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# Finding Roles for Interactive Furniture in Homes with EmotoCouch

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**Abstract**

Furniture is the building block of the spaces we inhabit. Its design and its functions shape how we use spaces, as individuals and as groups. While being an integral part of our lives, furniture is unaware of what happens around it. But what if furniture could change its appearance? What situations should it respond to? How might it communicate its state to those around it? Can we use emotional expression for such communication? To find and explore roles for interactive furniture in domestic spaces, we built EmotoCouch: a provocative prototype that uses combinations of color, patterns, and haptics designed to convey emotions. We gathered feedback to the concept of an emotional couch from an online study with 138 participants and in a laboratory study with 14 parent-child pairs. Our findings identify promising future directions, use cases, and opportunities for the use of emotion for expressive communication by furniture.

**Author Keywords**

Emotions, furniture, couch, domestic environment, haptic feedback, embedded hardware, color.

**ACM Classification Keywords**

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

## Introduction

As a common object in shared living spaces, couches are used by individuals and groups in many different activities from quiet resting to socializing at a party. Due to this versatility they provide an ideal platform to investigate future use cases for interactive furniture in domestic spaces. Expressing and responding to emotions is an important part of people's lives: people respond emotionally to other people, animals, or even objects. Current furniture can already elicit emotional responses from its shape, use of textile, or color; however, so far these characteristics have been static and unchanging. Sensors and actuators offer an opportunity to make furniture that can automatically change its appearance, be more interactive, or even convey specific emotions based on its current surroundings. A couch that has its own emotions has the potential to play many different roles in a home; delighting kids when they come home with a new appearance, offering comfort by changing to a preferred design when someone is sad, showing an angry design if people are arguing to highlight tension, or showing an excited design when a family cuddles on the couch to subtly encourage family time together.

But how do people react to such interactive and expressive furniture? In what context would they want their furniture to express a particular emotion? Can they even identify the couch's emotions and, if so, will it delight or annoy them? How will it affect them and the other inhabitants of the home? And in what ways might it affect the space itself?

By building EmotoCouch (see Figure 1), a playful and provocative prototype, we sought to investigate these questions and to explore how furniture might

communicate emotions as a form of interaction. We gathered data using two different methods: building a physical prototype and conducting an online survey. Fourteen parent-child pairs gave us feedback on our physical prototype EmotoCouch and emotional furniture in general in a lab study. To gather feedback from a larger number of participants, we also conducted an online survey with 138 participants.

In the following, we report briefly on our findings about the emotional association and then focus on the opportunities and use cases for interactive furniture we identified in our studies.

## Related Work

In previous research, technically enhanced furniture or household items have often used standard information displays to provide a means for in-situ interaction in a specific context [5] or lights to convey information as an ambient display [3]. Other research created original pieces of furniture for playful experiences [2, 7] or to support better experiences in the work context<sup>1</sup>. These projects also illustrate that changing the design of furniture can elicit an emotional response from the people using it. Our designs were also inspired by consumer products and previous work on interactive objects, such as the mood lighting products by Philips<sup>2</sup> which illustrate the power of colored light to set mood scenes or Karotz<sup>3</sup> which shows a range of information including e-mail alerts or weather forecasts an ambient electronic device could display.

<sup>1</sup> <http://360.steelcase.com/>

<sup>2</sup> <http://www.philips.co.uk/c/mood-lighting/334887/dec>

<sup>3</sup> [http://store.karotz.com/en\\_US/](http://store.karotz.com/en_US/)



figure 1. EmotoCouch in a living room setup.

More closely related to our focus on furniture, Jealous Furniture<sup>4</sup> is a bookshelf and lamp that becomes envious of the amount of time a user spends online. Gaver et al. [2] deployed three different interactive tables, each of which encouraged ludic engagement by residents. By supporting open ended and playful engagements, users were able to endow the pieces with their own meanings. These works in conjunction with the emotional models and emotional associations of perceivable cues provided the creative foundation for designing the cues for the six emotional states of EmotoCouch.

### Designing for Emotions in a Couch

To study people’s reactions to an emoting couch, we chose a subset of emotions. As we were interested in a spectrum of different emotions we selected emotions from each quadrant in the Circumplex model of emotions [8]. The six emotions we chose for the couch to convey were excited, afraid, angry, calm, depressed/sad, and happy (see Figure 2).

While much work has been conducted in the field of psychology to explore people’s associations of colors [4, 10] or patterns [8] with emotions, less work has looked at this in the context of lights [1]. We built on the available work and created combinations of color and patterns aiming to create the highest possible identification with one distinct emotion. We verified our choice by creating images of the conceptual look (see middle column of Figure 3) and testing them in an online survey while being aware of the limitations of realizing that look in the actual prototype (see right column of Figure 3).

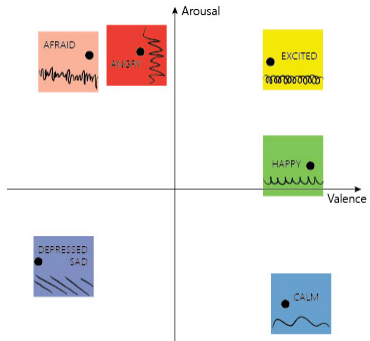


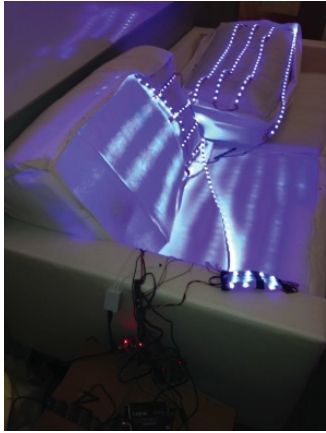
Figure 2. Chosen set of emotions in the circumplex model

<sup>4</sup> <http://www.pntscreen.net/projects/jealous-furniture>

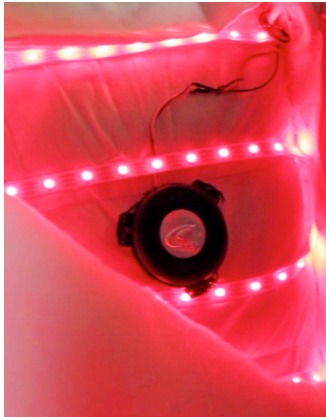
We designed different haptic behaviors to convey slow to fast and smooth to jerky movements in order to build up on related work of emotional associations with physical movements [6], e.g. a steady, repetitive, medium-paced drum beat for “happy” or a very irregular, fast one for “afraid”.

| Emotion       | Conceptual Look | Prototype Look |
|---------------|-----------------|----------------|
| Neutral       |                 |                |
| Excited       |                 |                |
| Afraid        |                 |                |
| Angry         |                 |                |
| Calm          |                 |                |
| Depressed/Sad |                 |                |
| Happy         |                 |                |

Figure 3. Color/pattern combinations for a subset of six emotions.



**Figure 4.** LED strips embedded into the custom built cushions



**Figure 5.** Embedded bass speaker to create haptic feedback

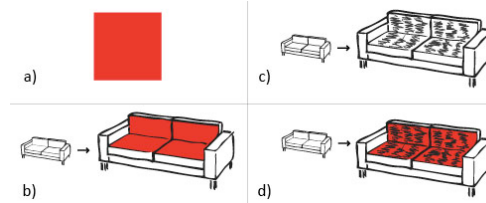
### Building a Couch that Expresses Emotions

To build the actual physical prototype, EmotoCouch, we purchased an IKEA KARLSTAD couch frame and built four custom cushions. The cushions contain 640 embedded individually controllable LEDs. Using the LEDs the couch's color can be changed (see Figure 4). In our prototyping process we also experimented with a variety of dynamic light behaviors, such as pulsing, fading, or transitions between colors. For our lab study we decided to only use static single colors, as we wanted to focus on studying the emotional association of the chosen individual colors. We created different patterns on the cushion covers for each emotion based on related work as shown in Table 1.

We created haptic feedback by playing subsonic sounds using a bass speaker embedded in one of the couch cushions (see Figure 5), which causes a person sitting on the couch to feel vibrations. We designed six different haptic behaviors to convey slow to fast and smooth to jerky movements inspired by related work on associations with physical movements to emotions [6], e.g. a steady, repetitive, medium-paced drum beat for "happy" or a very irregular, fast one for afraid.

### Evaluation Methods

To assess whether people associated the emotion we intended with the color and pattern combinations we chose we conducted an online survey and a lab study. For the online study we recruited 138 participants (84 female, 54 male; median age = 30, 18-61) using Mechanical Turk. We asked participants to associate one or more emotions with different designs (see Figure 6) and asked them to optionally describe why they associated that emotion with the picture, and in what situations a couch might express that emotion.



**Figure 6.** Examples for Angry of the four different pictures to which survey respondents associated an emotion

The laboratory study focused on exploring the physical experience with our prototype and how people interact with it. We recruited 14 parent-child pairs, with children covering the age ranges of 6-9, 10-12, and 13-15. They were taken individually to EmotoCouch, which was set to a specific emotional state, and asked which emotion(s) they associated with its appearance from our six chosen emotions, Neutral, or Other, and why. We concluded with semi-structured questions about interactive furniture in general.

Participants' free responses on the survey and the lab study created a large amount of rich qualitative data, over 3000 notes. We began data analysis using the affinity clustering methods on a subset of notes from the lab study to identify themes (about 500 notes). Informed by these themes, two researchers independently coded a subset of free responses answers from online survey and study and then discussed to agree on a final set of codes. These codes were then used to analyze all free responses independently and discussed to agree on a primary and (if appropriate) secondary codes which were used for further quantitative analysis.

### How Emotional Should Furniture be?

The idea of a couch being more than just a passive piece of furniture seemed intriguing to our participants. However, they also discussed considerations about how an emotional couch would fit in their home décor, what should trigger changes in the couch's appearance, and preferred emotions for their couch to display.

#### *Living Spaces Are Curated*

Several participants mentioned that such a couch would influence the look of their living room. Some thought that they would like to use the couch's designs to actively affect interior design as expressed by P5: "When I put different pillows on it, it would exude a different emotion for the whole room." However, others were more concerned about how it would fit the well-planned interior design of their existing space especially as the appearance is dynamic (P11: "Having the couch change color wouldn't match [the rest of the room].") Pragmatically, sentiments like these remind us that a couch is only one piece of furniture in a living space and must integrate with other elements, even if it changes.

#### *Autonomous or Manually Controlled?*

While décor considerations matter, a more actively debated question, particularly between by parents and children, was whether the couch should autonomously express its own emotions or be set manually to a desired state. Participants who expressed concerns with the couch being autonomous were mostly parents. They preferred the ability to set the emotion/appearance of the couch. Furthermore, they were concerned about adding yet another "emotional being" in their household and did not want P6: "one more thing you'd have to be sensitive to." or feel that they need spend time worrying about how their

behavior might affect the couch, e.g. C7: "I'm so used to have the couch as a piece of furniture and not thinking about how it's feeling and [that] stuff affects it." Instead, many stated they would want the couch to be available to assist them, for example so they could set it to a certain design to help them relax.

In one of the biggest differences we observed between parents and children, more kids liked the idea of the couch behaving autonomously. They suggested the couch might be an "emotional companion," being there for them P11: "if anyone felt a little not well, comforting them" as well as being something they would take care of, e.g. C1: "You could start petting it to calm it down, cheer it up, pet it or sit there with it." A few parents related to the idea that an autonomous couch would be more "service-like", e.g. as light therapy.

#### *Only Positive Couches Please*

Some participants said that they only want a couch with positive emotions (e.g. P3: "Nobody wants your couch yelling at you."). Mostly parents expressed interest in having the couch in a relaxing or soothing state. P11: "After a long day at work and coming home, that blue one would feel really nice, very soothing." Data from the survey shows a preference to associate emotions with Positive Valence to the designs. Out of all 1199 responses for combined Color+Pattern pictures, 58% were either Excited (20%), Calm (19%), or Happy (19%). Some participants speculated about potential emotional transference and liked this idea if the couch was positive (C1: "If the couch is happy, I'm happy, too"), but expressed concerns for negative emotions (P6: "Not angry, depressed, or sad. Since it can change your emotions. Emotional transfer is not good.").

### **When Should a Couch show Emotions?**

We analyzed participant responses to identify situations when they might want furniture to display emotion.

#### *Couches Like People*

Many participants felt that a couch could convey emotions while it was being used. Overall 21% of comments (160 of 778) described designs appearing in situations when the couch was being used, such as during parties, when relaxing or sleeping, watching TV, playing games (both physical and digital), or sitting.

#### *Couches React to Environment*

Participants frequently mentioned the surrounding environment of the couch as a reason for the couch to display a design (18%, 141 of 778 comments). Participants focused primarily on aspects like the activity level (M3: *"It likes all of the activity going on in our house with the kids and animals."*), weather (M122: *"It would be afraid if there is a storm outside."*), time of Day: C13: *"early morning or late at night"* or the physical surroundings, like a particular place the design would fit (e.g. garden, beach).

#### *Couches Dislike Abuse and Loneliness*

Two types of negative situations participants associated with the couch showing emotion were varying levels of abuse and being left alone. In 15% of comments participants mentioned the couch being mistreated in some way. These situations often featured pets

(M22: *"definitely when the cat scratches it"*) and when too many people or kids were overloading the couch (P1: *"if there's kids jumping on the couch"*). Another theme, most commonly described for the Depressed/Sad design, was loneliness, mentioned in 8% of comments. Many people felt the couch would be unhappy alone, when it could not do its job (C1: *"everybody in the house stopped sitting on it or going near it"*).

#### *React to Resident (Co-dependent Couch)*

Similar to how a family member or friend might react to how you are feeling (e.g. offering comfort if you are sad), participants thought the couch might display a particular design in response to their emotional state (mentioned in 10% of comments).

#### *To Encourage Certain Behaviors*

By changing the couch's appearance, inhabitants' behavior could be influenced. A theme that emerged was the notion of the couch using its emotional displays to encourage or reward certain behaviors. These included accomplishments (e.g. M110: *"The couch would feel this way when I got a promotion at work. It is exciting and fun!"*), when the family is together (P8: *"Whole family is there and we are playing games and having popcorn"*) or proactively trying to change the mood. For example, P6: *"tell everyone to calm when everyone is home from work or school to calm people down before bed."*

Several participants expressed ways emotional furniture could encourage good behavior. These included helping them get into a certain mind set (P3: "If it could sense that I'm tense, it would try and get me out of that."), reflecting their actions (e.g. C1: "It would make you think more about what you are doing, you wouldn't bring messy food and not clean-up after yourself"), and reminding them of their schedules by waking them up (P11: "Energetic type of color when I need to wake up") or making them uncomfortable (P7: "It could encourage me to do something that I might want to do or might not have the energy.").

**Which Emotions did EmotoCouch Successfully Convey?**

We further aimed to explore how well and consistent emotions can be conveyed through visual and haptic feedback in a couch. Here, we only report on our high-level insights (see Table 1).

Our color choices for Angry and Calm had the most participants associating the emotion intended. However, both are still relatively low at 42% and 46% of participants respectively. Participants were very selective in choosing Angry and rarely associated it with any other emotion (88% of the 90 times Angry was chosen it was what we intended). Conversely, Calm has a high percentage of successful associations because participants frequently selected this emotion overall. Only 2% of participants chose Afraid for the salmon color we selected, making it very unsuccessful. For the remaining three emotions, 32% associated green with Happy, 27% yellow with Excited, and 22% associated purple with Depressed/Sad.

| Attempted Emotion | Design Association   |
|-------------------|--|
| Excited           | ✓ Bright colors, split response to pattern, haptics conveys activity |
| Happy             | × Pattern might be too close to waves                                |
| Calm              | ✓ Waves and blue   |
| Depr/Sad          | × Keep color as it works for calm and neutral                        |
| Afraid            | ×  |
| Angry             | ✓  |

**Table 1.** Consolidated Feedback on Designs

When investigating which emotions were selected instead of the ones intended by our designs, we found that respondents often chose emotions with similar characteristics in the Circumplex Model. Respondents were associating the design with a similar emotion, just not the exact one intended. This might suggest changing our approach to aim for conveying a targeted emotional range instead of one distinct emotion.

Confirming related work, we observed that people tended to perceive designs as positive if it showed a color they liked, even if the design intent was a negative valence emotion. Many explanations for participants' associations with a certain design were very personal. These observations suggest that the ability to personalize emotional furniture would be crucial to its success.

**Discussion**

We started with a goal of consistently conveying emotional states and rendering the couch's emotional state glanceable without requiring "setup" (e.g. telling EmotoCouch what color and pattern you want for Calm). We still believe developing a default set of designs is a necessary starting point. However, after seeing the wide range of interpretations of the same pattern, the impact of favorite colors, and the necessity of fitting in with existing décor, it is clear that the ability to personalize emotional furniture will be crucial.

Personalization could range from asking for favorite colors (a fun chance for discussion among family members), presenting a range of patterns or even allowing participants to choose a design to associate with a specific situation (e.g. noise level that might indicate "party" or "nighttime"). The delight parents

and children had telling us about their favorite furniture and discussing EmotoCouch together suggests families might enjoy personalizing their furniture.

### Conclusion

Motivated by a desire to understand how people react to furniture that changes its appearance, we designed and prototyped EmotoCouch, a couch that uses lighting, patterns, and haptic feedback to express emotions. Through a survey and lab study we explored how consistently the designs were associated with the intended emotions. The studies further elicited usage scenarios for interactive furniture, such as reacting to people's presence or the environment, as well as assisting with behavior change. Overall, participants were intrigued by the possibilities of furniture with feelings, especially positive feelings, and some children suggested the couch might serve as an emotional companion. The situations participants described for when a couch should show emotions help make clear the sensing needed to detect a desired situation. Concerns participants raised, such as whether the couch should autonomously display emotions or be manually controlled, or questions about whether emotional furniture would create another obligation in participant's busy lives, would be valuable to explore through deployment of interactive furniture in people's homes.

Moving forward we are expanding the range of sensors and actuators embedded in EmotoCouch and connecting it to the Lab of Things SDK<sup>5</sup> so that it can be easily deployed into people's homes for in-situ studies and use data collected by other in-home sensors.

<sup>5</sup> <http://www.lab-of-things.com/>

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