Chapter 13

FELT: Communicating Emotion through a Shape Changing Textile Wall Panel

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Additional information is available at the end of the chapter

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Abstract

FELT is a 5" × 6" (150 cm × 180 cm) computational textile panel, made up of four modules of frame and textile that was designed to understand what emotion is communicated to people using vision and touch from a still and shape changing textile. The purpose of FELT is to determine what still and shape changing, textural expressions of computational textiles can communicate emotion to people at the scale of an architectural wall. The central idea is that for both still and moving or shape changing textiles, there will be differences in what is communicated to people depending on whether the people experience the textiles via vision alone or via both vision and touch. In this chapter, two methods are described that were used to carry out the research. The first method is a design method used to produce shape changing textiles. The second method described is the user study. There are two user studies that will be discussed in this chapter to understand what emotion[s] are communicated by shape changing textiles and the FELT wall panel. If architects, artists, designers, engineers and scientists, and others could begin to understand the nature of what various textile expressions communicate, and what computational textiles communicate in transformation, then it would be possible to more clearly understand the role that texture of a computational textile plays in communicating emotion through a computational object. A textile that can move or change its shape could be used on a robot as robot skin, for example, for people who may benefit from some communication through vision and touch. A computational textile may be used on a wall, a pillow, curtain, furnishings, toys, and many other designed objects to communicate to people and children who do not have access to their emotions. This may be a child with autism or someone not in touch with what they are feeling. A textile can be used to have nonverbal communication with people through vision and touch.

Keywords: shape changing textiles, textile expression, computational textiles, emotion, communication

1. Introduction

Textiles used to create shelters have for centuries communicated narratives and stories to people and their communities. One only has to look at an example of Berber carpets used to make ancient tent shelters to learn about the communication of stories through images and symbols (**Figure 1**).

This figure shows tents erected by the nomadic Berber people of Morocco made from woven carpets knotted with sheep, goat, and/or other animals' hair. The carpets are richly patterned, and according to Barbatti, a Swiss scholar and writer, some of the symbols and patterns used date back to the hunter gatherer cultures of the European Mesolithic and Upper Paleolithic ([1], p. 16). For example, many of the hundreds of symbols used, including chevrons, x's, lozenges, Solomon's stars, and the floral motif called a "camel track," have to do with fertility.[1]

Yet, what of the information in textiles that can be carried through seeing and feeling texture and using the haptic system to receive communication from a textile rather than relying on symbolic form and symbolic color or symbols in general? Is it possible to communicate *intentionally* with people through textiles without using symbols? Is it possible to communicate emotion through textural expression of a textile? Emotion is selected as a quality to communicate in these studies as emotions are directly related to bodily experiences rather than sorting out things symbolically. In this chapter, the author will explore the potentials for texture to communicate emotion to people engaging in seeing and touching a still and shape changing, computational textile wall panel (**Figure 2**). The term computational textile is not a common term but one that has been in use for a decade or more. The term computational textile will be used

Figure 1. Shelter of Berber carpets. http://ethnographic-morocco.blogspot.com/2013_04_01_archive.html (Accessed December 2, 2017). Photo by Coralle Merier, 2009, Creative Commons License https://creativecommons.org/licenses/by-nc-sa/2.0/legalcode

[1](For a good description of the symbols and meanings on these Berber Carpets see Barbatti [1]:21).

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in this chapter because typical computer commands to microcontrollers and other sensors are employed to make the textile behave or respond in a specific way. Computational textiles are textiles others often call e-textiles, electronic textiles, or smart textiles. If it is possible to communicate through texture and shape changing computational textures using vision and touch, then designers, engineers, and others may use computational textural expression in their designs for furnishings, robots, and other objects to communicate emotion to people. This opportunity may be especially useful in objects, places, and furnishings designed for people who are unable to communicate their emotions, or express their emotions to others and themselves. These computational objects can help those people get in touch with what they are feeling.

Figure 2. FELT wall panel.

1.1. Background: relating expression, communication, and emotion

Designers and artists have always been engaged with the problem of creating expressions that expand beyond their own experiences into something that can be shared, of finding ways to place viewers in a world that is relational. Expressions can communicate and are methods to connect and live with others, across boundaries. In this section, the relationship between the two words, i.e., expression and communication will be discussed. Expression and communication through the body, and the ways in which expression in a body, human or animal, is or is not communicated are discussed. If designers, scientists, and others understand that communication through the body is perceived through the expressions and habits formed by the body in its habitat, then it is possible to understand how the body communicates and is communicated via emotion.

If you look up the word *expression* in the Oxford English Dictionary, you will find two meanings ascribed to it. The second meaning has most relevance for this chapter. This meaning of expression designates it as a "representation" or "manifestation," for example, "the action of expressing or representing (a meaning, thought, state of things) in words or symbols; the utterance (of feelings, intentions, etc.)" (Oxford English Dictionary, accessed December 2, 2017) [2]. A critical word in this meaning or definition is that of intention. The word intention will be returned to later in this chapter. When the term "expression" is used in this chapter, no ontological claims are made. The word considered here is closer to the term "expressive power" as defined in computer science. "Expressive power" means the "measure of ideas expressible in any particular language" (Wikipedia "Expressive power (computer science)" accessed December 2, 2017) [3]. The language examined in this chapter is shape changing textile textures rather than symbols.

Communication has three primary senses in the Oxford English Dictionary [4]. The first of these senses is related to affinity or having something in common; the second is related to imparting or transmitting something: "The action of communicating something (as heat, feeling, motion, etc.), or of giving something to be shared." The last sense is that of having access, access between two people or places, having a shared physical link. Before discussing the methods and results of the experiments with FELT, it is important to understand the relationship between expression, communication, and emotion.

In *The Expression of the Emotions in Man and Animals*, Darwin starts to look at the issue of expression in the bodies of humans and animals (1890/2009). In this follow-up to *The Origin of the Species*, he describes hundreds of human and animal body expressions in minute, detail and maps them to different emotions and functions [5]. Yet Darwin made no comment on the causal connection between expression and emotion.

Darwin never investigated whether a person could experience an emotion without a corresponding bodily expression or whether bodily responses were a necessary condition for an emotional experience ([6], p. 100). Neither did Darwin make a connection between expression and communication.

In Darwin's account, many expressions of emotion such as the hair rising on the back of a person's neck when afraid are leftover responses related to an evolutionary function designed to maximize chances of survival in some prehistoric time. For example, writing about the

behavior of a hen trying to chase a dog away from its brood, Darwin notes what he considers to be the principle cause of erect feathers, as follows:

> *(B)irds when frightened, as a general rule, closely adpress all their feathers, and their consequently diminished size is often astonishing. Though with birds, anger may be the chief and commonest cause of the erection of feathers ([7], p. 97).*

Summarizing from an extensive report on the expressive behavior of two classes of vertebrates, Darwin was trying to understand the function of emotional expression in the context of evolution. *Expression in this sense is about changing the body in relation to the environment*. In the case of the birds, by closing their feathers, they withdraw from the environment and by opening their feathers in anger they make an approach to it.

According to the psychologist Nico Frijda, the expressions that Darwin discusses are not intentional and have very low communicative value other than in the broadest sense of communication because those expressions are not intentional. In such cases, Darwin describes above the communication is a by-product of witnessing a message that was not intentionally sent although others received it ([8], p. 60). The message was inferred by an observer based on the subject's body in context.

Frijda argues that there are actually two senses of communication. A more restrictive sense refers to behavior produced in order to be perceived by another animal, and "*in order to influence the latter's behavior*" ([8], p. 103). This more restrictive sense is understood as true communication. Frijda proposes that to understand emotional expressions is to sense the impact of those expressions on the observer.

For Arnheim, a German perceptual psychologist, the meanings of esthetic expression can be understood through the expressions of the body. In dance, a dancer expresses happiness and joy by moving his/her body upward and an audience can recognize this as happiness. Similarly in dance, if a dancer wishes to communicate sadness to an audience, his/her body droops downward ([9], p. 261). People's ability to make inferences through these intentional clues is described as a process whereby people draw on their understanding of the relationship between patterns of bodily sensations and the emotions they produce ([9], p. 259).

This message is the kind of intentional, influential communication that artists and designers often want to achieve with their designs and is of interest in the FELT experiment.

1.2. Feeling things and being felt

James Gibson, a psychologist, argues that there is no separation between the body and the environment. In Gibson's account, therefore, energy flows into bodies from the environment and energy flows out from our bodies into the environment, such that it is impossible to understand the body without considering the environment ([10], p. 5). He writes about the environment as a place of flow and forces. The haptic system unlike any other perceptual system encompasses most of the body and literally puts people in touch with their world; it "lets us grab a hold of things" ([10], p. 97).

A specific quality of the human haptic system is that unlike the human visual system, it enables people to explore and alter their environment. Further, this ability means that people

can also change what they perceive using their haptic system, which again is not possible with their visual system. Gibson gives a good example of this: "when we reach out to feel the edge of a table, we feel the edge, but simultaneously the table makes a dent in us." He argues that there are poles of experience that place the concepts of subject and object in a continuum. If you wish, you "can focus on the dent made in your hand or you can focus on the edge of the table" ([10], p. 99). The equipment people use to explore, feel, and alter their environment is the same equipment people use to feel and produce emotional experiences ([10], p. 99). As the philosopher Mark Johnson writes, "emotions are both *in us* and *in the world* at the same time (…) they are one of the most pervasive ways we are continually in touch with our environment" ([11], p. 67).

For Damasio, a neuroscientist, an emotion refers to a process in which initial expressive states of the body (that people can see) or physiological changes are associated with feelings. He defines feelings as the "idea of the body being in a certain way" ([12], p. 85).

John Dewey develops his own idea of emotion by connecting it to a person's lived situation. That is, for Dewey, there are emotional situations, not emotional states of mind. He writes: "I am happy" means "I feel happiness in me, and simultaneously in the situation I encounter" ([11], p. 67). By defining emotion as a transactional process, Dewey does not interiorize the concept of emotion that he argues has led to its banishment from the discussion of making meaning and creating knowledge ([11], p. 67). In his argument, Johnson picks up on a long history of abolishing emotion from scientific discourse, which happened by separating the brain from the body and by trying to maintain subjectivity and objectivity which he sees as abstractions rather than organism-environment transactions ([11], p. 67). In writing on Dewey, Johnson explains Dewey's position that hinges on connecting exterior environment with interior feelings in a way that is essentially symbiotic:

> *If emotions are merely private, interior, subjective responses then they tell us nothing objective about our world. (…) Once we see that emotions exist precisely because of the ways they are connected to our shared world and permit us to function within it, then it becomes possible to recognize their crucial role in our communal well-being ([11], p. 67).*

2. Methods used to determine emotion communicated from still and shape changing textiles

In this section, the author describes the design methods used to produce five shape changing textiles used as preliminary designs in a study which generated the texture for the final FELT panel. The chapter will also include the design methods to produce the final FELT panel.

In addition to discussing design methods, the author will also explain the user study with five textures, which informed the FELT panel. In both studies, participants were asked what emotion was communicated from photographed textures, textures that can be seen and touched, a preliminary group of five shape changing textiles as well as the final FELT panel.

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2.1. Design of five shape changing textures

The textures for the studies were inspired from animal reactions some of which Darwin mentions. These reactions are seen in **Figure 3**. It was expected that movement of each animal's skin, fur or feathers would communicate or permit a person to infer a different emotion(s). Textures were developed based on the following animals and associations: a cat with its raised fur, which could indicate fear, alarm, or shock; a bird, whose feathers could indicate an angry state as discussed by Darwin ([7], p. 97); and an elephant whose skin wrinkles could indicate a number of emotions depending on how it was manipulated in compression and in tension. Only three of the five animals were selected as within this group as these three were deemed the easiest of the five to show expression through their fur or feathers and because these three showed all of the animal expressions seen in the five original animals.

A series of textile textures were fabricated from cotton muslin and felt and test-activated by pulling threads that were integrated in the fabric (**Figure 4**). Several of the textures were selected for their similarity to the reactions and the mobility seen in the skins of animals (**Figure 5**). In order to keep the focus on the transformation of the texture of the material rather than color, all five samples were made from a cream-colored felt. All the textures were 9" × 9" (23 cm× 23 cm) in size. There were varying textures, which were designed with the goal of communicating specific emotional qualities from excited to calm and either negative or positive. The samples included smooth textures, rough and triangulated textures, rounded textures, and textures with superimposed formal systems. All the samples, which were laser cut, were mounted on a box that hid the motors that actuated the texture (**Figure 6**). Some of the samples, i.e., Textures 2–4, required weights to return to their basic position. Each sample had a different motion and speed, which changed the texture of the textile. The motor speed for each textile was set so that the textures would transform in a way that mimicked the breathing of an animal in a relaxed state. Here is a link to a video that shows the five textures and the textures' range of motion and speed: http://vimeo.com/85620116.

In the end, five textures were settled on for the last study. During this study, the five textures were mounted on top of foam core boxes, which hid motors and wires inside. The motors were programmed to move the textiles slowly, at the pace of a calmly breathing creature. Small slats of wood weighted the textures so that they were pulled back down into their original position (**Figure 7**). The foam core boxes were mounted on the wall of a room at eye height so that people who participated in the study could see and touch them easily.

Figure 3. Animal reactions.

Figure 4. Transformational textures inspired by animal reactions.

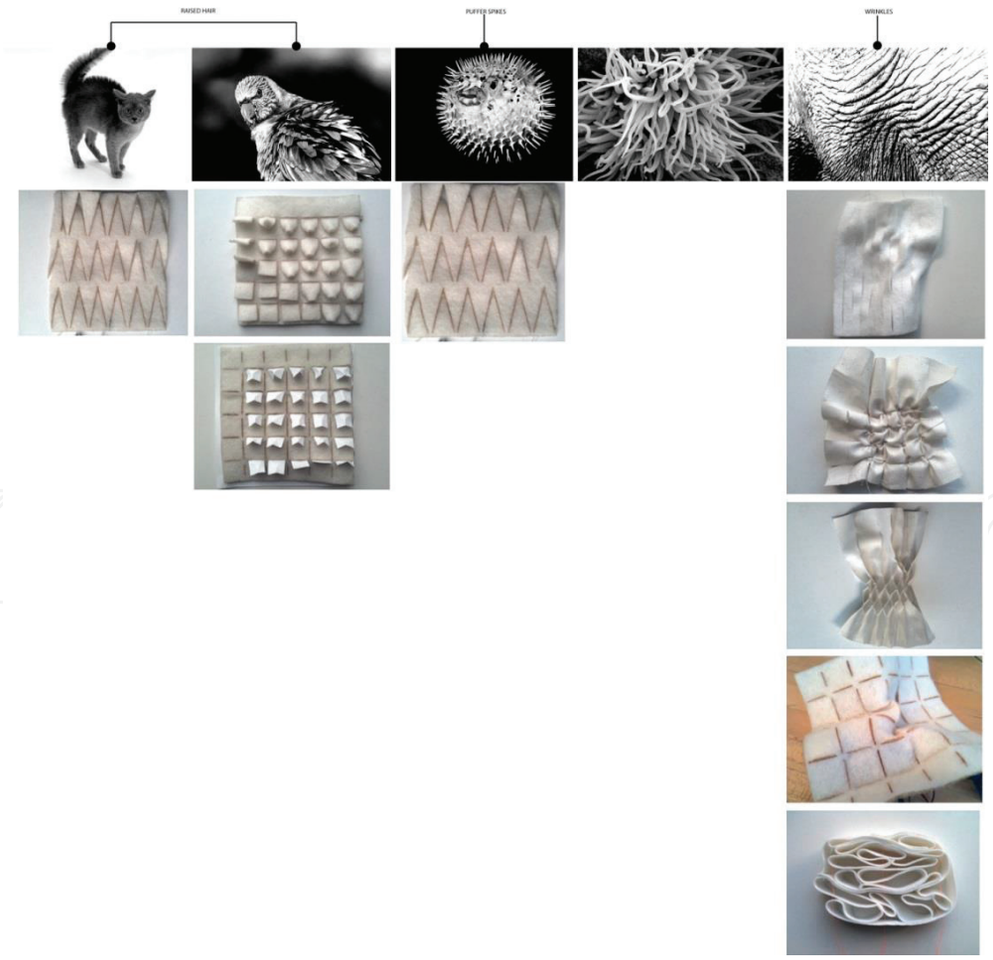

Figure 5. Selecting the textures that connected with animal reactions for the study with five textures.

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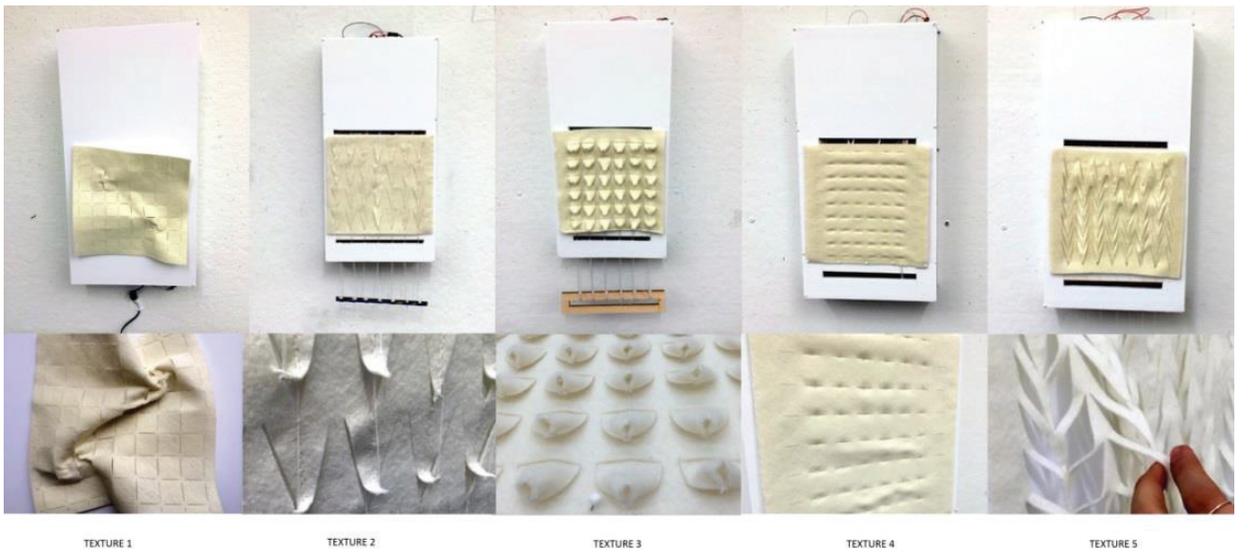

Figure 6. The five textile samples mounted on foam core boxes above, close ups photos below.

Figure 7. Face word graphics (The Makaton Charity: accessed December 2, 2017) [13].

2.2. User study with five textures: mapping emotion to still and moving textiles using vision and touch

The second method used in this experiment was the user study. The purpose of the study with five textures was to obtain participant feedback using vision and then vision and touch about emotions communicated from still and then moving textile expressions. An outline of the study is as follows:

1. Textiles are Still
   a. Looking **(ROUND 1)**
   b. Looking and Touching **(ROUND 2)**

2. Textiles are Moving

a. Looking **(ROUND 3)**

b. Looking and Touching **(ROUND 4)**

2.2.1. The hypotheses of the user study with five textures

There were actually four hypotheses for the study with five textures. Each hypothesis was tested in a round of the study. **Table 1** shows a summary of the hypotheses.

In Round 1, it was expected that using vision alone, people would consistently associate specific emotional states with specific characteristics of the textures of textiles in a state of stillness. Crisp, curvilinear shapes associated with positive, excited, and happy feelings; smooth curvilinear shapes associated with positive and calm feelings; triangulated shapes associated with negative and angry feelings; smooth triangulated shapes and superimposed systems, or a poorly defined combination associated with negative, depressed, and calm feelings.

In Round 2 of the study with five textures, it was expected that when people could see and touch a still texture, a negative emotional association using vision alone would change to a positive emotional association using both vision and haptic senses. When people used vision and the haptic senses together, the emotional associations changed.

In Round 3, participants were asked using their vision what emotion was communicated by textures in a state of motion. It was expected that this would raise or lower the prior rating of

Hypothesis number	Hypothesis description
Hypothesis 1, round 1	It was expected that using vision alone, people would consistently associate specific emotional states with specific characteristics of the textures of textiles in a state of stillness. Crisp, curvilinear shapes associated with positive, excited, and happy feelings; smooth curvilinear shapes associated with positive and calm feelings; triangulated shapes associated with negative and angry feelings; smooth triangulated shapes and superimposed systems or a poorly defined combination associated with negative, depressed, and calm feelings.
Hypothesis 2, round 2	It was expected that when people use vision and the haptic senses together the emotional associations would change. It was expected that when people could see and touch a still texture, a negative emotional association using vision alone would change when using both vision and the haptic senses to a positive emotional association.
Hypothesis 3, round 3	It was expected that when the textures were in a state of motion that this characteristic would raise or lower the participants' rating of what was communicated on a Circumplex grid based on what was associated with that texture motion.
Hypothesis 4, round 4	It was expected that the act of touching the moving textures would again change the ratings and what the textiles communicated.

Table 1. Study with five textures four hypotheses.

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that texture's position on a Circumplex Model of Affect for that texture in Round 1 based on what was associated with that texture motion.

Round 4 focused on what happened when the participants were permitted to see and touch the moving textures. It was expected that the act of touching would change the participants' responses concerning what emotion was communicated by the textile.

2.2.2. Study procedure

The study with five textures took place at M.I.T in January 2014, with 19 participants, i.e., 15 women and 4 men. The age range was 18–55. Participants were primarily faculty and students from the M.I.T. School of Architecture and Planning. There were also faculty and students from Aero Astro and Civil Engineering as well as from Harvard Graduate School of Design. Each session took 1 hour to complete four rounds of questions. The participants interacted with the textiles one on one with me in the room. All the participants were able to see the textiles and to touch them with their hands, and all were able to speak and write in English. The interviews were recorded by video with sound as well as by handwritten notes. All the textile samples were mounted onto foam board boxes, which hid servomotors and hung on a wall at about 46" (137 cm), which is approximately eye level for adults. The participants were standing as they viewed the textiles and were interviewed at each textile separately. All the textiles were uncovered for the entire interview.

In all four rounds, the participants were asked the same series of four questions. After the participants had the opportunity to see or see and touch the textiles, they were asked to freely associate for the first question.

1. For the first question, a set of three questions was asked in order to encourage the participants to give expansive answers. For example "What are some words that describe some emotions that you could attribute to this textile?" and "What are some adjectives that you could use to describe the mood of this textile?" Participants were told that the free association should focus on what the textile communicated to them in terms of emotional attributes. Participants were also told that it was Okay to talk about things that the textile reminded them of and to talk about any particular associations or memories that they attached to the textile. Their responses to this question were recorded by written notes and on videotape.

After this first question, the participants answered the questions presented on stapled 8.5" × 11" (22 cm × 28 cm) sheets of paper. The next two questions asked were those used in Studies 1, 2, and 3, which are as follows:

2. What does the texture communicate to you?

(Negative Mood) 1, 2, 3, 4, 5 (Positive Mood)

The participants were asked to circle a number between 1 and 5.

3. What does the texture communicate to you?

(Relaxed) 1, 2, 3, 4, 5 (Stimulated)

The participants were asked to circle a number between 1 and 5.

Last, the participants were given a sheet of faces which projected emotions and asked to pick a face in order to answer question 4.

4. Face: What mood would you associate with this texture?

Happy, Cross, Scared, Sad, O.K., Horrible, Worried, and Excited.

Then, they circled the words that they thought described one of the faces on the sheet. The faces are shown in **Figure 7**. The participants could circle as many of words as they wished.

After answering the four questions for one textile, the participants were asked to proceed to the next textile until all five textiles were reviewed for Round 1. Then, the participants were asked to begin at Textile 1 to start the next round or Round 2, then Round 3, and last Round 4.

2.2.3. The results of the user study with five textures

The results from the user study with five textures showed that emotions communicated to people using vision alone, then vision and touch together, and from still and moving textiles changed. Three analytical methods were employed to understand the results from each round of the study. These were Russell's Circumplex Model of Affect, face word cloud graphs, and the free association results.

2.2.4. Circumplex Model of Affect analysis

The most useful analytical tool was James Russell's Circumplex Model of Affect, which will be presented first. James Russell is a psychologist and professor of psychology at Boston University, who designed a two dimensional model of emotional affect in which people are asked to place words along an x axis where positive is happy on the far right of the axis. Negative is sad on the far left of the x axis. On the y axis, the highest point is excited or pumped. The lowest point on the y axis is calm [14]. **Figure 8** shows words Russell mapped to a Circumplex grid as an example. Note the position of words which express emotion on the grid. Happy excited words like "astonished" and "delighted" are in the upper right quadrant. Calm and sad words like "depressed" and "gloomy" are in the lower left quadrant. To create the Circumplex texture plot for this study, the numbers circled in questions 2 and 3 on the survey provided x coordinates and y coordinates respectively for each participant. Then the x coordinates and the y coordinates were averaged for each round to make the Circumplex plots in **Figure 8**.

During Round 1, the participants were invited to view the textures displayed in a still state. The results from Round 1 presented were not as expected. Textures 1, 2, 3, and 5 were all expected to start off in the upper-left quadrant, communicating agitation/anger, with Texture 4 starting in the lower-left quadrant, communicating boredom/depression. Instead, Textures 1, 2, 4, and 5 start in the right side of the quadrant, communicating positively and happiness. Texture 3 ends in the upper-left quadrant, communicating negativity/anger. **Figure 9** shows the Circumplex plots for all four rounds.

During Round 2, the participants were invited to view and touch the textures displayed in a still state. It was expected that all the textures would be on the positive half of the grid for

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Figure 8. Circumplex Model of Emotional Affect for words, redrawn from Russell's Circumplex ([14], p. 1167).

this round, which was confirmed once Texture 3 had moved to the right. However, Texture 5 rather than going up in excitement once touched read as more subdued, indicating it was visually more interesting to see than to touch. Texture 1 moved up into the excited/happy quadrant and Texture 4 remained almost in the same place.

In Round 3, the participants were invited to see the textures in motion. It was expected that all the textures would end up in the upper-right half of the Circumplex, which the results showed was the case. However, surprisingly, Texture 4 moved into the upper-left quadrant communicating agitation/anger.

In Round 4, the participants were invited to see and feel the textures in motion. It was predicted that the textures would stay in the upper-right quadrant, which proved to be the case. However, with one exception, all the textures rated lower on excitement and/or had lower y coordinates. The exception was Texture 3, which moved up considerably on the excitement scale. While this was not in the hypothesis 4, this result is understandable because participants had interacted with the textile samples3 times previously.

In the following analysis, Texture 3 alone will be looked at more closely because it had the highest variance compared to the other 4 textures. This meant people either loved or hated it. Texture 3 will become the texture used in the FELT wall panel.

2.2.5. The free association analysis for Texture 3

The next most useful analytical tool was the response to the free association questions. These responses helped to add nuance and understand why certain textures moved where they

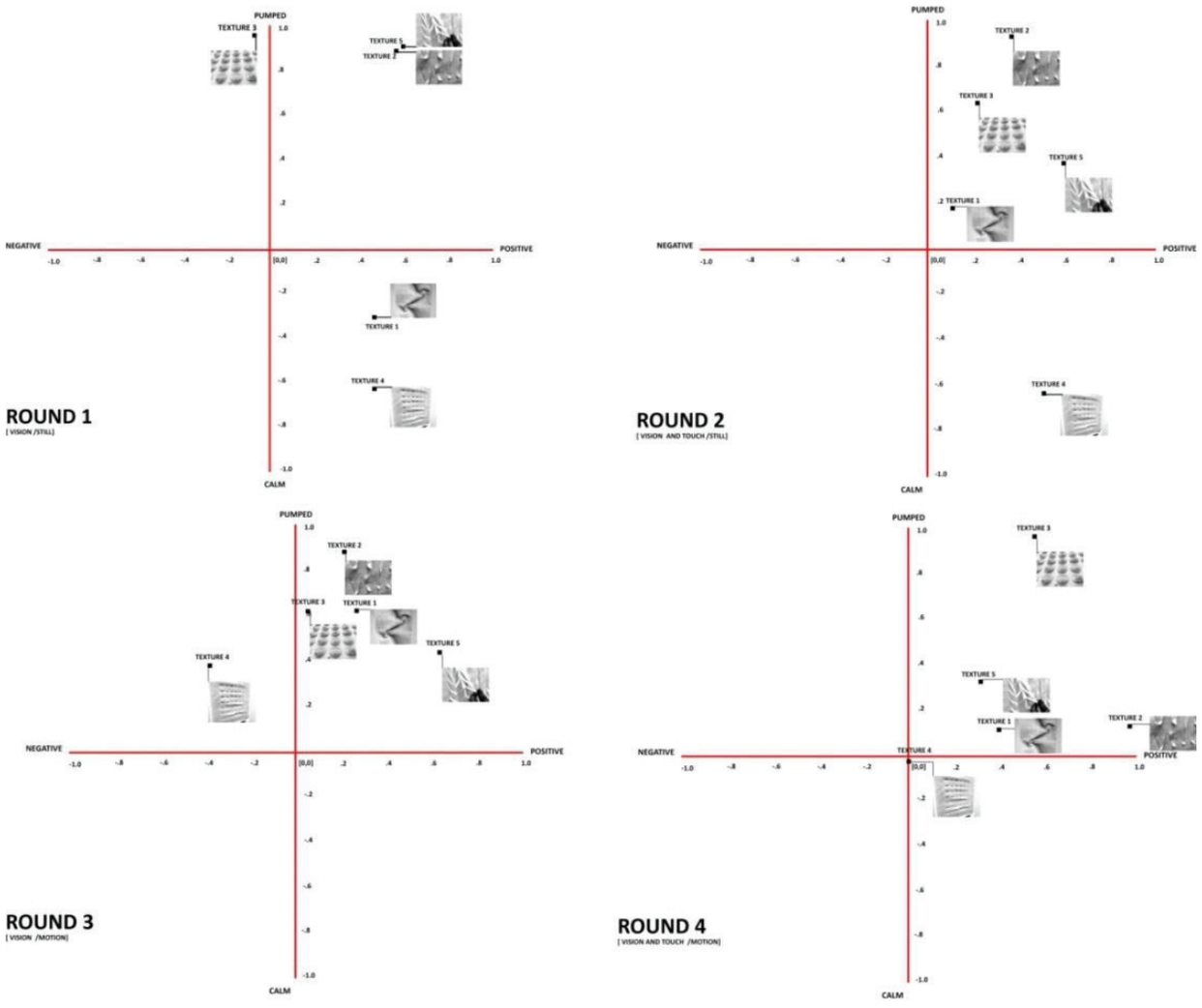

Figure 9. Circumplex Model of Affect for all four rounds.

did in the Circumplex analysis. The free association also showed change and transformation in communication of emotion as participants they stood in front of a texture. This showed that the communication of emotion was not static. In addition to this, several categories of responses emerged as the results were analyzed. These categories are often overlapping and it is certainly possible to describe other categories. The participants' comments are marked with a code (P), so that the comments can be connected to specific participants.

These categories include:

1. Memory and analogy relating to the texture via previous experiences.

This was by far the most popular response category.

2. Vitality or lack of vitality of the texture.

3. Expectation or comparison to imagination or previous texture.

4. Feels to skin.

5. Aggression or harm; understanding if texture will behave as if to harm.

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Not every texture had all of these categories. A summary of the results from the free association is presented. Only three of the five categories mentioned emerged in the responses for Texture 3. These categories were memory/analogy; aggression or harm; and expectation or comparison.

The results for Texture 3 showed high variance. People reacted strongly to it either positively or negatively. For example, in Round 1, many people had good memories of this texture; these memories tended to be of in-animate objects like sweaters, bathmats, etc. For example, participant 18 said "pleasant anticipation; calls to mind a bath mat; soft to feet causes of cushioned feel; it might not be soft in this case difficult to tell; fabric looks soft; stiff protrusions like spikes or uncomfortable to touch." However, more were like participant 9 "ohh… uh scary, looks like aliens with boobs; cows breasts; got scared too many breasts; do not want to touch it; makes me tense; like a Dali piece or Indian Shiva sculpture." Participant 12 was "disgusted by biomorphic holes and aggregated forms; plant like; geometric natural form; like pores; my gut reaction is fear; negative; what it evokes is negative; it looks relaxed but if I get close to it would throw water at you."

In general, for all five textures, the results showed that participant's previous life experiences influenced what was communicated. In addition, people compared their experiences with previous rounds of the study, so expectation was a big factor. The results showed that textures which appeared livelier or more vital received more positive responses. Haptic manipulation made it possible for people to change what was communicated over the duration of the touching round, which either improved or decreased the positive aspect of communication. If the expectation was that something appeared soft and it was not soft to touch, this lowered the positive aspect of communication. If a texture seemed to respond to touch this increased positive communication. Negativity was increased by touch, specifically when the texture either became less vital under the pressure of touch or seemed to actively disregard touch. This made for a negative communication. In addition, if a texture was similar to a living breathing thing, people were worried about harming it or being harmed by it. Many people discussed animals in their responses, animals that were breathing, as expected.

2.2.6. Face Word Cloud analysis

The information from the Word Face question showed much less agreement between individual responses than seen in the Circumplex grid. Participants could select more than one face as a response. As a result, there was much less correspondence compared the Circumplex Model of Affect. However, it was expected that allowing this selection could show more nuanced communication. Many participants added their own word to the faces to express what they felt was communicated back from the texture. The results are included for Texture 3 (**Figure 10**).

Texture 3 shows variable responses in each round. This range should imply that the texture moved considerably on the Circumplex grid, which, indeed, it does. As expected, "worried" has the highest word count in Round 1, and Texture 3 starts on the negative side of the grid to the left of the y axis. In Round 2, the word "happy" received the most counts and the texture moved from the left to the right side of the y axis. In Round 4, "happy" and "excited" had the leading counts, which corresponded to its location on the Circumplex grid. In Round 3,

Figure 10. Face word clouds for Texture 3 Rounds 1–4 (left to right). Word graph generated using [15].

however, participants used the words "scared," "worried," and "excited" to describe Texture 3. One would, therefore, expect the texture to move to the left side of the y axis. Instead, its position in Round 3 is very similar to its position in Round 2. **Figure 10** shows the word graph results for Texture 3.

2.2.7. Conclusion and discussion of the study with five textures

The four study hypotheses given in **Table 2** were best answered by the Circumplex Model of Affect, the results of which are reported in Section 2.2.4. To sum up the results from the Circumplex Model of Affect, hypothesis 1 was not true. Hypothesis 2 is partially true because it is true when people were able to see and touch the textures, their responses changed, but not always for the better. Hypothesis 3 is true; all the textures received a higher rating of excitement than when they were still. Hypothesis 4 is true, all the ratings did change. However, using the Circumplex Model alone produces a static map, which shows only a slice of a

Hypothesis number	Hypothesis description	Result
Hypothesis 1, round 1	It was expected that using vision alone, people would consistently associate specific emotional states with specific characteristics of the textures of textiles in a state of stillness. Crisp, curvilinear shapes associated with positive, excited, and happy feelings; smooth curvilinear shapes associated with positive and calm feelings; triangulated shapes associated with negative and angry feelings; smooth triangulated shapes and superimposed systems or a poorly defined combination associated with negative, depressed, and calm feelings.	Not true
Hypothesis 2, round 2	It was expected that when people use vision and the haptic senses together the emotional associations would change. It was expected that when people could see and touch a still texture, a negative emotional association using vision alone would change when using both vision and the haptic senses to a positive emotional association.	Partially true
Hypothesis 3, round 3	It was expected that when the textures were in a state of motion that this characteristic would raise or lower the participants' rating of what was communicated on a Circumplex grid based on what was associated with that texture motion.	True
Hypothesis 4, round 4	It was expected that the act of touching the moving textures would again change the ratings and what the textiles communicated.	True

Table 2. Hypotheses for study with five textures results.

more complex series of events by which textures or things communicate emotions to people. The free association method, for example, showed that a participant's reaction to a texture changed over time, often starting from memory or analogy as a hook, which then developed into reflections pertaining to other ways in which the texture communicated to them.

The methods here were helpful in regard to determining how much more complex is the problem of understanding what is communicated to people by still and moving textural expressions. Further, these methods suggest that the problems of understanding emotions communicated by raw materials are different from communications from materials found in completed objects such as clothing or architectural screens. This issue calls for a different approach to answering the problem of what emotion is communicated by material expression. This is a problem of making meaning. On this point, the author argues that meaning is made in context in specific situations, as argued by [16, 17, 11] in Sections 1.1 and 1.2. The problem with studying textiles is that they are unfinished products that can be used to make some other product, which calls for other ways to consider how to frame what textile expressions mean. Textiles are an inherently unfinished product until they are selected and fashioned into something in a specific context. To use a textile before it has been fashioned into something is to imagine "what it could be."

In the FELT study, the textile shown to the participants was a full-scale 5" × 6" (150 cm × 180 cm) wall panel, which was on a much larger scale than the textures shown for the study with five textures. In addition to the change in scale, FELT is large enough to truly divide the space of a room and becomes a wall or room divider rather than just a textile sample. The author will describe the study for using the FELT wall panel in the next sections.

2.3. Design process for FELT wall panel

FELT is a large approximately 5" × 6" (150 cm × 180 cm) modular panel in **Figures 1** and **10**. The design for FELT was selected to replicate Texture 3 in the study with five textures because this texture produced the widest range of responses from love to intense dislike in terms of what the participants perceived it as communicating. FELT was an opportunity to explore how changing the scale of a textile could change what emotion was communicated to people from the textile expression through vision and touch. Four key steps were followed in order to make FELT. The first was making the fabric, the second was designing the framework to hold the textile, the third was connecting the electric motors to the frame and textile, and last was mounting the frames with textiles onto a rack, which allowed it to be used as a screen or a divider in space (**Figure 11**).

The textile texture for FELT used two sheets of white felt laser cut and sewn to create a 22" × 35" (56 cm × 89 cm) panel, thereby replicating Texture 3 at a larger scale. The felt used was a wool and polyester blend. The final size of the sheets of felt was determined by the maximum that could be cut on the laser cutting bed.

Figure 12 is an exploded axonometric drawing showing the various layers of the FELT panels in the Plexiglas box. **Figure 13** is an axonometric showing one Plexiglas box mounted on the supporting rack.

Figure 11. Close up of FELT Plexiglas frames and textile panels.

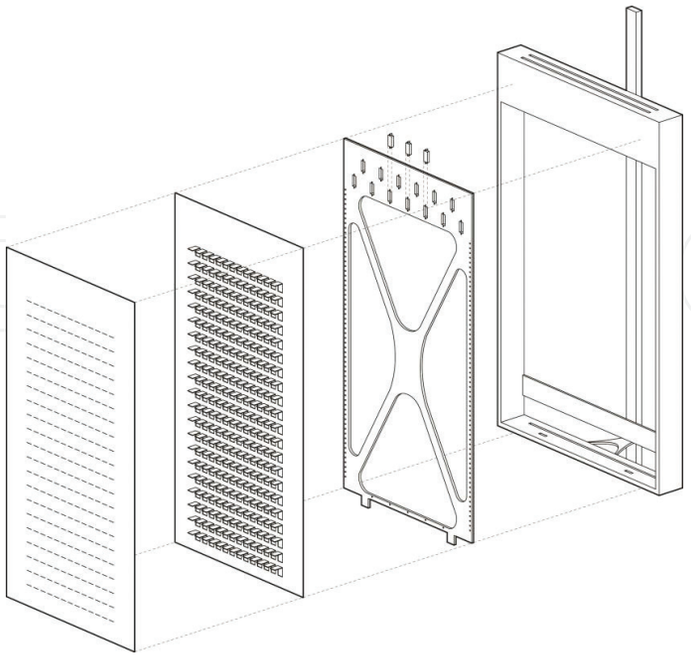

Figure 12. Exploded axonometric of FELT Plexiglas frame, aluminium frame and textile sheets 1 and 2 of the felt textile panel.

http://dx.doi.org/10.5772/intechopen.70032

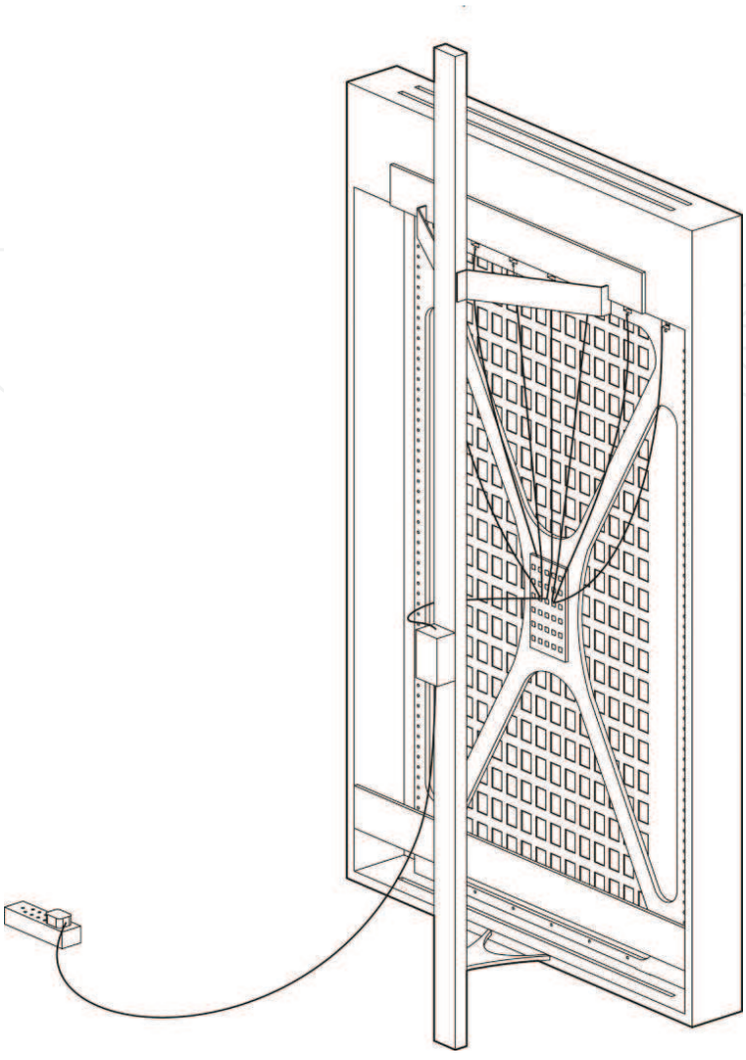

Figure 13. Axonometric showing one Plexiglas box mounted on the supporting rack.

The first step was making the textile panel. A first sheet of felt was cut into 1" wide × 1.2" flaps. A second sheet was cut with 1.2" long slits. The flaps on the first sheet were feed through corresponding slits on the second sheet to make the fabric. Second, the end of the flaps sticking out of the slit was sewn together making a cone shape. Then each cone was linked with a monofilament thread at the top. This monofilament thread slipped under the flap through the slit at the top and goes behind the fabric to be tied to a small digital 19 g/2.8 kg torque, 14/60° at 6 V servo motor at the top of the felt panel that pulled all the monofilament threads for that column of flaps. A second monofilament thread is linked to the cone at the bottom edge. This monofilament slips through the slit below and then runs behind the fabric to a weight that pulls the flaps back to their original position (**Figure 14**).

The second step was to sew the completed fabric to the aluminum frame (**Figure 15**). Once the fabric was on this frame, the motors were attached to the frame and to the monofilament lines from the fabric. Then, the entire aluminum fabric ensemble was snapped into a Plexiglas box, which held the panels (**Figures 1**, **11–13**).

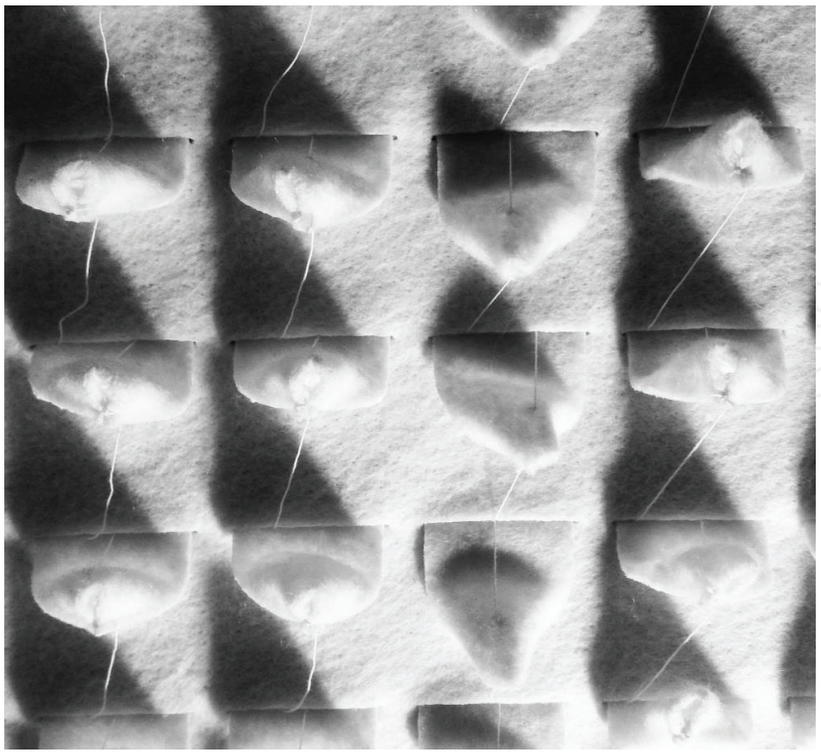

Figure 14. Close up of a FELT textile panel showing monofilament going up to be tied to a motor and another monofilament going down to be pulled by a weight.

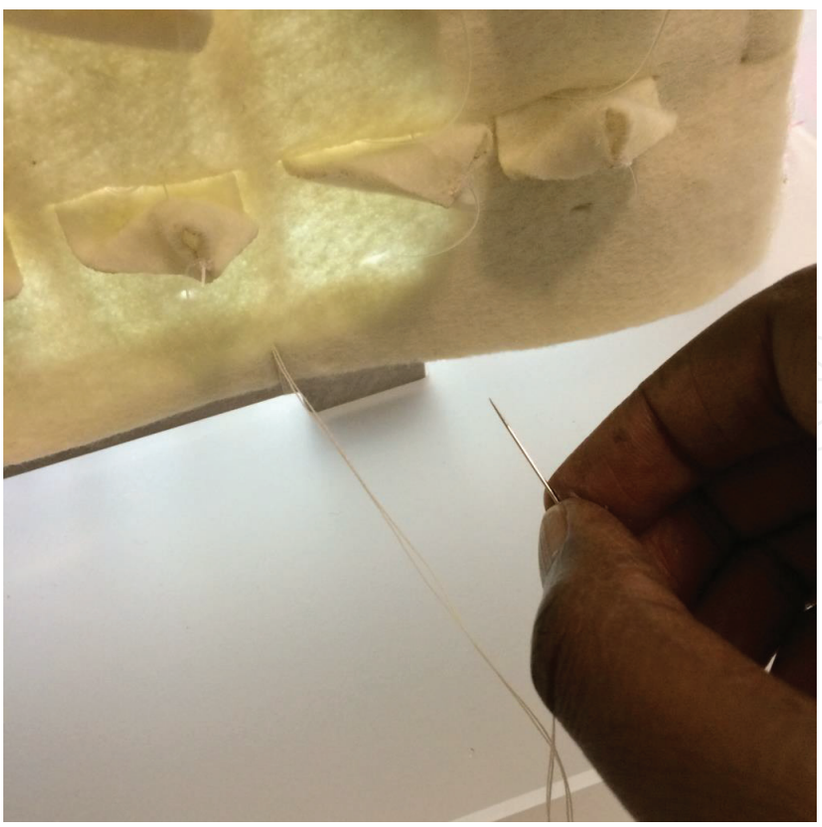

Figure 15. Sewing the felt panel to aluminum frame.

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Figure 16 shows the wires from the motors going into breadboard and power source. **Figure 17** shows corner detail in Plexiglas frame.

2.4. User study with the FELT wall panel using vision and touch

The purpose of the FELT study was to obtain feedback from the participants in regard to the emotional attributes a textile or texture on a large-scale screen communicates to them through *vision* alone in a still state and in a moving state. The FELT study was also designed to obtain feedback on the emotional attributes from the same textile screen in a still and moving state when the participants used both vision and touch together. An outline of the FELT study is the same as the study with five textures in Section 2.2. An outline follows below:

1. FELT Panel is Still
   a. Looking (**ROUND 1**)
   b. Looking and Touching (**ROUND 2**)

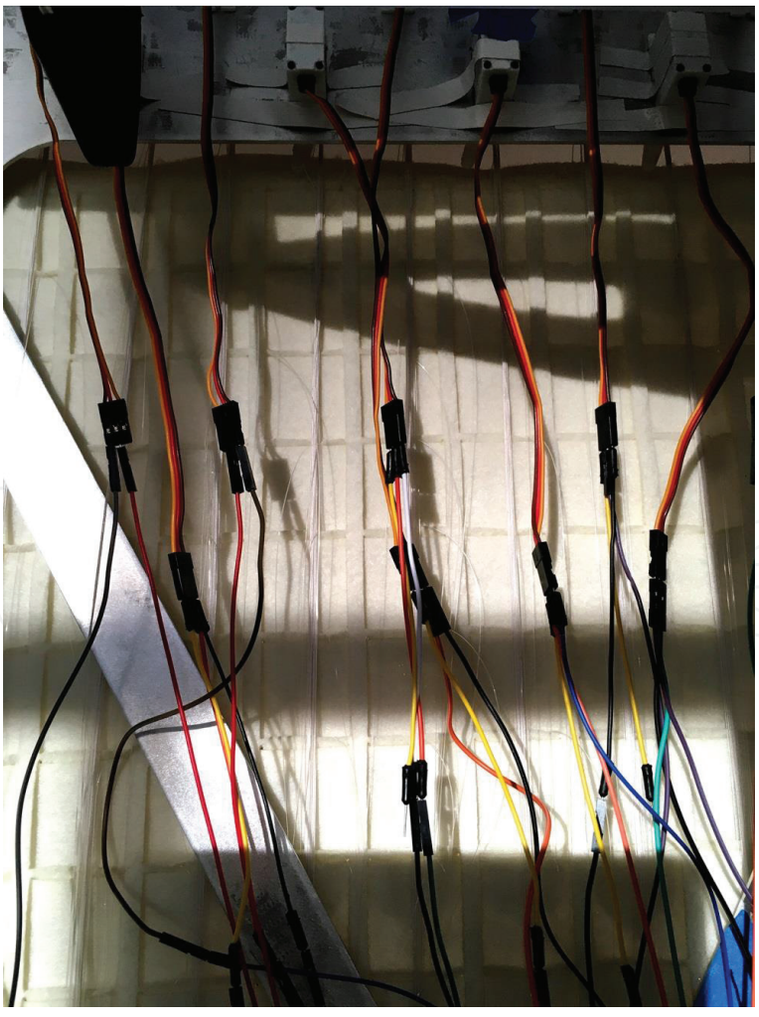

Figure 16. Back of panel showing motors and wiring at the top as well as threads that lift the textile flaps.

2. FELT panel is Moving
   a. Looking (**ROUND 3**)
   b. Looking and Touching (**ROUND 4**)

2.4.1. Hypothesis for the FELT wall panel

Table 2 shows the hypothesis for the study with the FELT wall panel.

2.4.2. Study procedure for the FELT wall panel

This final FELT panel study took place at the Pennsylvania State University in August 2016. There were 17 participants, 13 of whom were women and 4 were men. The age range was 20–65 with the men's average age at 36 and women's average age at 35. Each session took half an hour to complete four rounds of questions. The participants interacted with the FELT panel one on one with me in the room. All the participants were able to see and touch the textile panels. All

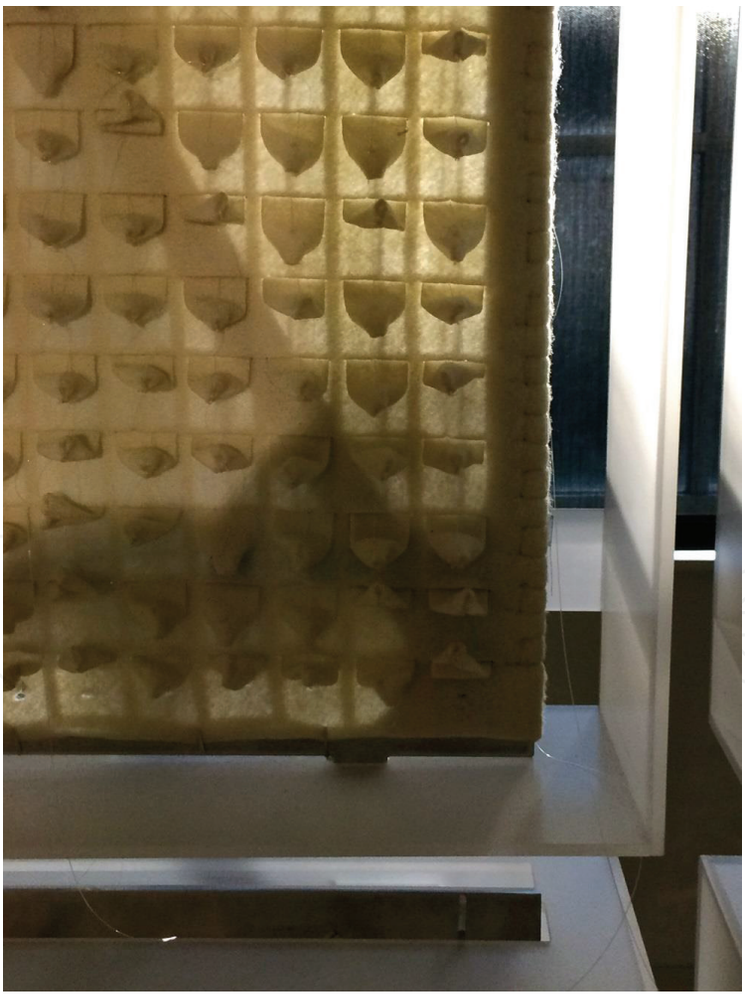

Figure 17. Detail at corner of textile insert in Plexiglas frame.

http://dx.doi.org/10.5772/intechopen.70032

the participants were able to speak and write in English. The interviews were recorded using handwritten notes. The panels used for the FELT project were four smaller panels making up one large 5" × 6" (150 cm × 180 cm) panel or the size of a room divider. The participants primarily stood as they viewed the FELT panel although one or two sat down to observe and interact with the panel. Each participant was interviewed separately.

The same four questions presented in Section 2.2.2 were asked of participants in the study for FELT. The same face/word chart was used as shown in **Figure 7**.

2.4.3. The results of the user study with FELT

The results from the FELT user study showed that emotions communicated to people using vision alone, then vision and touch together, and from still and moving textiles changed. Three analytical methods were employed to understand the results from each round of the study. These were Russell's Circumplex Model of Affect, face word cloud graphs, and the free association results.

2.4.4. Circumplex Model of Affect analysis for the FELT wall panel

The Circumplex Grid of Emotion plots show results that are consistent with the free association analysis. Question 1, which asked participants to rate 1–5 or negative to positive provided the x-axis data and question 2, which asked participants to rate from calm to stimulate provided the y-axis data. The Circumplex Grid was constructed with the averages of all the x data values and averages of all the y data values. Participants were much excited in Round 1, but when they touched the panels, they were disappointed in Round 2 when the visual appearance of the textile panels that appeared soft and pliable was not as soft and as pliable to their touch. Participants were further excited when the texture in the panels started to move or show motility in Round 3. In Round 4, when participants were permitted to touch the panels in full motion most, not all, participants reported a happy excited state as what was communicated back from the textile (**Figure 18**).

In terms of standard deviation, the highest negative/positive or x-axis data deviation was in Round 2, when participants could touch the textile texture. For the calm/excited or y-axis, the highest deviation was in Round 3 when participants could see the textile panels moving but not touch the panels.

2.4.5. The free association analysis for the FELT wall panel

There was some difference between the responses to the free association question in response to the study with the five sample textures and the large scale panel. Participants in the FELT study changed their positions to view the panel as expected to see the large- and small-scale features of FELT compared to no participants moving more than 3 feet away from the samples in the study with five textures, which were small textile samples mounted on the wall. Two people (P8 and P12) immediately and instinctively went to touch the large panel in spite of the verbal instructions issued not to touch it until requested. Before responding to the free association

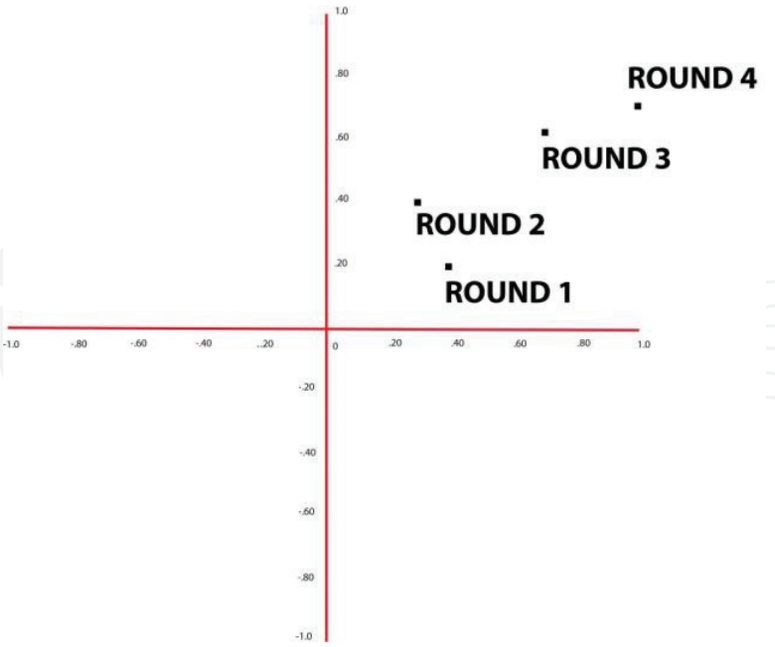

Figure 18. Circumplex Grid of Emotion for the FELT panel with the averages for all four rounds plotted.

question, four participants (P6, P8, P12, and P17) moved 8–10 feet away from the panel to have a look and then came back closer; in addition two participants (P13 and P17) sat down on a chair, which was near the panels or squatted to see what was going on in the lower panels.

In addition, several participants remarked on the light coming through the panels and that they were like windows when asked "what comes to mind?" One participant responded "A window, a curtain for a window, not a modern house, one like mom's or grandmother's house; this is like a cross and there is an extra band on one. It has a safe protected safe area. There was a war where I was growing up; windows were strengthened with tape to prevent glass from shattering" (P9). Also the large panel reminded people of walls as in this example, "what comes to mind is a pattern in a continuous wall; I am concerned with not knowing material which is just a physical aspect. It looks aggressive; like the thrown concrete on property walls in my country (Brazil). If you hit these walls and they are very sharp and you can be cut. But because the material is soft that will not happen here. But the pattern is not positive because it is like that concrete and because it is pointed and regular" (P6). Other participants connected it architecturally with descriptions like "high design corporate chic; an interpretation of 1960's modernism" (P3). In addition to connecting it visually with things associated with architecture people talked about the frames holding the textile which was unlike the study with five textures where no one mentioned the boxes hung on the wall. Participant 17 for example saw "duplicity, in the fact that there is more than one panel which means each panel not unique. I did not notice before but the backbone is different; the whole series of 4 is mirrored about vertical axis, probably unintentional. It is the idea of a hung textile in a frame with a sub-frame. I feel a lot of tension in backbone looks like it is pulling it apart and the fabric is trying to escape the frame more on the right side than left; it is like a person being stretched" (P17). This participant, an architect was reacting to the fact that the piece was made in four identical panels or frames, but the aluminum "backbones" that were seen through translucent

felt showed different shadows, making the appearance duplicitous. Participants were asked about the lighting and often tried to figure out what was and was not a part of the study, for example, participant 8 asked if the shadow behind the panels was part of the project.

Outside of these comments in Round 1, many of the remaining comments fell into the categories that were seen in the study with five textures. As stated in the study with five textures, these categories are often overlapping and it is possible to describe other categories even as the ones selected do work. It maybe that these categories were similar to those in the study with five textures because when it came to really capturing their thoughts and words participants wanted to use for the free association, participants stood close or about 2 feet away from the panels to look at the texture, which is the same physical position participants took in the study with five textures. Thus, most of the responses were primarily about the texture up close. There are some of the categories raised in Round 1 of the FELT study, which are as follows:

1. Memory and analogy relating to the texture via previous experiences

This was by far the most popular response category

2. Vitality or lack of vitality of the texture

3. Expectation or comparison to imagination or previous texture

4. Feels to skin

5. Aggression or harm; understanding if texture will behave as if to harm

6. Noise

7. Color

In contrast to the free association for Texture 3, every round for FELT had all of these categories. A summary of the results from the free association is presented. A list of the hypotheses for FELT is provided your convenience in **Table 3**.

As in the study with five textures, analogy and memory were the most often used responses in Round 1 and in to a lesser extent in Round 3 when the textures were in motion (**Table 4**). There were no responses from the same participants that were the same across any rounds for the FELT wall panel. Every response was unique from round to round.

2.4.5.1. Free association results: general discussion

All but one of the 17 participants in the FELT study had general comments to offer at the end of the four rounds. Some of the most salient are included below.

Concerning the environment of the study, participant 3 raised the issue of the environment in which the FELT study was taking place. She stated "the environment is anti-sceptic; feels like a design crit; clean but welcoming environment; feeling like a hospital; ethos of cleanliness; curious how these response would have been in different context." Participant 12 also had his expectations framed by the location of the FELT study. Participant 12 stated, "We are in an iconic building on campus and so I anticipated something different from walking in the front door."

Hypothesis number	Hypothesis description
Scale and Context Hypothesis	*It was expected that participant responses would change if the textile was designed as a large architectural panel or space divider rather than small textile sample.*
Hypothesis 1, round 1	*It was expected that using vision alone, people would consistently associate specific emotional states with specific characteristics of the textures of textiles in a state of stillness. Crisp, curvilinear shapes associated with positive, excited, and happy feelings; smooth curvilinear shapes associated with positive and calm feelings; triangulated shapes associated with negative and angry feelings; smooth triangulated shapes and superimposed systems or a poorly defined combination associated with negative, depressed, and calm feelings.*
Hypothesis 2, round 2	*It was expected that when people use vision and the haptic senses together the emotional associations would change (as seen in Study 3). It was expected that when people could see and touch a still texture, a negative emotional association using vision alone would change when using both vision and the haptic senses to a positive emotional association.*
Hypothesis 3, round 3	*It was expected that when the textures were in a state of motion that this characteristic would raise or lower the participants' rating of what was communicated on a Circumplex grid based on what was associated with that texture motion.*
Hypothesis 4, round 4	*It was expected that the act of touching the moving textures would again change the ratings and what the textiles communicated.*

Table 3. Hypothesis used for the study with FELT.

Some participants were not sure what was and was not part of the FELT study. Some found the light shining through the felt panels, which made dark shadows on the panels distracting, for example, participant 13 states that "the X shadows at the back were a distraction, interrupts the way we are looking at it." In addition, participant 2 stated, "the light coming through pulls one's eyes to the darker areas until it starts moving; then one starts to notice the lighter areas."

Also in terms of the noises, participants heard one remarked "the panels were not moving as much as it sounded like they were moving." And, "it is difficult to classify in terms of sound and difficult to classify in general because of the noise. It is less obtrusive" (P2).

The narrowness of the face emoticons was another large topic for comment not just in the general comments section but also throughout the four study rounds. 10/17 participants (P4, P5, P7, P8, P9, P11, P12, P13, P15, and P17) drew in their own faces, wrote in additional emotions or mentioned that the faces did not offer enough variety in emotion to be adequate to describe what they thought was being communicated by the texture.

	Round 1	Round 2	Round 3	Round 4
FELT panel	16/17 (P1, P2, P3, P4, P5, P6, P7, P8, P9, P10, P11 ,P13, P14, P15, P16, P17)	9/17 (P2, P4, P5, P7, P9, P10, P11, P16,P17)	11/17 (P2, P4,P5, P7, P8, P10, P11, P13, P14, P15, P17)	9/17 (P4, P7, P9, P10, P11, P14, P15, P16, 17)

Table 4. Free association responses for FELT that included references to memories and/or analogies.

Some mentioned that if this panel was breathing wall that would be scary. This was somewhat a confusing statement made by participants because the panel was quite large.

Color emerged again as an important topic in the general comments section. Six out of seventeen participants had something to say about color at the end of the study. "It's not colored" (P2), "color changes how you think about this or a print would change my reaction" (P4) "I like that there is no color and it is pure white; the sound works for it, adds to the liveliness of it" (P10) "I thought change was going to be color, color is important and affects emotion and situation" (P13). "If the material could be smart then movement and color could change according to touch and kind of touch aggressive touch versus soft touch." (P15).

2.4.6. Face word cloud analysis for the FELT wall panel

The face word graphic analysis for all the four rounds for FELT is above in **Figure 19**. All graphs are at the same scale and are based on word counts from the responses given to question 4. As you can see in **Figure 19**, when looking at all the graphs together across all four rounds, "O.K.," "excited," and "happy" are words that stand out consistently. "O.K." starts off as the primary reading in Rounds 1 and 2, but "excited" and "happy" emerge almost equal in count to "O.K." in Round 2 and take over as equal counts in Round 3 with "excited" being the highest counted word in Round 4. This response is understandable as it is the first time the textile motors were turned on. "Excited" in Round 4 never becomes as strong as the "O.K." in Round 1. In addition to "O.K." fading from Rounds 1 to 4, the emergence of "worried," "curiosity," and "curious" exists at the beginning in Round 1 and 2 but gradually fade in Round 3 and almost entirely gone in Round 4. This was to be expected as participants became more familiar with the textile panel. In Round 2 "cross" appears as a second level of counts after "O.K.," "happy," and "excited." This is the only instance of the word "cross" rising to this secondary level in the four rounds. One speculation on the appearance of the word "cross" is that people were surprised by how rough the points and monofilament plastic strings felt when touched compared to the soft appearance. Fourteen out of seventeen participants indicated surprise, annoyance, or some negativity in their free association responses in Round 2.

In addition to the observations mentioned in the above paragraph, there are fewer words generated in Round 4, 14 words compared with Round 1, which have 17 different words. The density of words trails off as you look from left to right in **Figure 15**. This decreasing density seen in the word graph is the result of fewer counts for the smaller words in Round 3 and a

Figure 19. Word Face word graph for the FELT panel in Rounds 1–4. Word graph generated using Feinberg's Wordle [15].

coalescing of counts for fewer words. Thus, the scale of all the words in Rounds 1 and 2 is closer together than the scale of the words appearing in Round 4, for example. In Rounds 1 and 2, the word graph is made up of a blend of large-, medium-, and small-scale words. In Round 4, there are primarily large-scale words juxtaposed with tiny scale words with no intermediate scaled words.

2.4.7. Conclusion and discussion of the study with FELT

The scale and context hypothesis and the four study hypotheses given in **Table 5** were each best answered different methods. For example, the scale and context hypothesis was best answered by the free association responses. Participants did address the scale and context of the textile panel either in words or body movement as mentioned in Section 2.4.5. The scale and context hypothesis is true as expected.

The Circumplex Model of Affect most easily frames the remaining four hypotheses (**Figure 14**). However, the free association adds a level of explanation for why people select the choices they did for questions 1 and 2, which provide the x and y points for the model.

For the FELT study, hypothesis 1 is not true in the case of the large textile panel. In the FELT study Round 1, the textile texture is plotted low in the right quadrant of the model or positive trending toward excited. In the study with five textures, this same texture was seen as

Hypothesis number	Hypothesis description	Result
Scale and Context Hypothesis	*It was expected that participant responses would change if the textile was designed as a large architectural panel or space divider rather than small textile sample.*	True
Hypothesis 1, round 1	*It was expected that using vision alone, people would consistently associate specific emotional states with specific characteristics of the textures of textiles in a state of stillness. Crisp, curvilinear shapes associated with positive, excited, and happy feelings; smooth curvilinear shapes associated with positive and calm feelings; triangulated shapes associated with negative and angry feelings; smooth triangulated shapes and superimposed systems or a poorly defined combination associated with negative, depressed, and calm feelings.*	Not true
Hypothesis 2, round 2	*It was expected that when people use vision and the haptic senses together the emotional associations would change. It was expected that when people could see and touch a still texture, a negative emotional association using vision alone would change when using both vision and the haptic senses to a positive emotional association.*	True
Hypothesis 3, round 3	*It was expected that when the textures were in a state of motion that this characteristic would raise or lower the participants' rating of what was communicated on a Circumplex grid based on what was associated with that texture motion.*	True
Hypothesis 4, round 4	*It was expected that the act of touching the moving textures would again change the ratings and what the textiles communicated.*	True

Table 5. Results to the five hypotheses for FELT.

negative on the left side of the quadrant very high up on the *y* axis toward stimulated with a reading of agitated, angry, and aggressive as shown in **Figure 9**.

Part of hypothesis 2 is true. Responses did change when the textile texture was both seen and touched. However in the case of FELT, participant's touch did not produce a more positive response, in fact, it produced a more negative affect in Round 2.

Hypothesis 3 is true; the responses were more excited and trending toward positive and more stimulated for FELT when the textile texture moved.

Hypothesis 4 is true; the ratings did change in the final round. In this instance, the ratings were more positive and more stimulated than in Round 3.

The face word clouds supported the information from the Circumplex Model of Affect.

As in the study with five textures, the responses of people changed over the time of interaction, reflecting the changing information their eyes and sense of touch exchanged with the textile texture. Because the FELT study textile panel was much larger in size this seemed to produce more kinds of bodily exploration and thinking in the responses compared with the study with five textures.

2.5. Comparison of FELT wall panel and Texture 3

Figure 20 compares the plot averages in red for Texture 3, which was a 9″ × 9" (23 cm × 23 cm) sample. Texture 3 was the exact texture pattern used to make the large textile panel FELT. The results of the plot averages for FELT are in black in **Figure 20**. The FELT Panel received more

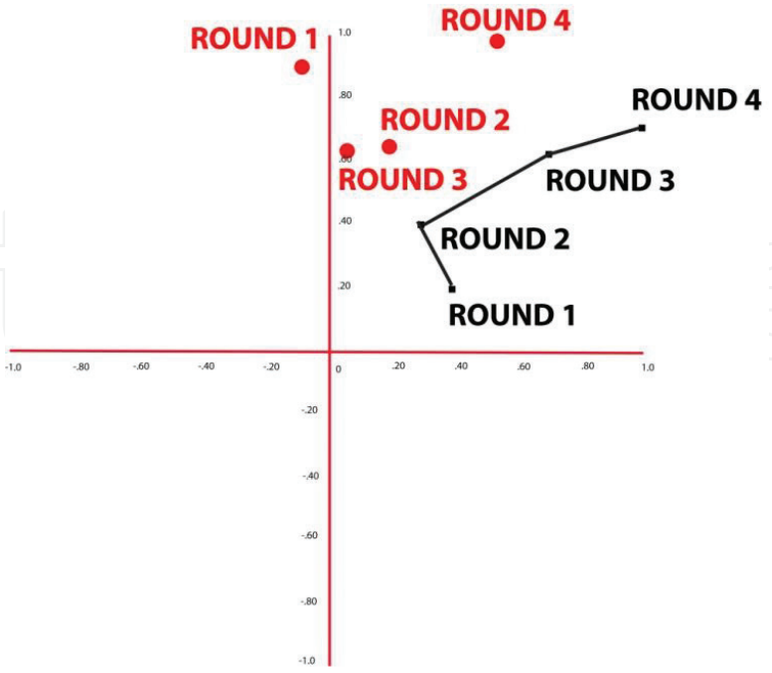

Figure 20. Comparison Circumplex Grid of Emotion plots for the FELT panel in black line with solid dots and the plot points for the original 9″ x 9″ (23cm x 23cm) Texture 3 in open dots.

positive ratings than those for Texture 3 and the FELT Panel received calmer ratings than those for Texture 3.

3. Conclusions and contributions

Hypothesis 1 was based on a belief that all humans are in some way hardwired or can understand certain shapes and textures in a very basic way through emotion. The experiments in this chapter did not prove this true, possibly because the context changes the messages of these shapes and textures.

Hypothesis 2 was based on the belief that once a person touches something that thing becomes known and thus is rated more positive. In addition, this hypothesis is based on the belief that if something was rated negatively using only vision that a negative visual rating could be overturned and rated positively using touch. Once a textile was touched, it did change its rating however, the change was not always positive.

Hypothesis 3 did affirm that when something in an environment changes, human reaction will typically, not in every case but most often, changes as well.

Hypothesis 4 is true. Yes, the ratings for positive/negative and stimulated/calm changed in every instance in study with five textures and the FELT study.

In closing, there are a few points of generalizable knowledge that demonstrated contributions of these studies. A summary of these salient points is as follows:

1. Using vision or vision and touch, the emotion(s) communicated to people changes during the process of exchange.
2. Emotions communicated through vision from a specific textile are different from those communicated using vision and touch.
3. Introducing motion or motility to a textile expression increases the stimulation and excitement of the emotion communicated by that textile. (The exception to this statement is seen in the study with five textures, specifically looking at Texture 3 in Round 3. In the Circumplex plot in Figure 20, Texture 3 shown in red ink decreases its positive rating in Round 3 compared to Round 2. It was expected to increase in positive rating.)
4. Analogy and memory are primary methods people use to understand what emotion is communicated by a textile.
5. The scale of the textile changed what emotion(s) were communicated from the textile because people must change their bodies to engage the larger scale.

Although these experiments did not prove that any specific live expression is related to any specific emotion, this work does demonstrate nevertheless that some expressions communicate in a range to most people somewhat consistently. Other expressions such as Texture 3 in the study with five textures had very strong, excited responses from different participants

on opposite sides of positive and negative emotion communicated. These opposing types of responses went away with the FELT wall panel. There may be many reasons for this difference. For example, Texture 3 was compared to other textures during the study with five textures and was an unfinished sample of textile. FELT had a defined function as a wall panel and was much larger scale.

Much communication that people take from expression is context based and is perhaps inference rather than direct communication. There is much more work to be done, however, if designers, scientists, and others are to fully understand the relationship between esthetic expression and communication. In the end, these experiments have shown that emotion communicated from computational objects is woven between that object or space and an individual body. In these experiments, each individual was observed forming his/her own analogy or memory map searching for and connecting experience to something else he/she has learned or experienced before about that material and emotion. In these experiments, people were witnessed in the moment of seeing or seeing and touching making new analogies and memories to keep with them about the material and emotion. There is more work to be done, too, in the field of neuroscience to further our understanding of how these analogy maps are created, their location in the brain, and how, whether, and to what extent certain aspects of certain emotions and certain kinds of experiences have the same or similar maps in the brains of most people.

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References

[1] Barbatti B. Berber Carpets of Morocco: The Symbols Origin and Meaning. Courbevoie, Paris: ACR Edition Internationale; 2009. Available from: from www.acr-edition.com

[2] Oxford English Dictionary. Expression [Internet]. n.d. Available from: http://www.oed.com/

[3] Expressive power. Computer Science. In Wikipedia [Internet]. n.d. Available from: https://en.wikipedia.org/w/index.php?title=Expressive_power_(computer_science)&oldid=741557765

[4] Oxford English Dictionary. Communication [Internet]. n.d. Available from: http://www.oed.com/

[5] Darwin C. The Origin of Species: 150th Anniversary Edition (Rep Anv edition). New York, NY: Bantam Dell; 1859

[6] Arnold MB. Emotion and Personality. Vol. 1. New York, NY: Columbia University Press; 1960

[7] Darwin C. The Expression of the Emotions in Man and Animals. 2nd ed. London, England: Penguin Group Ltd; 1890

[8] Frijda N. The meanings of emotional expression. In: Key MR, editor. Nonverbal Communication Today: Current Research. Berlin: Mouton Publishers; 1982. pp. 103-119

[9] Arnheim R. Expression. In: A Modern Book of Aesthetics: An Anthology. 3rd ed. New York: Holt, Rinehart and Winston; 1960. pp. 258-270

[10] Gibson J. The Senses Considered as Perceptual Systems. Oxford, England: Houghton Mifflin; 1966

[11] Johnson M. The Meaning of the Body: Aesthetics of Human Understanding. Chicago, I.L.: University of Chicago Press, 2008, 66 p

[12] Damasio A. Looking for Spinoza: Joy, Sorrow, and the Feeling Brain (Reprint edition). Orlando, FL: Harvest; 2003

[13] About Makaton [Internet]. n.d. Retrieved from: https://www.makaton.org/aboutMakaton/

[14] Russell JA. A circumplex model of affect. Journal of Personality and Social Psychology. 1980;**39**(6):1161-1178. https://doi.org/http://dx.doi.org.libproxy.mit.edu/10.1037/h0077714

[15] Feinberg J. Wordle—Beautiful Word Clouds [Internet]. 2008. Available from: http://www.wordle.net/

[16] Arheim R. Art and Visual Perception: A Psychology of the Creative Eye. Berkeley, and Los Angeles, CA: University of California Press; 1954. p. 426

[17] Dewey J. Experience and Nature. Vol. 1 of the Later Works, 1925-1953, In: Jo Ann Boyston, editor. Carbondale, IL: Southern Illinois University Press; 1925/1981