

The Dress Room: responsive spaces and embodied interaction

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ABSTRACT

What does it entail to be embraced by a space that responds to your actions? What kind of relations can we create between the active body and the active space? What qualities does the responsiveness have for creating certain experiences of a space? Through the Dress Room, I begin to explore the qualities of responsive spaces and embodied interaction. The Dress Room is a white cube that responds to the body's movements over the floor. The walls move, the room collapses or expands. I rely on a dancer to open up this experience. The outcome suggests that interacting with responsive environments can help create a sense of intimacy as well as motivate our motions within the space.

Author Keywords

Responsive spaces, embodied interaction, atmosphere, temporal form, intimacy, motivated motion, dance as method, modern dance

ACM Classification Keywords

H.5.1. Information interfaces and presentation (e.g., HCI): Multimedia Information Systems.

INTRODUCTION

What does it entail to be embraced by a space that responds to your actions? We know more or less what it means to interact with something with our hands and eyes just as we have seen a host of other modalities applied to the task of interaction. However, it seems as something we can always easily leave – that we can step out of the field of interaction. What if, the field of interaction encompasses the entire space we occupy? Not in the sense of a cave for virtual environments, nor in the sense of wearable technology, but as a responsive architectural space.

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As Dourish writes [9], all interaction with technology is embodied, but what will it mean to be fully embedded in these interactions? What will it mean to act in and interact with the behavior of the surroundings through our bodily movements? Indeed, what I am interested in with this study is to explore the kind of relations we can create between the active body and the active space. I see explorations like this as a step towards understanding what experiences and new types of interaction these responsive spaces can foster.

With the Dress Room (see Figure 1), the artist Henrik Menné and I created a responsive space that has served as the platform for a series of explorations. The Dress Room is a white cube that responds to the body movements over the floor. It is made from a white square textile tent suspended within a steel frame measuring 5x5x5 meter. The suspension allows for the entire room to move more than half a meter in each direction. The sensors in the floor detect where a body is and the room responds either by moving with or away from that body depending on the set-up. We explore the qualities of this type of interaction through modern dance. Through a dancer's experiences we begin to understand what experiential qualities, and thus what possibilities for interaction design, this kind of responsiveness affords.

The Dress Room was developed as an aesthetic exploration and is deliberately abstract in its expression. It has no function other than as a responsive enclosure.



Figure 1 The Dress Room, photographed from 2nd floor.

BACKGROUND

Looking outside the field of interaction design we find a series of disciplines concerned with the relationship of the body in space. We have phenomenology, which address embodiment understood as our lived engagement with the world [cf., 25]. We have architecture that is concerned with the practice of creating spaces for certain sensations and purposes [cf., 26; 33]. Lastly, we have responsive art installations which in different ways explore the aesthetics of responsivity [cf., 7]. With a scaffolding of the experiences and theories from these adjacent fields we can more readily step outside the traditional functional frame of interaction design and focus on the qualities of interacting with responsive spaces.

Responsive spaces

A responsive space can be as simple as Warhol's Silver Clouds (1966). In Warhol's Silver Clouds the room is populated with numerous large pillow-like silver balloons and opposite directed fans that creates turbulence. Walking into that room changes the turbulence and consequently the flow of the silver clouds. Indeed, their flow urges you to engage with them. For instance, to push the clouds gathered in a corner – give them a proper shove – see them whirl up in the air, see how their turbulence makes all the others flow too. Finding yourself encapsulated in this flickering environment of soft silver clouds compels you to keep them going. Yet, they have an oddly calming effect.

Dune by Roosegaarde [8] is another example. Here the ground of a dark room is filled with sticks that you walk through – like walking through a dune of Lyme grass at night. The sticks respond to your movements and sounds you make with waves of light and gentle cricket-like sounds. The room is dark except for the light from the sticks elicited by your behavior. The Dune can entice you to run, to clap and sing, and generally to play around, or it can be a calming backdrop for a serene stroll.

There are many other examples of responsive spaces [5; 6]. The point is, that the full enclosure occasions an experience perceptibly different than if the responsiveness had been confined to a wall, a floor, or been a containable artifact [6; 7]. Even the full-wall installations that change form, such as, Slow Furl [29] or the Hypo-Surface [12] create an experience that is more distanced because you can easily step out of the field of interaction. The challenge from an interaction design perspective is thus to get a sense of what kind of experiential qualities [cf., 22; 23] a fully embodied interaction can occasion.

Space and Body

An architectural space, in classic terms, is never static nor is the experience of it. As Lefebvre writes, “*it is by means of the body that space is perceived, lived – and produced*” [21, p. 162]. Along the lines of Lefebvre one of the pioneers of modern dance, Laban, did not see space as “*an empty container waiting to be occupied by a body but rather as a*

dynamic form that would come into existence only through a moving human presence” [27, p. 229]. The key here is the notion of space and experience being a co-production.

Architects sometimes refer to this ephemeral co-production as the *atmosphere* of a space [cf., 33]. An atmosphere depends on the light, the temperature, the physical layout, the human (social) activities, etc. Thus, while architects cannot control the atmosphere as it comes to be in any given moment of experience they can design for certain qualities in the physical environment that will affect it. The modernist architect Zumthor, well known for his evocative spaces, wrote a book about atmosphere [33]. Here he describes nine different elements that for him play a crucial role in his endeavors to render certain atmospheres within his buildings. These comprise: The body of architecture (the collection of things that makes up a place), the material compatibility, the sound of a space, the temperature, surrounding objects, the relation between composure and seduction, the tension between interior and exterior, levels of intimacy, and lastly, the light of things. These are all elements that the architect can design for. The human experience, and thus the production of the space, comes after the architect has left and the space becomes embodied.

Responsiveness as Temporal form

According to Zumthor [33], we immediately experience the atmosphere of a space. We immediately sense if we like to be there, if we sense danger, or serenity. The atmosphere is not something we need to contemplate. The question is, does the responsiveness of the space change this?

This is not a question of challenging Merleau-Ponty's notion of always already inhabiting the world and thus our ability to experience it without prior contemplation [25]. Rather, this is a question of what the temporal form of the space means for our perception of it. Since everything happens in time, time *per se* is not new to the equation. What is new is the temporal form of the space. Temporal form is perhaps best explained through the example of music. Music does not merely happen in time – time is conducive to its form [28]. The patterns of music cannot unfold except for over time – time is conducive to its form. My argument is, that time is likewise conducive to the responsiveness of the space. Thus, this will change not *how* we perceive, but for *how long* we will have to inhabit a space in order to experience its temporal patterns unfolding.

In her dissertation [7], Towards a Responsive Aesthetics, Carlson proposes to understand the responsiveness as a medium with which we can play and create certain experiences. She argues that it is not technology which is the determining factor in this medium rather it is the “*reciprocal openness and receptiveness between participant and artwork*” [7, p. 213]. I agree that the technology *per se* is not the determining factor for the experience, however, without the temporal form that the technology enables the experience would be no different

from any non-temporal space or artwork. It is, for instance, the fans in Warhol's Silver Clouds that enables the responsiveness. It is the momentum they induce in the silver cushions that make them clouds. Without the turbulence the installation would be pedestrian and unlikely to be experienced as responsive. Likewise in Dune, here the temporal form is created from computational logic executed to control input and output. For example, the system behind Dune is designed so the response to sensor input happens fast enough for the passersby to both notice and comprehend that she caused it.

What I want to explore here is the experience of the responsivity from a fully embodied interaction perspective. What experiential qualities does it have? What possibly new ways of inhabiting space it can encourage? What potential new types of interaction can we develop from this?

In the next part I introduce the ideas behind the Dress Room, its actual design, and the responsive forms we experimented with. The subsequent part hold an argument for using dance as a research method followed by an account of the dancer's experiences from dancing of the Dress Room. Lastly, I provide an analysis of the experiential qualities we can create from this type of fully embodied responsive forms.

REFERENCES IN THE DRESS ROOM

The Dress Room is an abstract installation made in an attempt to focus the experience around the responsivity. It is conceived as a space you take on like a dress. The references are a combination of Fuller's "Garment for Dancers" [27] and the serene white cube of art galleries.

The Dress

Fuller was a dancer, choreographer, and inventor, who practiced a predecessor of modern dance called free dance [27]. Free dance was developed in opposition to the constraints of classic ballet. It was primarily concerned with the qualities and energy of the movements. For this type of dancing Fuller invented and patented "Garment for Dancers" [27] (see Figure 2). The dress had gradually emerged from experiments with dancing draped in



Figure 2 Loïe Fuller performing her serpentine dance in her "Garment for Dancers" from 1892 [27]. Left: photograph by unknown. Right: photograph by Frederick Glasier.

excessive amounts of silk and later extended with hand held poles of bamboo or aluminum to assist swirling the silk [27]. The dress was used in her Serpentine dances in which she, for instance, used the energy from the swirling silk to move in new ways.

The Dress Room's relation to the body is less direct and less compliant to the curves of the body. Yet, the Dress Room is about letting the white garment create a space in co-production with the movements of the body.

The White Cube

The white cube is traditionally known from modern art galleries – if not in principle even further back from cathedrals and Egyptian tombs [3]. As O'Doherty [3] pointed out in his seminal book "Inside the White Cube: The Ideology of the Gallery Space" the white cube is a space that aims to shift the focus of the viewer from context to content. The white cube excludes the outside. It has been cleared of everything besides the white walls. No daylight enters and only light source is electric, and thus time is eternal. The point is, of course, for the art to be enjoyed or studied in its own right rid of current fashions. However, as O'Doherty also argues [3], the institutionalization of the white cube has made it a context of its own. It has been what artists come to expect and thus inevitably also have in mind when they create.

The white cube of the Dress Room draws on this duality of contextual relation. It is stripped of any recognizable functionality and classic spatial ornaments and thus meant to serve neutral backdrop where the audience can focus on their movements and the responses from the room. Yet, it bears the symbolic of the white cube and thus we also hope to install an expectation in the audience of experiencing art – of mentally entering the serenity of a gallery while open to new experiences. The textile fabric of the walls and the visible machinery is also an indication that this is not a gallery for paintings. It is slightly different, and thus expectations are hopefully adjusted.

In a sense the Dress Room is not about "the white cube" but about the perception of and responses to the energies within the room in motion.

THE DRESS ROOM

The Dress Room is a responsive space. It moves. It adapts. The floor senses where you are. The room responds. It follows you. It stops. It collapses then expands. You are enclosed. It is a dress you wear. Sometimes it fits, sometimes it misbehaves. It invites you to move. To explore. To dance. The Dress Room blurs the boundaries between architecture and clothes.

As a framework to describe the Dress Room I use the framework of trinity of forms that I have previously developed [31]. The trinity of forms comprises the physical form, the temporal form, and the interaction gestalt. The physical form refers to the material expression and

construction; the temporal form refers to designed patterns of computational logic that processed through sensors and actuators can result in movements, animations, sounds, and other forms of expressed state changes. The interaction gestalt refers to set of human actions within the environment and the context in which they happen. The framework was developed as a lens to convey the key aesthetic aspects of interaction design and is thus well suited for describing the Dress Room [31].

The Physical Form

The Dress Room (see Figure 1) is a 5x5x5m cubic steel frame with a 3,75x3,75x3,75m white cotton tent suspended on wires inside. The wires are attached to eight pneumatic pistons, one for each corner of the tent. The pistons are supplied with pressured air from a compressor located in the basement of the building (for noise reduction). The floor in the room is equipped with 64 simple buttons made from tinfoil and foam and covered by black dance vinyl all mounted on eight plywood planks. The floor buttons are wired into two Arduino Mega boards connected with serial communication. The pneumatic pistons are through relays wired into the master of the Arduino boards.

Each piston can be turned on or off. Turning a piston off will slack the line and enable a pull to the opposite site. Moving the whole room in one direction would require all the pistons on the opposite site to be temporarily turned off. Each piston is controlled independently so it is entirely up to the computational logic to shape the room's movement patterns.

Interaction Gestalts

The room is accessible through a two-meter high slit in one side of the white cube. Interacting with the Dress Room entails no special equipment or training. We wanted to enable as immediate an approach to the room as possible. Everyone can walk in. Everyone can take on the room. The dress. The interaction can be intentional or a side effect of mere moving about in the room for other reasons. In either case, the room responds.

Alterations in the design

Originally, we wanted to capture more than just people's positions on the floor. Due to the dynamic nature of the walls and ceiling, however, we could not use cameras or Kinects for motion capture – there was no place to mount them. We then decided on embedding light sensors in the floor as a way to capture the shadows from the body. In the small-scale tests it worked fine, but in the final setup with 100 light sensors embedded in the plywood planks we did not manage to get any stable readings. After a substantial time of debugging we gave in and chose the simple and cheap solution of tinfoil and foam-sheets.

Anecdotally, we realized upon testing it with light sensors that people need little actual control to make up stories of how it responded to their actions. Thus, even if the input

was rather erratic people felt in control and came to get their story, of how the interaction worked, confirmed. We just nodded not wanting to interfere with their experience.

Soon after the room was fully operational we realized that, when moving around inside, it was almost impossible to sense the movements even when they looked quite dramatic from the outside. The reason, we understood, was the lack of reference points. The all-white cube and the pitch-black floor left little for the eyes to work with. We therefore decided to add a reference point in form of a white taped square in the middle of the floor. That helped.

The Temporal Form

The temporal form of the Dress Room is all about the computational logic of controlling the pistons based on an input from the sensors in the floor. The resulting expression is thus what constitutes the responsive form.

While we had some initial ideas about the design of the responsivity and thus the temporal form, it was not until the full-scale room was erected that we could become more specific. Thus, the explorations into the temporal forms became a series of experimentations trying out the reaction times and the experiences of different combinations of actions. For example, how did it look and feel when all four corners and thus the whole wall moved in unison compared to a swooping behavior where the top would move first and the bottom would follow? Or how did it affect the sensation of the room when it moved diagonal? With 8! possible combinations it was not meaningful to go through them systematically rather we chose to explore a series of distinguishable forms as means to become familiar with its expressional vocabulary. This process was not unlike getting acquainted with a new instrument. We also experimented with the power of the compressor changing the strengths of the pistons and thus the possible tempi of the movements.

On the input side we experimented with the effective layout of the sensors. Each square measured approximately 50 cm thus a step would easily bring the body to the next square. If each step would prompt a movement in the walls a body moving rapidly across the floor would not allow for the walls to finish their movement before a new was triggered. This easily caused a flickering expression in the walls rather than a sensation of the whole room moving. Thus, we had to carefully consider the reactions to adjacent squares in the floor. Alternatively, we could combine several adjacent squares and let them have the same response pattern making it more plausible that the room would finish a movement. This, however, lessened the sense of impact for the person moving around in the room as only every other step were likely to cause a (new) response.

After experimenting with all these aspects our selves we set up two types of responsive forms each with two variations for the dancer to experience.

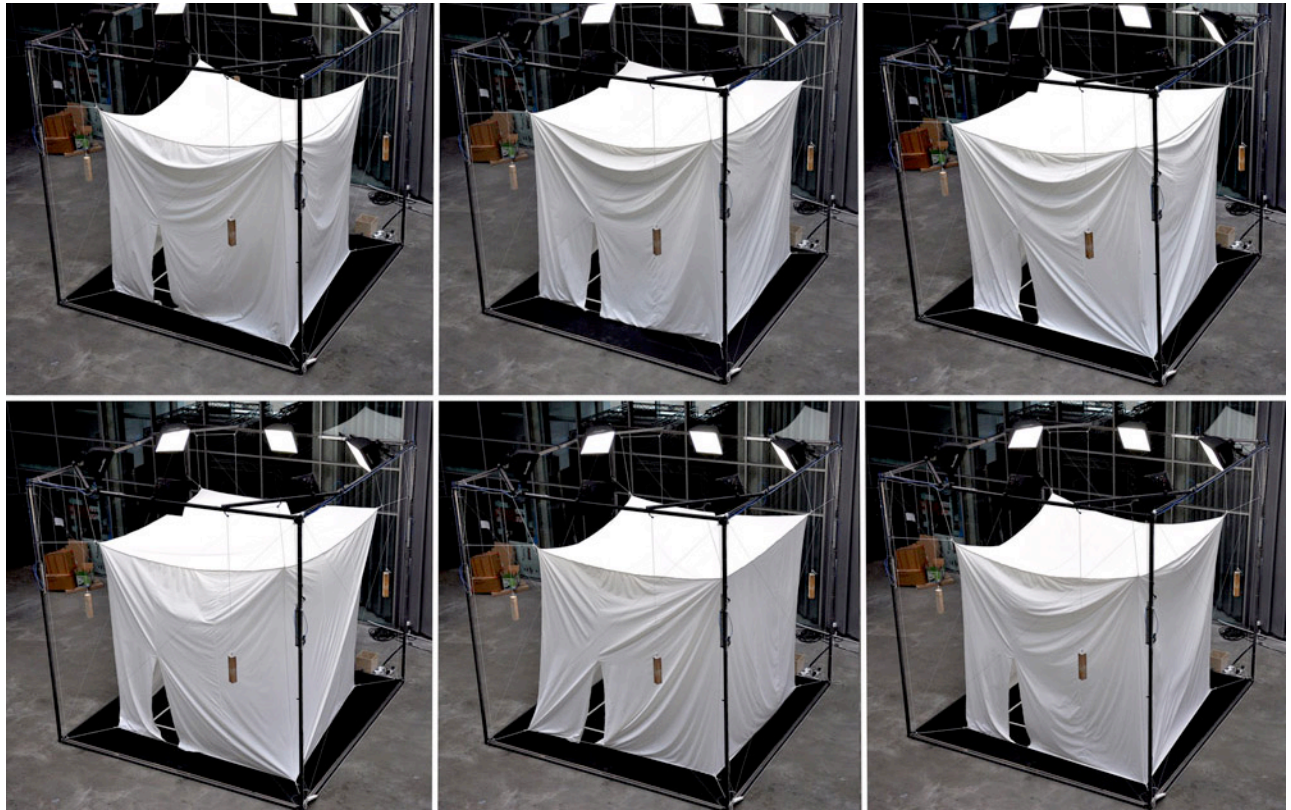


Figure 3 A series of pictures illustrating the motions of the room following the dancer inside. Photographer: Rina de Place Bjørn.

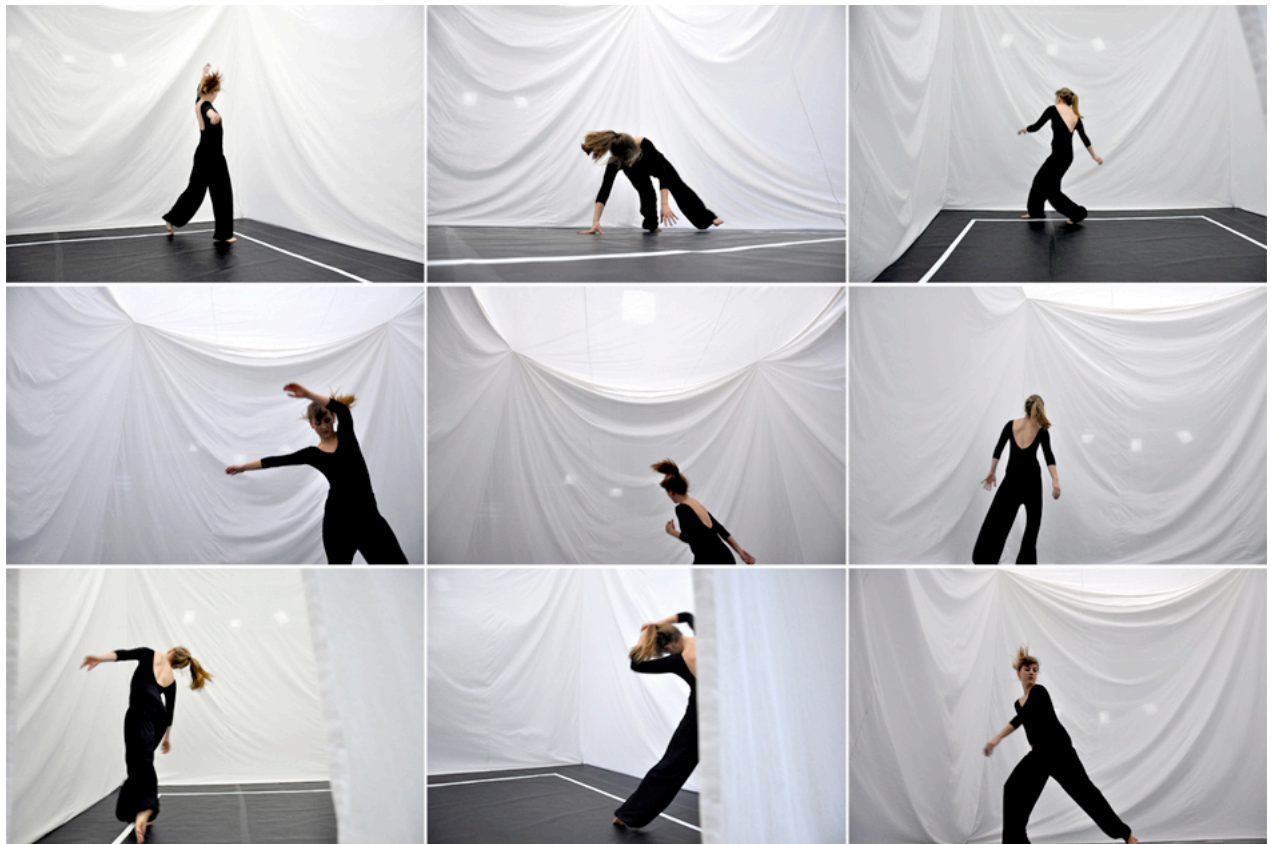


Figure 4 Nana dancing the room. The pictures are taken through the opening in the room. Photographer: Rina de Place Bjørn.

First Type Responsive Form: The Room as a Dress

We started out letting the room respond as a dress in the sense that the walls would follow the body within.

The room follows you around. It makes you feel that you wear a room. You feel in control. You belong together. You cannot escape – the door keeps evading you.

Indeed, stepping into a corner would move the room towards that corner, stepping towards a side would make the room move towards that side, etc. (see Figure 5). Activating the area around the center would justify the tent.

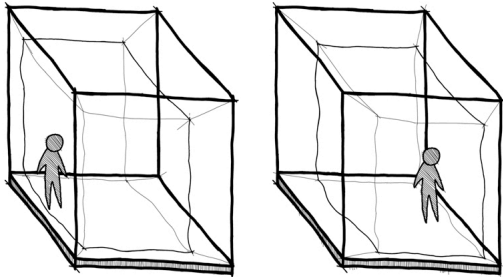


Figure 5 Sketch of the room responding as a dress.

In the first version we had combined the sensors in the floor in larger squares of four or eight to cause the same response. This meant that only every other step would result in a new response but that the room would be more likely to have time to complete a movement to its end (e.g., traversing half a meter to the left).

In the other version we introduced a much finer granularity having almost all squares in the floor causing a different movement. We also let the top and bottom pistons react independently allowing for a gradual movement of a wall. The room would now gradually sweep towards its destination. Adjacent tiles would cooperate in activating the movement of the room in the direction towards the edge or corner. However, if the person changed direction the sweep would not be completed and thus only hinted. This version resulted in constant activation of the pistons and thus it demanded a higher pressure in the pistons for the movements to become explicit before a potential change of direction.

Second Type of Responsive Form: The Vertical Response

The second type of responsive form was designed to explore the vertical dimensions of the room. We had deliberately created the room with a high ceiling allowing us to collapse it without coming in contact with the person within. This response form was modeled over an idea of a cathedral. In the first version moving towards the edge would make the ceiling collapse creating form of enclosure. Moving to the center would make the ceiling rise up to full height creating an increasingly grandiose space (see Figure 6). This responsive form immediately changed the focus from the walls to the ceiling.

In the other version we made the set-up asymmetric diagonal in the sense that the fully erected room would be the response to standing in one specific corner (see Figure 7). The rest of the room would be different stages of collapsed.

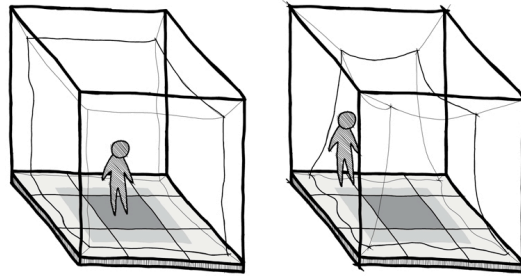


Figure 6 Sketch of the room in centered vertical response form.

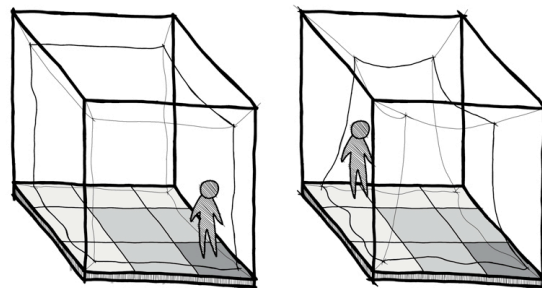


Figure 7 Sketch of the asymmetric diagonal form of vertical response.

We could have created numerous other responsive forms. In the process of their making and testing, however, we realized that even if there were differences in their expressions and how they were experienced these differences did not really exceed the overall experience of the physical responsive room.

DANCE AS RESEARCH METHOD

While Merleau-Ponty [25] never explained what he meant the phenomenological method entailed it seems obvious that to explore a space must involve some sort of inhabitation. Still, what does it mean to inhabit an abstract space like the Dress Room? It is abstract like art yet it demands more than an onlooker to be understood. It demands active participation. Thus, I have chosen a method that meets this space at its level of abstraction while still enabling active bodily engagement. I have chosen to use modern dance performed by a professional dancer whose experiences I have sought to understand through observations and interviews.

In her book *Closer* [17] Kozel combines phenomenology and her experience as a dancer to open up a series of art installations through her own performances and subsequent reflections on her experiences. She argues that, “*potential dense or difficult concepts can be demystified and given a*

sort of intuitive fluidity once they are read through the body” [17, p. XV]. Kozel uses dance as a basis for design but more importantly as a method of inquiry. She proposes a guide of how to carry out this phenomenological method through dance. Which can be summarized as: “

- *Take your attention into this very moment*
- *Suspend the main flow of thought*
- *Call your attention to your body and what it is experiencing*
- *Witness what you see hear and touch, how space feels, and temperature, and how the inside of your body feels in relation to the outside [...]*
- *Take a break (a moment, a day, a year)*
- *Describe what you experienced [...]*
- *Take a break (a moment, a day, a year)*
- *Reexamine your notes [...]*
- *Revisit, repeat, reiterate your process”*

[17, p. 53-55]

What is left out of this quote is primarily the details about how to write up the experience. This is not to indicate that the documentations process unimportant. Indeed, a lot can be lost and gained in the attempt to articulate and communicate the experience. In this case, however, I am not dancing myself thus this process will not be an introspective but rely on interviews and observations. This poses other challenges in terms of asking appropriate questions from enough different angles and through different formats.

There is a long tradition for using dance to explore the relation between body, technology, and architecture [27]. A contemporary example is in Flamand’s choreographies. He explores the body on the techno architectonic stage through a series of collaborative productions [27]. He has, for instance, worked with architects like Diller + Scofidio (Moving Target), Zaha Hadid (Metapolis), or Jean Nouvel (Body|Work|Leisure). Others, like Lilah Steece has developed a choreography for Rem Koolhaas’ Seattle Public Library. The choreography is an attempt of addressing the physical frame of the building as well as the rich color aesthetics and social concepts embodied by the space [32]. Birringer [2] also brings up how dance can be used for testing installations before a performance and thus ultimately serve as knowledge production for improving the design. Most of these interdisciplinary collaborations between architecture, dance, and technology have had the performance as the ultimate goal [2; 4; 27]. This is perhaps because only few of these collaborations arise from within architecture with an ambition of knowledge production that can transcend the performance and give new insights back to the field. One of the exceptions is the work by Thomsen [30]. Thomsen has developed two dance and interactive architecture performances in collaboration with a choreographer and an interaction designer: The Changing Room and Sea Unsea [30]. She used the performances to gain an understanding of the potential of parametric design

in the manifestations of the “*virtual other*” and “*fluid practice*” [30].

From within HCI and interaction design we too see examples of dance used as method to inspire new forms of interaction [cf., 10; 15; 19]. Yet, dance used as method for analyzing interaction and spaces, like Kozel does it, is still rather uncommon unless the responsive space is made explicitly for dance [cf., 14; 16; 20; 24].

Further, it has become popular within HCI and interaction design to use Laban Movement Annotation [18] as means to understand the physical relation between action and reaction within the interaction system. This is not, however, what I am interested in here. I do not necessarily believe that there is something in the physical form of the Dress Room that translates into other contexts. What I am studying here is the experience of the responsivity. What sensations it fosters and what possibly new ways of inhabiting space it encourages.

Overall, I argue that dance and dancers hold a key to understanding responsive spaces through an account of their experiences. Kozel is able to make these phenomenological accounts of spaces based on her own dance. I argue that the method can be extended into secondhand accounts of the experiences based on interviews with the dancer both immediately after the dance and again a while later.

DANCING THE DRESS ROOM

I have relied on modern dance as a method to explore the qualities of the Dress Room. Modern dance can be seen as an exaggeration of how we generally move about in space and thus the insights of embodied interaction we can gain from this will not be confined to the action of dance (cf., [27]). Compared to the pedestrian the modern dancer is more aware of her body in the environment and sensitive to the input she receives. She is likely to respond more expressively to changes and in general she roams more freely in the spaces she occupies. These are all qualities I find useful as means to explore the relationship between the active body and the active space. Lastly, modern dance is not meant to accomplish anything beyond the sensations and expressions created through the movements [27]. Likewise abstract is the Dress Room. It does not do anything but move, and there is nothing to do in to but move around and, perhaps, stand still. And in that capacity the two remains at the same level of abstraction. The point of the study is for the dancer to engage with the room through movements and for us as researchers to come as close as possible to her embodied experience.

Anecdotally, the Dress Room was not designed as a dance scene. It was exhibited at a university for a couple of months and had over a 100 visitors. I started out with some informal conversations with the visitors; however, I soon realized that they did not stay inside the room long enough for me to be confident in the quality of their responses. I

learned that many of them simply did not dare to really move around, as their actions were visible from the outside. Alternatively, they did not see the purpose to be in there beyond the first realization of connection between their movements and responses in the room. While I could have asked them to stay longer I also found that they had a hard time putting words to their experiences. Thus, interviews with the pedestrian audience did not seem like a reliable method to open up the Dress Room.

Instead I engaged Nana a young professional dancer. Nana danced the room with each of the four responsive forms over the course of three days. Each session lasted approximately 10 - 20 min. with minimum two of sessions per responsive form. Inspired by Kozel's instructions I instructed Nana to focus on her experience while dancing but other than that let her dance as she felt. She was aware that the room would respond but was not told how or why.

I observed her dance from the opening in the side of the room as well as the overall movements of the room from the outside (with video recording for later re-examination). Furthermore, I conducted semi-structured interviews immediately after each session aimed at learning about her experience of dancing the room. The most profound descriptions of her experiences came, however, after the first couple of sessions. She would later more or less repeat her first accounts with only a few additions. To some extent this may indicate that it was less important which responsive form I used and that it was the responsivity in itself she reflected on. Likewise inspired by Kozel I followed up on her experiences in another semi-structured interview several months later.

Nana's embodied experience

Overall Nana described the Dress Room as a constant source of inspiration. She explained that even when she repeated a series of movements within the same responsive form and the response from the pistons was the same the fabric would ripple differently each time creating an overall unique expression. Further, Nana repeatedly expressed the experience of dancing the Dress Room as a form of trance where her pulse was repeated in or synchronized with the pneumatic pistons. She explained that the pistons gentle whooshing sounds, and pulling of the walls experienced in correlation with her own pulse and movements created a strong symbiotic sensation. Indeed, to Nana the Dress Room had become a sort of dance partner in an improvised dance. A partner she would be in sync with. This process made her feel a certain unity with the space "*it was like the room and I had become one integral body of movements.*" Adding to this, Nana explained in the later interview that an important part of creating this sensation probably had been the fact that the interaction did not happen through her hands but through her "*feet and weight – through the movements.*"

Regardless of the responsive form Nana would spend the first period of the first session getting to know the "language" as she expressed it – not systematically – but through her dance trying to figure out which behavior had which effect at what impact. She would play with tempo and dramatic expressions. She explained that after a while she ceased to focus on how her actions influenced specific responses, and instead she eased into a dance where her motions became responses as well as actuators. "*It is not unlike getting to know something – could be a person, a thing, or a room. The process from the first meeting, till you feel at ease, till you can give something of yourself...in that room.*" In the later interview she further explained that even if she needed to familiarize herself with every new responsive form she had started to feel more safe in the Dress Room after the first day because "*the body had gotten more used to it.*"

Lastly, Nana explained while demonstrating through body language how certain responses in the Dress Room would inspire her to do certain movements. For example, in the first type of responsive form (see Figure 5), which was modeled over the behavior of a dress, Nana primarily danced along the edges of the room wanting to push the boundaries of the room. It was also towards the edges that the room responded most expressively. The second type of responsive form (see Figure 6), the one with stronger emphasis on the vertical movements, made her seek the middle in a rising motion that corresponded to the expansion of the room to its full size. She explained and demonstrated how it somehow made her use her upper body more even if it technically had no influence on the responses. She expressed it as "*a sense of uprising*" where the roof would rise from a collapsed form when she moved towards the middle. This movement made her feel a joy and as a boost of energy. Nana did, however, not feel equally empowered in the version with the diagonal form where the erected room would be a response to her stepping into the corner.

These were Nana's experiences as best articulated by her and through my questions. I do not claim these as universal experiences; however, I do not find anything in them that makes them particularly private either. I see them as an indication of what experiential qualities we can expect to create through fully embodied interaction in responsive environments. The following is an analysis of Nana's experiences in terms of experiential qualities for fully embodied interaction in responsive environments.

EXPERIENTIAL QUALITIES: INTIMACY & MOTIVATED MOTION

The two experiential qualities that Nana experienced in the responsive room can be articulated as intimacy and motivated motion. Below I will extrapolate those in the context of the atmosphere as articulated by Zumthor and introduced in the beginning of the paper [33].

Intimacy

In Zumthor's nine elements of atmosphere one of them is 'levels of intimacy' [33]. Within architecture, physical scale in relation to the human body is generally known as a primary parameter to create different levels of intimacy [cf., 11]. Zumthor, however, argues that intimacy is not really about physical scale but about how you are allowed to feel in the space [33]. To exemplify he uses Palladio's Villa Almerico, la Rotonda in Vicenza to show how a large scale space can make you feel empowered and free and not just alienated as would be the classic assumption in the presence of such dimensions [1; 33]. In that sense Zumthor leaves the rather safe physical parameters (of scale) and engages in the more complex human experience of the space (of intimacy) while still somehow link it to the physical scale and aesthetics.

Nana's experience in the Dress Room indicates that intimacy can come from yet another source than scale and aesthetics. Indeed, the plain white cube of the Dress Room offers little in terms of that kind of intimacy. The responsiveness, however, seems to carry a mode of relationship, which over time can develop into an intimate one. In the beginning it is a new language, it is unfamiliar, it carries this temporal form that is not immediately decoded. The Dress Room's responsiveness becomes an animation, which probes Nana to become familiar with it through moving her body. Further, in the interview conducted a long time after, she remember how she felt more safe dancing the room after the first day. This seems to indicate that exposing our body to an unfamiliar responsive environment may be a bit daunting at first it may be something we need to overcome.

Indeed, while the process of becoming familiar with a responsive space may be prolonged the sense of intimacy with that space may be increased when it eventually happens. Nana's experience of learning to *speak the language* or of *having a dance partner* may have created a stronger sense of belonging than an unresponsive space ever could.

Motivated Motion

Zumthor [33] sees architecture as a spatial as well as a temporal art in the sense that the architect must think about how people move through the building. As he writes "*Hospital corridors are all about directing people, but there is also the gentler art of seduction, of getting people to let go, to saunter*" [33, p. 41-43]. He refers to this element of atmosphere as "*between composure and seduction*" ([33], p. 41). Zumthor's notion of the temporal refers to the co-production of space in the sense of Lefebvre and Laban [21; 27] – the co-production that happens *in time*. This differs from the temporality of the responsive forms in the Dress Room where *time is conductive* to their forms. Thus, the elements from which to seduce people to move around differ. Further, the Dress Room is a cube with a single opening to the outside thus its physical form alone

offers little to create composure and seduction. The exception being that a spacious room with no obstructions enables and invites to move about freely within.

Nana's experiences of simply being inspired to move by the changes in the room, of being drawn towards the sides (in the first two responsive forms) or the middle (in the third) indicates that the responsive form of the Dress Room is key to motivating certain motions – that the composure and seduction can be created from the responsive form of the space. Nana did not just move her feet but her whole body in a response to the upward motion of the ceiling – even when she knew the room would not sense that. This indicates that she experienced the interaction as fully embodied and, as Carlson [7] also observed in her studies, that she was not concerned about interacting with the room but about the co-created responsive dynamics.

The Dress Room's ability to motivate Nana to move towards certain areas of the space as well as to move her body in specific ways indicate that responsive spaces can have a significant qualities when it comes to motion motivation. Noticeably, Nana was dancing and thus already in motion but there was nothing in her dance that would predispose *how* or *where*.

CONCLUSION

With the Dress Room, I sat out to explore embodied interaction with responsive spaces. From a methodological stance, and along the lines of Kozel [17], I have argued why modern dance is a valid and valuable research method to explore this kind of fully embodied interaction. Thus, with the Dress Room as a simple responsive space explored through modern dance I have begun to outline some of the experiential qualities of being embraced by a space that responds to our bodily motions. My explorations have indicated that responsive spaces hold the potential to make us form a kind of symbiosis with the space they are in – that the temporal form of the space's responsivity enables us to design for a sense of intimacy. They further indicated that our actions and the space's responses become interchanged and while the body and the room moves together they are constantly motivated/actuated by one another. The mutual responses of the body and the space are integrated but not the same. They are in a cause-and-effect relationship that is constantly evolving. Through relying on ideas and notions from phenomenology, architecture, and responsive art I have been able to step outside the traditional functional frame of interaction design and focus on the qualities of interacting with responsive spaces. This is not to say that the outcome is irrelevant for functional interaction design – on the contrary. I believe that there is a lot to be gained from making such excursions as they help broaden the scope of interaction design both aesthetically and functionally. After all, "*function resides in the expression of things*" [13, p. 166]. Thus, exploring new expressions will eventually lead to new functions.

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