

# **Breath, skin and clothing: Using wearable technologies as an interface into ourselves**

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## **Abstract**

There is a common ground that exists between the first person methodologies of performance practice and the technology research of Human Computer Interaction (HCI). Exploring this common ground, this essay describes movement research *based* in performance and somatics and then *applied* to the design of digital networked interfaces for wearable technologies. The research is based on a body of knowledge practices from performance/somatics that operate ‘from the inside out’, using the experience of the moving body to construct knowledge. Within both performance practice and HCI, there is a need to construct models of the user’s experience. One of the key questions this paper asks is: How can we bridge specific domain knowledge within performance practice to transform design strategies for our new technologies? The first section provides a theoretical context for bridging embodied practices from performance to HCI, and looks at 1) how performance methodologies can be used as a model for experience, 2) applying existing design concepts for creating gestural movement vocabularies in interaction, and 3) developing methods that bridge from experience to experience modeling. The second section provides a design context through the description of the development of the interactive wearable technology art piece entitled *exhale*, an installation that illustrates how first person methodologies of performance can be used to inform the design of digital interfaces/interactive clothing within an experiential environment.

## **Keywords**

Wearable technologies

Digital network interface

Human-Computer Interaction

Embodied Computing

Contextual Performance Practices

Not only can we be aware of each part of our physical self, we can be aware with each part of our physical self. This leads to a very intimate, almost microscopic experience which is the self.

(Cohen 1994)

Clothing is peculiar in the sense that it conceals in its very conspicuousness and reveals what it appears to hide.

(Guedon 2002)

### **1. Theoretical context – bridging embodied practices from performance to HCI**

I am interested in accounting for experience as a practice based function of accessing and constructing knowledge, as it is defined within performance practice. When I make the statement that experience accesses and constructs knowledge, I am speaking specifically of the subset of knowledge that can be experienced by our body/mind, and that is constructed through experiential and embodied practice. I am gathering shared evidence within HCI, and performance (somatics) that supports this view of experience, where experience constructs a way of understanding, and of creating knowledge in practice, while framing this within the greater field of HCI as well as performance.

There is a common ground that exists between the domains of HCI and performance practice. I refer to this shared ground as first person methodologies: techniques and protocols that articulate models of experience. It is precisely the differing frames of

reference between the domains that can reveal an under-theorized area of practice. The need to have models of interaction used to design the experience of the ‘user’/‘performer’ can be seen to be one such shared starting point that is framed through differing methodological strategies. How is interaction conceived, constructed, and integrated within a design process? What are the underlying assumptions that differ between these domains?

### **2.1 Performance methodologies: a model for experience**

I explore interaction as a space of lived experience and enactment, as something that is simultaneously inter-body and intra-body. Specifically, I explore human computer interaction – defined by *human* experience in which action and meaning are inseparable – as a model for developing relational human computer interaction systems.

Within the field of Human Computer Interaction, Dourish (2001) lays a strong argument for a foundation in HCI that validates the notion of an embodied interaction. The need to augment abstract reasoning and objective meaning with practical action and everyday experience is central to this approach. Dourish notes that his contribution is foundational, rather than methodological, which opens opportunities for methodological modeling and testing as a critical next step in the development of this area.

Suchman’s (1987) ethnographic research, which views all activity as situated and embodied, and her interest in purposeful, intentional activity, alongside Nardi’s (2001) work in constructing a ‘theory of practice’ within HCI based on the development of activity theory and intimacy between human and machine constructed through intense relational concentration, provide strong bridging links to our work.

### **2.2 Designing gestural movement vocabularies**

What are the properties of a gestural movement vocabulary? In Activity Theory, Nardi (2001) illustrates the notion of a ‘function organ’ – a transforming bond with an artifact. A photograph depicts a child listening intently to the radio, the expression of intense concentration suggests the creation of a relation between body and object. In dance and theatre the gesture itself can also become a ‘function organ’, an artifact that creates or enacts a transforming bond between the participant and their own movement. In this way, we think of the gesture *itself* as a function organ: an artifact that creates affordances for interaction.

The design of specific gestures that can become enactors is a notion common to theatre and dance practice. Richard Schechner (1985) uses the term *restoration of behavior*, to describe gesture as ‘material’. Restored behavior is organized as sequences of events, scripted actions, or scored movements. He refers to these as strips of behavior, and states that a restored behavior, although ‘originating from a process, used in the process of rehearsal to make a new process, or performance, the strips of behavior are not themselves process but things, items, *material*’ (Schechner 1985: 35). This concept of gesture as source ‘material’ for designing interaction models is central to our work.

Augusto Boal states that ‘bodily movement *is* a thought, and a thought expresses itself in corporeal form’ (Boal1992: 61). Boal’s *arsenal of theatre* can be used to re-enact, or re-materialize the body state that accesses or indexes that thought or ‘thought-unity’. Grotowski refers to an acting score as a script for designing *point of contact* or connection (Schechner and Hoffman 1997). In Interaction Design this is the equivalent of interaction schemas, which are navigated in order to construct the instantiation of the interactive experience. Grotowski speaks to the necessity of scripting gestural sequences in order to construct connection schema: ‘What is an acting score? The acting score is the elements of contact. To take and give the reactions and impulses of contact. If you fix these, then you will have fixed all the context of your associations. Without a fixed score a work of mature art cannot exist’ (Schechner and Hoffman 1997: 54-55).

We suggest using gesture as a ‘function organ’, as a mechanism that can assist in defining properties for a scripted interaction score. These gestural function organs have the goal of

paralleling processes to construct Grotowski's concept of mature art: works of 'mature interaction' (Schechner and Hoffman 1997: 55).

### 2.3 From experience to experience modeling

What do we mean by experience modeling? By bridging domains of performance practice with HCI, we are focusing on an area of enacted cognition: the *enactment* of descriptors, or schemas for movement. Previous research in the use of exploring experience/performance methods within the HCI community has occurred in the domain of user-centered and participatory design (Forlizzi and Ford 2000). This has included: *experience prototyping* that fosters an 'empathetic' and 'embodiment' approach to user-centered and scenario-based design (Buchenau and Suri 2001; Burns, Dishman, Verplank, and Lassiter 1994). Interval Research's exploration of *informance*: informative performance and *bodystorming*: physically situated brainstorming, *repping*: re-enacting everyday people's performances, and explorations of how low-tech solutions can create a design environment that focuses on the design question rather than the tools and techniques (Burns, Dishman, Verplank, and Lassiter 1994; Scaife, Rogers, Aldrich, and Davies 1997). Salvador and Howells (1998) shifted the focus group methods to something they called Focus Troupe: a method of using drama to create common context for new product concept end-user evaluations. Simsarian (2003) has explored the use of role-play in extending the richness of the design process. In the *Faraway* project, Andersen, Jacobs, and Polazzi (2003) explored story telling and 'suspension of disbelief' within a context of game and play in a design context. In addition, exploring other subjective aspects of creative process, such as the use of creating ambiguity in design, has been described by Gaver, Beaver, and Benford (2003).

In the performance domain, dance analysis and somatics specifically construct systematic articulated movement models directly from the *experience* of the moving body. Somatics is defined as the *experience from within the lived body* and includes practices such as Feldenkrais and Alexander technique. From the somatics perspective, knowledge is constructed *through* experience (Hanna 1998; Johnson 1995) and requires that experience

be directed or focused through *awareness*. Experience alone is not a pre-cursor to knowledge acquisition, since experience alone could result merely in conditioning, or in accessing conditioned responses. In somatics this would be termed ‘somatic amnesia’. However, when experience is specifically directed through the focus of attention, knowledge acquisition takes place which can be referred to as ‘Somatic learning’, an activity expanding the range of what Hanna terms ‘volitional attention’ (1979: 137-52). While Csikszentmihaly (1990) suggests that human experience operates within a limited field of attention, other movement systems within somatics consider attention to be a generative attribute of awareness that can be augmented, increased through a process of somatic learning (Hanna 1998).

Rudolf Laban’s movement analysis systems (Laban 1974; Newlove 1993), and the work of other researchers such as Bartenieff (1980) and Blom & Chaplin (1982), are examples of gestural typologies based in experiential practices of dance (Schiphorst 1997; Schiphorst, Calvert, Lee, Welman, Gaudet 1990) which model a range of qualities and modes of movement. These typologies can be used for gestural mapping and modeling qualitative movement characteristics such as intentionality, interest, attention and body state. They present potential experience models for the classification of aspects of movement, and define a means to approach gestural and choreographic protocols.

Participatory design, experience design, performance, theatre, dance and somatics share a common focus in modeling or representing human experience. These domains also share the ability to articulate and explore engaging experience through movement, emotional response, sensorial qualities, and temporal/dynamic qualities of experience and of movement.

### **3. A design context example – *exhale***

In this second section, I use an example of an interactive installation, *exhale*, that has been designed based on principles outlined above. In *exhale*, the experience of breath,

interaction through movement and touch, and the experience of ‘wearing’ one’s own physiological data was a design intention.

*exhale* is an interactive art installation based on designing and fabricating ‘a-wearable’ body networks for public, social space. The term “a-wearable” is used to refer to a synthesis of ‘wearing’ clothing that uses attention to afford “awareness” of the self. In *exhale* networked group breath is used as an interface for interaction. The rhythm of breath is a mechanism for sharing our bodies’ affective non-verbal data. This occurs through responses in the linings of skirts worn by the participants. Networked breath is used to create output patterns through small fans, vibrators and speakers that are embedded in the lining of these sensually evocative skirts. This response enables a hidden and ‘inner’ one-to-one communication between bodies in the installation, so that one body’s breathing can directly affect another body’s skirt. At the same time, collective group-breath is made visible on the *exterior* layers of fabric on the skirts by using a specialized fabric printing technique that enables certain fibers to ‘light up’ in a continuous cycle according to collective breath rhythm. Breath bands wrapped around the chest measure the ebb and flow of the breath cycle. As clothing, and as a type of costuming, the skirts of *exhale* cross our gendered modes of ‘wear-ability’, and are able to ‘contain’ both inner and outer senses of self. *exhale* interaction enables an expression of collective group empathy through the use of breath. This artwork integrates somatics and gestural interaction with textiles and garment design, developing new communication metaphors for wearable technologies and wireless networks. *exhale* premiered at the Emerging Technologies exhibition in Los Angeles at SIGGRAPH (August 2005).

This description is organized into the following components: experience, artistic concept, interaction, and technical description. Together, these sections address various aspects of creation, production and working method:

- 1) how the public will *experience* the installation as they approach, enter and interact within it;

- 2) what is the *artistic concept* that supports that experience, and unifies the concept of *breath* as a starting point, and the concept of *wearing ourselves* through garments, clothing or costume;
- 3) how the *interaction* enables *group breath* to be expressed through the garments, and how interaction utilizes modes of self-to-self, self-to-other, and self-to group communication.
- 4) how the piece is *technically designed* and constructed in order to support the artistic concept and participant experience;

### 3.1 *Exhale* experience scenario

Participants walk towards the darkened space, becoming aware of eight textured and sensual garments: skirts made of silks, and organza, natural fibers in earthy and vibrant tones, hanging from cables stretched from ceiling to floor. The visual image is a small forest of ‘skirt trees’: skirts suspended at various heights in space, connected to vertical cables dropping in plumb lines to the earth. A light positioned at the base of each skirt illuminates it upward from below, highlighting and bringing light to its materiality (Fig.1).

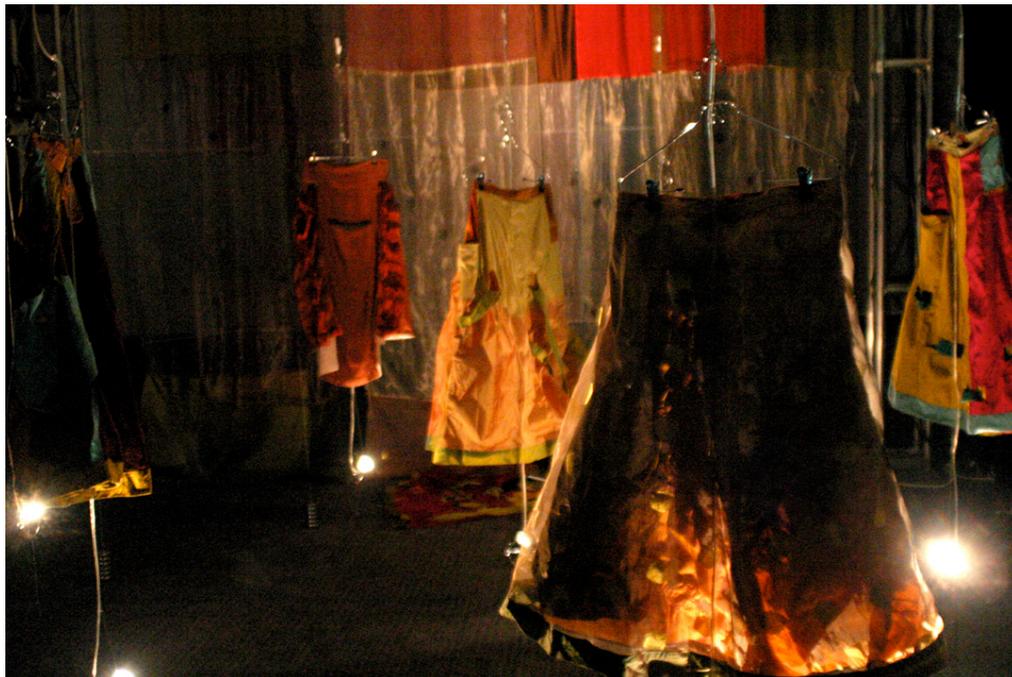


Figure 1: *exhale* uses a ‘forest of skirt trees’ suspended floor to ceiling by cables

Guides assist the participant in ‘dressing’: putting on the skirt and wrapping the breath sensor around the rib cage, a process that occurs behind a draped area. Once outside the dressing area, a Polaroid image of that participant is taken by the guide and placed in a small bag that is also attached to the vertical cable. These small ‘purses’ have see-through front pouches that enable the image of the wearer to be left in the space, as a memory of the skirt, and as a mechanism to bring the skirt back to its home, once the participant’s experience is complete.

As a participant moves through the space, consciously shifting their own breathing cycle, they create three kinds of interactions: the interactions of self to self, self to other, and self to group: wirelessly communicating and creating a shared breath state. And as the lining of each skirt ‘breathes’ with the participants, the small fans and vibrators respond to the breath beneath the lining unseen to others; the small speaker within the skirt marks the sounds of the breath data creating a body network that tickles and caresses and whispers from within. Collective group breath acts like moving dimmers, slowing lighting up, and then dimming fibres on the outside of the skirts, following the pattern of matched breath patterns. These fibres only light up when participants breathe in the same pattern as one another.

Initially, the guide shows the participant how to actuate the small vibrators and fans in the lining of the skirt based on their own breath: the interaction of self to self. Once the participant experiences and understands his or her own relationship to self-data, the guide invites them to share their data with other participants in the space. Sharing data occurs through touch sensitive conductive fabric strips sewn within the side linings of the skirts: the interaction of self to other. Participants can stroke or caress another skirt creating a shared data space between skirts. Multiple participants can create shared connections through touch. Once contact with another participant is made, the actuators within the skirt lining move in relation to the connected participants. Participants navigate the sharing of their own data through caress. Therefore, a participant’s experience, based on

the actuators sewn within the linings of the skirts, can move from their own data, to another's data, to a group of data. When any two participants breathe using the same breath pattern, the 'light fibres' sewn onto the outside of the skirts light up in the same pattern as the breath: the interaction of self to group. When all participants breathe in the same cycle, the breath fibres slowly ebb and flow with the group breath within the installation.

### 3.2 Artistic concept – breath, skin and clothing

The artistic concept of *exhale* is in its most essential form: 'to wear our breath', as a mechanism for redirecting our attention to our own body states, individually, and between bodies in a space, creating a group ecology through its breath. In *exhale* the breath is contained within the body, and also is *worn* on the body, shared through the garments and the garments response in a group-body, a group-breath. This cycle of inside and outside forms the modes of representation selected for this wearable art installation.

#### :: breath ::

... the work with breathing starts with sensing the inner atmosphere of our organism—the basic [...] stance we take to ourselves and the world.

(Lewis 1997: 45)

So it all ends, in wordlessness... Yet, something forms within the world of my tears, shaped by the world that caused it; something takes shape within this uttered breath that builds an image of breath.

(Goyen 1999: 41)

Breath reflects a state of rhythm and intention *as we wear ourselves*. This concept of breath as a starting point, as a marker for representation, and as an *input* to be mapped through navigation, selection and interaction allows us to use breath as a metaphor for synchronizing and coordinating: that is, giving and receiving data. Breath is a source of information, as well as a pattern in which to communicate that information. Our bodies' respiratory system is connected to most of the body's sensory nerves; so that any sudden or chronic stimulation coming through any of the senses can have an immediate impact on the force or speed of our breath, or can stop it altogether. Intense beauty, for example can 'take our breath away'; fear 'stops us in our tracks'; deep contentment is often accompanied by fuller, more languid and more rhythmically even and connected breathing.

We can – within limits – intentionally hold our breath, lengthen or reduce our inhalation and exhalation, breathe more deeply, and so on. When we do so, the nerve impulses generated in the central cortex as a result of our intention bypass the respiratory center and travel down the same path used for voluntary muscle controls. Breathing is both autonomous and conscious, and can move between these two physical control systems of the body. The process of exhaling is a process of release and letting go: 70% of the body's waste products are eliminated through the lungs through the respiration cycle. Breathing in concert with another is a physical way to synchronize with another's body state, enabling a sharing of internal state, represented through multiple physiological signals, and synchronized through attention. At times of physical duress such as death, illness, distress, and also states of intimacy, human bodies instinctually connect with another through synchronizing breath, either consciously or unconsciously. This can be seen in the work of mid-wives and labour-coaches during birthing; sports coaches during high performance physical training; in meditation techniques that calm and quiet the body; in the work of pain therapists that use attention to re-direct the body's proprioceptive state. Instinctively small children will synchronize breath to give or receive information with a parent or loved one, often in the form of feeling tone or 'feeling state' information.

Neurophysiologist Antonio Damasio has studied the connection of ‘feeling states’ in the body and asserts that a given feeling state is associated with specific physiological patterns (such as breath rhythm) along with a set of processes including thought patterns and emotion (Damasio 2003: 112-33). His research suggests that these ‘feeling’ body-states are an inter-connected set of feeling, thought, emotion and physiological functioning: each of these being present and affecting the other. He asserts that the induction of a body-state can be brought about through attention to *any* one of the inter-connected patterns: so that attention to physiological patterning (for example breath) can induce a body state, or conversely, attention to another associated patterns, such as the occurrence of certain thought patterns can also induce the body state. This inter-connectedness between physical data, and the state of the body creates a complex but coherent set of body-data.

What does this mean in the context of this art-work? Using Damasio’s notion of body-state allows us to start from a physiological pattern of the body, such as breath, as an access point to contacting and sharing state data between bodies. We synchronize breath in order to align communication non-verbally. Synchronizing breath enables a tuning of the natural and proprioceptive systems of the body, as breath is both autonomous and consciously controlled. Poetically, breath has been attributed to notions of life-force, or the presence of life in non-organic objects. In William Goyen’s novel, *The House of Breath*, memories of a house from childhood are attributed with breath, and the notion of intention, thought and breathing as being one and the same:

Through the mist that lay between us it seemed that the house was built of the most fragile web of breath and I had blown it – and that with my breath I could blow it all away. (Goyen 1999: 181)

The beauty of this poeticism is that it is also echoed in concepts occurring in fields as diverse as neuro-science (Damasio’s neuro-physiological assertions of body-state and body-maps), and Yogic teachings of Pranayama and the Science of Breath, where breath, thought and intention are also seen to form a coherent union.

**:: wearing ourselves ::**

Another important artistic concept in *exhale* is the concept of *wearing ourselves*. In *exhale* we *literally* wear ourselves through our breath. The breath-band adorns the rib-cage, creating a physical holding and wrapping, a sensual and safe and felt textured cut of fabric, as it simultaneously *captures* our breath, our data. We *reveal* our breath through the properties of the cloth itself in the form of the skirts, our breath is revealed as it shimmers in light and dims with each exhale on the fibres of the fabric. Our clothing expresses properties of adornment, revealing, concealing, sensuality, pleasure, intimacy and containment [Fig.2].



Figure 2: *exhale* Breathband measures breath, while RFID tag enables breath exchange

One of the artistic goals is to develop an interface for expressive non-verbal interaction in the context of a wearable or ubiquitous environment. Ubiquity and wear-ability bring our technologies closer to the surface of our body, and sometimes even under our skin. Metaphorically we would say these technologies are drawing [us] closer to ourselves. And while they draw closer, they also allow us to move. Mobile technologies recognize that people move and are moving; and mobility sustains movement, allowing people to move themselves with their environments, and within their environments.

Our colloquial language uses phrases such as ‘she wears herself well’, ‘he wore a smile’, and the almost cliché and well-rendered phrase ‘I am wearing my heart on my sleeve’.

These phrases point to ways in which the body has its own tendency to *reveal* inner states, intimate and personal aspects of the self, often affective, feeling states, through the concept of *wearing the self*. To wear the self is the body's way of communicating its own knowledge and being. In *exhale*, we ask the question: how can the body itself contribute its tacit, experiential and first-person phenomenological knowledge as both experience used within the design of wearable interaction, and experience of the environment itself? We explore the use of smart fabrics and interactive textiles, which integrate flexible electronics and flexible displays as an interface in wearable computing garments that express *ways of wearing the self*.

### 3.3 *Exhale* interaction

Interaction within *exhale* is comprised of three interaction modes: 1) self-to-self, 2) self-to-other, and 3) self-to-group interaction. The interaction mode determines which participant's breath data is actuating responses inside the lining of any given skirt. Participants are able to choose, to select and to switch interaction modes. Interaction modes are selected through *touching* or *caressing* specially designed fabric panels that are sewn into the skirts. These fabric panels recognize qualitative aspects of the touch gesture and direct the breath data to the actuators within the participant's own skirt, or to another participant's skirt. The third category of interaction: self-to-group is created when participants are breathing in concert with one another, and is not selected through touch.

#### **:: input ::**

Breath is used as the *input* interaction in all three modes. Breath is measured using a breath band which is wrapped around the chest area, around the clothing, and which measures the contraction and expansion of the rib cage. These images [Fig.3] illustrate some initial prototype tests with conductive fabric, however they do not reflect the final breath band design. Prototyping fabric swatches, such as those show here, allows the testing of functionality alongside the potential experience of the texture and 'feeling' of

the fabric, the result of the experience, and the technological configurations necessary to create the whole set of interactions.



Figure 3: Prototyping Conductive Fabric for touch and as passive conductor.

### :: output ::

The *output* or response to breath data depends upon the interaction mode. When the participant first puts on the skirt they are in self-to-self interaction mode. In this mode the ebb and flow of their breath data creates responses in the linings of their own skirts. Each skirt has small *vibrators, fans and speakers built into the linings*. As the participant breathes, the data patterns (speed and intensity) of the vibrators and the fans ebb and flow in response to the participant's breath rhythm.

A second kind of output is used with the self-to-group interaction mode, also called collective breath interaction. This mode is enacted when participants within the installation breathe in the same tempo pattern as one another. When this occurs, the output for group interaction is the display of collective breath on specially designed fibers on the surface of the skirt fabric. These fibers are imprinted with a specially designed nano-inkjet technology, which creates a conductive and light emissive surface that can

display variable light levels depending upon the ebb and flow of the breath data that is used to control the pattern of the light [Fig.4].



Figure 4: LED array embedded within fabric to display continuous breath data.

### **:: selecting modes through touch ::**

The interaction modes of self-to-self and self-to-other are selected through touch on custom designed touch RFID pads embedded into the fabric of the skirts [Fig.2 above]. These touch pads recognize qualitative aspects of movement. A softer caress selects data from another skirt and outputs it inside the lining of the participant who is ‘pulling’ the breath toward them. A harder directed ‘pushing’ caress sends the data from the

participant's skirt to the partner's lining. Participants can reselect their own breath data by caressing their own skirt. These touch pads are specially designed using heuristics described in the technical section below.

### 3.4 *Exhale* technical description

In order to implement our higher-level goal of developing expressive non-verbal interaction that brings awareness to the body's states in the context of a wearable or ubiquitous environment, we ask two questions: how can we model the environment, its participants, their artifacts and their interactions to enable the goal of expressive non-verbal interaction in the context of a wearable environment? And how can the moving body itself contribute its tacit, experiential and first-person phenomenological knowledge as both experience used within the design of the model, and experience of the environment itself? The first question moves from the outside inward, and the second moves from the inside out; the first we answer through our technical research goals, and the second, through our artistic inquiry and creation.

The objectives of the technical research in *exhale* is to identify current smart fabric textiles that are available in the context of flexible electronics and flexible displays and to develop our own heuristics of interaction through touch and breath in order to build this into a wireless network, capable of transferring data on the body, to other bodies in a public space. We call our touch selection input 'threads of recognition' because it refers to metaphors of input recognition in the context of smart textiles research. We are working on developing a wearable platform based on a body area network that utilizes Bluetooth on the body, in combination with custom made hardware, running on a Toshiba PDA platform.

An *exhale* skirt is a custom-made garment with electronics embedded within it to form a sensor and communication system that can exchange physiological signals and responses with another *exhale* skirt.

Each skirt has a small portable computer, or PDA, that coordinates and interprets the data communication. Along with the PDA, there are several very small computers that control embedded transducers – fans and vibrating motors – and that are mounted on individual circuit boards, called ‘islands’. These ‘islands’ interact with the PDA via a Personal Area Network, or PAN, constructed using Bluetooth technology.

Connections that cannot be made wirelessly are made using conductive fabric ‘wires’ which are composed of a transparent directionally conductive fabric contained in a non-conductive fabric or sewn directly into the skirt to form portions of the skirt itself. There is also a pressure-sensitive pad area, constructed of the conductive fabric wires, connected to one of the Bluetooth ‘islands’, to provide touch-based gesture data. The PDA has two specialized devices attached to it as well: an encoder that converts the analog electrical signals from a breath sensor into digital format, and an RFID sensor that is used to identify nearby skirts via small disks sewn into each skirt. The breath sensor is an adjustable, stretchable band worn about the chest that generates an electrical signal on each exhalation and inhalation. This signal is conveyed to the PDA via the encoder, where it is analyzed and then transmitted to a central system, along with information on which *exhale* skirts are near to this skirt as well as any gestures reported from the pressure-sensitive pad.

The central system routes the analyzed signals to other *exhale* skirts, based on the ‘neighbourhood’ information that has been gathered. At the same time, the breath signals from groups of skirts are gathered together and analysed; this collective breath is then sent back to the skirts within the group, and displayed on each skirt as a pattern of light using special light-emissive fibres controlled by the PDA. The PDAs also activate their fans and vibrating motors, using their Bluetooth ‘islands’, when the gesture or breath data matches their criteria.

The central system converts the data obtained from the skirts – the physiological data, the RFID data and the pressure pad data – into a visible and audible representation of the

state of the installation space and its participants. A video projection system and multiple speakers are used to convey this representation to the participants within the space.

[Fig.5]

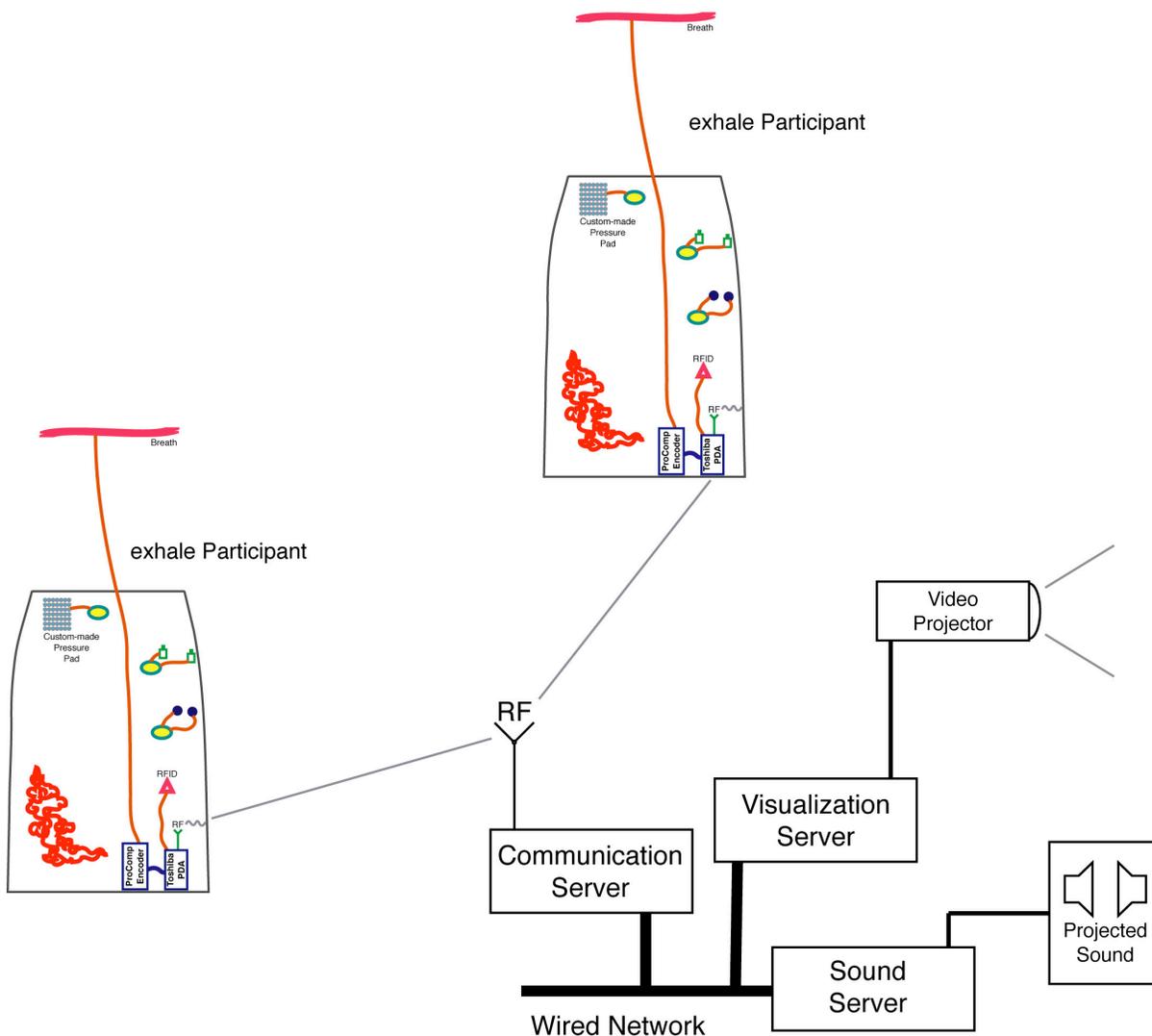


Figure 6: Networked Interaction in *exhale*.

## Conclusion

This essay illustrates how we can augment experience design with first person performance methodologies found in theatre, dance and somatics. *exhale* is an example in designing and testing experience models based in this strategy. The differing frames of

reference between the domains of HCI and performance practice reveal an under-theorized area of practice, which can be explored through experience modeling. Embodied interaction is a reflective process that is simultaneously inter-body and intra-body. In addition, this essay has provided a case-study for a model of designing embodied interaction by applying the use of gesture as a ‘function organ’, as a mechanism that can assist in defining properties for an interaction score that Grotowski describes as scripts, or *points of contact*. The experience with the *exhale* installation illustrates that participants can learn to shift their own threshold of attention, awareness and body-state through the interaction affordances created within movement and embedded within the garment. They participate in becoming expert users of their own physiological data, and in playfully engaging with an emerging co-operative and physically and emotionally negotiated body state and collective system state. Social navigation is created through the perceived data flow (through the interaction with RFID tags in exchanging breath) and represented through the actual data flow (through the server). As such the installation is also its own experience workshop, and is a starting point to continue to explore methodologies of experience modeling.

As an installation, *exhale* was an initial exploration of modeling experience through a variety of gestural protocols that led to the design of an interaction language facilitated by wearable garments. This work is a starting point to mapping more complex data relationships to body state and intention. The *exhale* installation illustrates that participants can become playfully engaged in simple feedback loops of ‘attending to’ their breath, and sharing that data with others in the space. *exhale* also points to next steps in research: exploring mapping and ‘meaning’ in data patterns across participants body state, extending types of physiological data (brain waves, GSR, temperature), types of output actuators (vibration, local sound, local motor memory), as well as building an intelligent model of interaction which includes memory, resonance and meaning in the devices themselves. This kind of work that integrates performance practices as a design strategy in wearable garments and technologies continues to model experience through deepening first person methodologies. And as the Digital Cultures Lab at Nottingham exemplified, such methodologies and communities of practice also require cross-cultural

workshop spaces that can enable and iterate the practice itself through shared experience and reflection with other artists and practitioners.

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