than a month
- ◯ Less than a year
- ◯ 1-3 years
- ◯ 4-6 years
- ◯ 7-10 years
- ◯ 11-20 years
- ◯ 20+ years

Any additional Context you might want to give about how your experience over the years:

* 9. How would you describe your weaving experience and involvement?

- ◯ Consistent hobbyist – I weave regularly as a leisure activity.
- ◯ Occasional weaver – I weave from time to time for enjoyment.
- ◯ Professional weaver – I weave as a part of my profession or for commercial purposes.
- ◯ Novice – I am new to weaving and have limited experience.

Any additional Context you might want to give:

* 10. What type of loom do you primarily use for your weaving activities?

- ◯ Manual loom
- ◯ Automatic loom
- ◯ Both manual and automatic looms

* 11. Please specify the looms you have worked with before in your weaving activities?

- ☐ Traditional hand loom (e.g., basic hand-operated looms)
- ☐ Floor loom (e.g., shaft looms, jacquard looms)
- ☐ Table loom (e.g., compact looms for smaller projects)
- ☐ Frame loom (e.g., portable looms with a rectangular frame)
- ☐ Backstrap loom (e.g., tied around the weaver's back, traditional weaving)
- ☐ Inkle loom (e.g., small looms for narrow bands or straps)
- ☐ Circular loom (e.g., looms with a circular frame for circular or tubular weaving)
- ☐ Tapestry weaving (e.g., hand-held or upright looms for creating images or designs)

Other (please specify) or any additional Context you might want to give:

* 12. How do you typically create weaving draft/patterns

- ☐ Manually (e.g. using graph paper)
- ☐ using a Software
- ☐ use Pre-made drafts

Other methods used or any Additional details (eg name of software used etc)

Textere: Pre-Study Questionnaire

Expressing Ideas

* 13. How easy or hard would it be for you to represent an idea/ concept using ...

	Very Easy	Moderately Easy	Medium	Moderately Hard	Very Hard
Color Palette	○	○	○	○	○
Shapes/Lines	○	○	○	○	○
Symbols/Icons	○	○	○	○	○
Images/Illustrations	○	○	○	○	○
Text (Words, Phrases or Sentences)	○	○	○	○	○

Post Study Questionnaire

* 1. Does the use of 'text as a starting point for idea generation or expression'

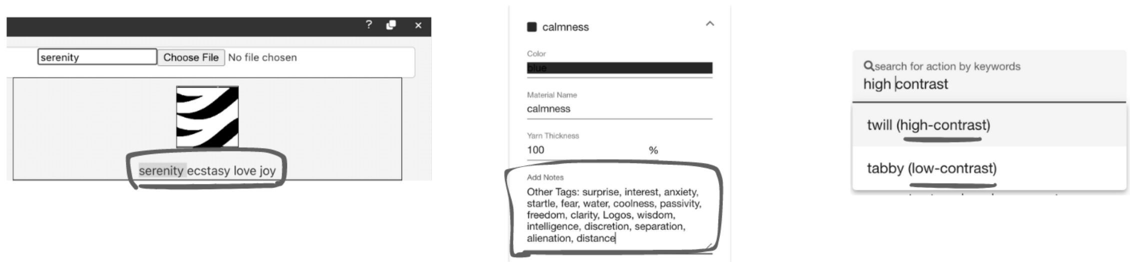
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
align with your preferred mode of thinking(whether it's through textual or spoken language)?	○	○	○	○	○
make it easier for you to articulate your weaving draft ideas	○	○	○	○	○

* 2. "Text to visual mapping" - refers to obtaining pattern, color and weave structure using text input. How helpful do you find the text-to-visual mapping features in Textere ...

PATTERN COLOR WEAVE STRUCTURE

	Not Helpful	Slightly Helpful	Moderately Helpful	Extremely Helpful	
for understanding the significance of each visual element(pattern, color, weave structure)	○	○	○	○	○
for choosing which visual element options are closer to your intended vision	○	○	○	○	○

* 3. How helpful do you find the text-tagging(marked in red) in Textere..



	Not Helpful	Slightly Helpful	Moderately Helpful	Extremely Helpful	
for understanding the significance or meaning of each visual element(pattern, color, weave structure)?	○	○	○	○	○
for choosing which visual element options are closer to your intended vision?	○	○	○	○	○

* 4. Does Textere's ability to generate a range of visual options using text restrict your creativity?

- ○ Not at all
- ○ Slightly
- ○ Moderately
- ○ Mostly
- ○ Completely

* 5. Instead of using multiple softwares to translate an image to a weaving draft like in AdaCAD, Textere allows users to choose images and obtain weaving drafts within Textere itself.

Do you think efficiency to be an important factor that would motivate your use of Textere?

- ○ Extremely important
- ○ Very important
- ○ Somewhat important
- ○ Not so important
- ○ Not at all important

* 6. Do you think the concept of using text to obtain visual elements for weaving drafts

	Not at all	Slightly	Moderately	Mostly	Completely
Is practical?	○	○	○	○	○
Is appealing?	○	○	○	○	○
enhances accessibility to those not familiar with visual literacy (interpreting ideas using visual elements)?	○	○	○	○	○

* 7. Would you be willing to use a text-based approach like in Textere, if you had a text-based idea that you wanted to convert to a weaving draft?

- Not at all Willing
- Slightly Willing
- Moderately Willing
- Mostly Willing
- Extremely Willing

Post-Interview Questions: 20mins

1. How would you describe your overall experience using Textere for draft creation?

2. Now that you've seen the traditional way of finding color,pattern and weave structure and some potential ways text could be incorporated in this workflow, can you think of ways in which this could help you or fit into your current work flow, do you see a scope etc.

3. Can you think of scenarios where text-based inputs might be useful to you if you wanted to create a weaving draft, to eventually create an artifact?

4. In cases when the word did not yield a visual element, what was your thought process like (to see if they used other visual options available to see which is closest?) <If the situation occurs>

5. What specific features or functionalities of the digital authoring tool did you find helpful in the process of creating weaving design patterns? Why?

6. Did you encounter any challenges or difficulties while using the digital authoring tool? If yes, please explain.

7. Based on your experience, what improvements or enhancements would you suggest for the system to better support users?

8. Do you find the concept of using text to obtain visual elements for weaving drafts practical and appealing? Why?

9. Do features in Textere (like text-tagging and mapping) enhance accessibility while creating a weave draft ? Explain

10. Does the integration of text and visuals in Textere result in a more efficient process (with lesser context switching)? Why?

11. Would you like a platform where all 3 - direct, image, text are available?

Appendix B

Pilot Studies

We conducted 2 pilot studies with two HCI researchers before the main study to ensure the study procedure is clear and streamlined. Our participants were a post doctoral researcher and a PhD HCI research student.

We conducted both pilot studies on Zoom to replicate the study setup in the main study. We performed all the steps of the study including the pre-study questionnaire, demonstration of both the tools, the participants performed both Task1 and Task 2, and we ended the study with a post-study questionnaire and semi-structured interview. In addition we spent some time at the end of the pilot study to get feedback about the procedure and what could be changed or improved.

In pilot study 1, we faced some technical issues with hosting the study remotely on zoom and trying to give the participant access to the tools. Apart from this, in both pilot studies, participants were able to follow instructions. One participant needed more time to complete the tasks allocated while the other completed the tasks within or before the allocated time.

Based on participants' feedback and our observations, we decided to allocate more time to the system interactions as compared to the explanation of the tool, as we observed that the participants picked up the tool better if given freedom to spend more time hands-on with the tool. Further, we also simplified task instructions, by removing any information not directly related to the tasks. Finally, we disabled features of the underlying tool that were not part of the study to reduce distractions. We also decided to provide the pre-study questionnaire asynchronously, before the study day.