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## Designing with Breath



*“One must first come to know, through observing oneself—just what one does with breathing.”<sup>1</sup> Elsa Gindler*

*“Clothing is like a language’s lining... Language and clothing are intimate technologies indeed.”<sup>2</sup> Jean-Claude Guédon*

*“The work with breathing starts with sensing the inner atmosphere of our organism—the basic stance we take to ourselves and the world.”<sup>3</sup> Dennis Lewis*

### 6.1 Introduction

This chapter, *Designing with Breath* extends and focuses the exploration that began with the *whisper* research. It *extends* the whisper research by working more closely with materials, fabric, texture, sensuality and the concept of ‘wearing the self’. It *focuses* the *whisper* research by working solely with breath as a physiological source of information and by exploring breath more specifically in the context of experience.

This chapter describes the design process of *exhale*, the third in a series of interactive wearable art installations. While *whisper* visualized body-data ‘from the inside out’ projecting it onto localized light-sonic pools, *exhale* positioned its actuators beneath the linings of skirts. As such *exhale*’s expression of breath was palpable yet ‘invisible’, mapping breath data to vibration through small motors and the micro-movement of air

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<sup>1</sup> Gindler, E. (1995), op. cit., p. 9.

<sup>2</sup> Jean-Claude Guédon points to the relationship between our clothing, technology and communication in *Nothing to Wear*, a review of the Banff New Media Institute’s Intimate Technologies Summit, by Jean-Claude Guédon translated by Timothy Barnard, *Horizon 0, Issue 4, Touch, private-public* (retrieved August, 2006) <<http://www.horizonzero.ca/textsite/touch.php?is=4&file=2&tlang=0>>

<sup>3</sup> Lewis, D. (1998). *The Tao of Natural Breathing: For Health, Well-Being and Inner Growth*. Delhi: Full Circle.

through small fans sewn beneath the linings of skirts. This shift from public to private ‘viewing’ of data created an intimacy that was unseen by others, yet felt palpably by the self. The exploration of breath as experience was developed through design process that included workshops, concept development and implementation.

This chapter characterizes the concept of *Designing with Breath*, focusing on sensory experience in the design of *exhale*. It provides context for this research by describing the artistic context for *exhale* in relation to the experience design process of interaction and exhibition, and by presenting a background for embodied practices of Designing with Breath.

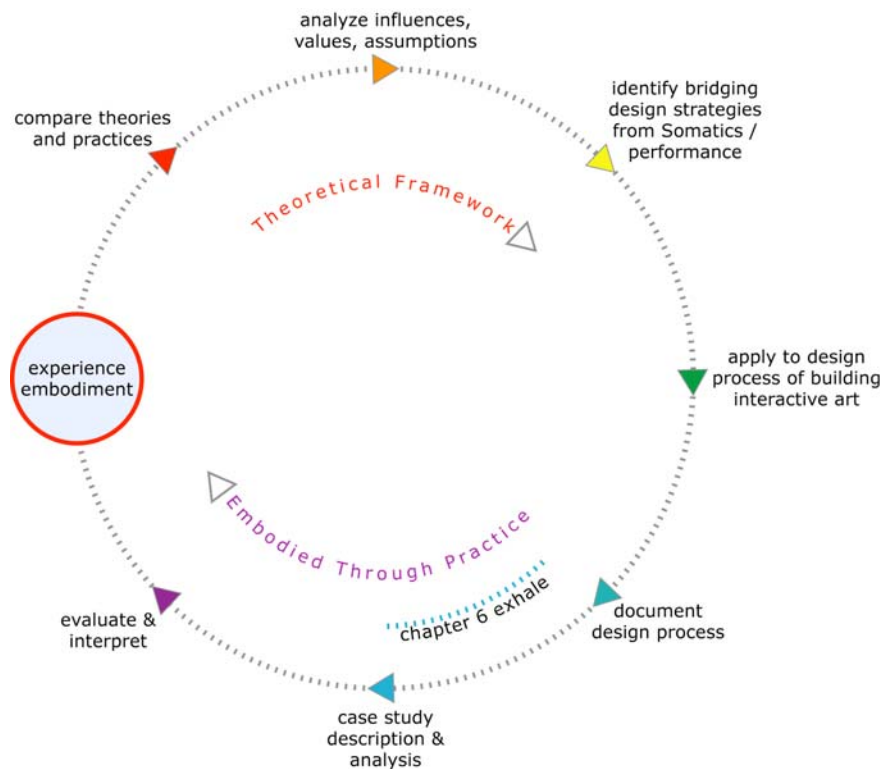
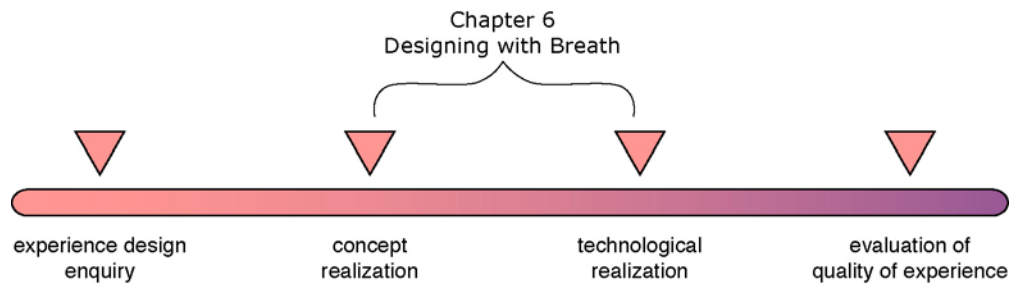


Figure 50. Focuses on Sensory Experience in the Design of *exhale*

Following contextual and background materials, this chapter describes the processes of *Designing with Breath*. This will be illustrated through an analysis of the heart[h] workshops, a series of three exploratory workshops applied during the concept refinement and technology development stages of the design process of *exhale*.



**Figure 51. Focuses on Sensory Experience for Concept and Technology Design**

The heart[h] workshops occurred at a later stage in the design cycle than the *whisper* workshops viewed in the previous chapter. As such they employed partially operational prototypes including garments and breath sensors that could support greater understanding of the technical processes and constraints involved in designing with breath. As introduced in Chapter One, technical processes include first-person access to the self as well as the computational processes of technology. The workshops incorporated reflection-in-action in relationship to experience, validation and critique. The analysis of the heart[h] workshops is explored through the lens of the embodied *values*, identified in Chapter Two: the values of self, attention, experience, and interconnectedness.

To conclude, this chapter highlights and summarizes outcomes of *Designing with Breath* illustrated within the heart[h] workshop process, demonstrating concept realization and technological implementation. Again, these outcomes substantiate the instrumental value of embodied techniques, offering examples of how the material properties of technology and experience can support the aesthetics of meaning-making through technology.

## 6.2 Artistic Context and Background

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*Designing with Breath*, explores the design process of *exhale*, an interactive wearable art installation. In *exhale*, breath, skin and clothing come together within a set of evocative and sensual skirts that are embedded with body-area-networks that exchange and elicit breath within a shared network. There are two central design themes in *exhale* that are summarized by the concept 'wearing our breath'. These themes are: 1) the use of breath as a somatic indicator of state, and 2) the exploration of material, movement and fabric within interactive garments that move with us, that express our selves through strategies of hiding and revealing, and that work with breath to support identity, connection and communication. Aligning with the artistic goal of *whisper*, the underlying concept of *exhale* is cultivating self-observation in such a way that body-state can be observed and shared with others in a networked environment. As described in Chapter Two, many physical techniques in somatics and performance use breath as a mechanism to direct attention to our own physical processes. Within these frameworks, attention to breath is experiential, and can increase self-efficacy.

*exhale* was the third of a series of wearable prototypes that included *whisper* and *<between bodies>*. In *exhale*, breath is used to actuate small vibrators and fans sewn into the linings of skirts. *exhale's* breath data actuates physical vibration and the micro-movement of air on or close to the skin. The placement of these actuators beneath the skirt lining explicitly hides them from the visual sense. In this way *exhale* explores the *legibility* of physical actuation (such as vibration) *without* dependence upon visual perception.

*exhale* was exhibited at Siggraph 2005 Emerging Technologies, Olympic Games Showcase, Canada Pavilion, Torino 2006, Future Fashion in Pisa in 2006, and the Digifest Mod Festival, Toronto, Canada, May 2006.

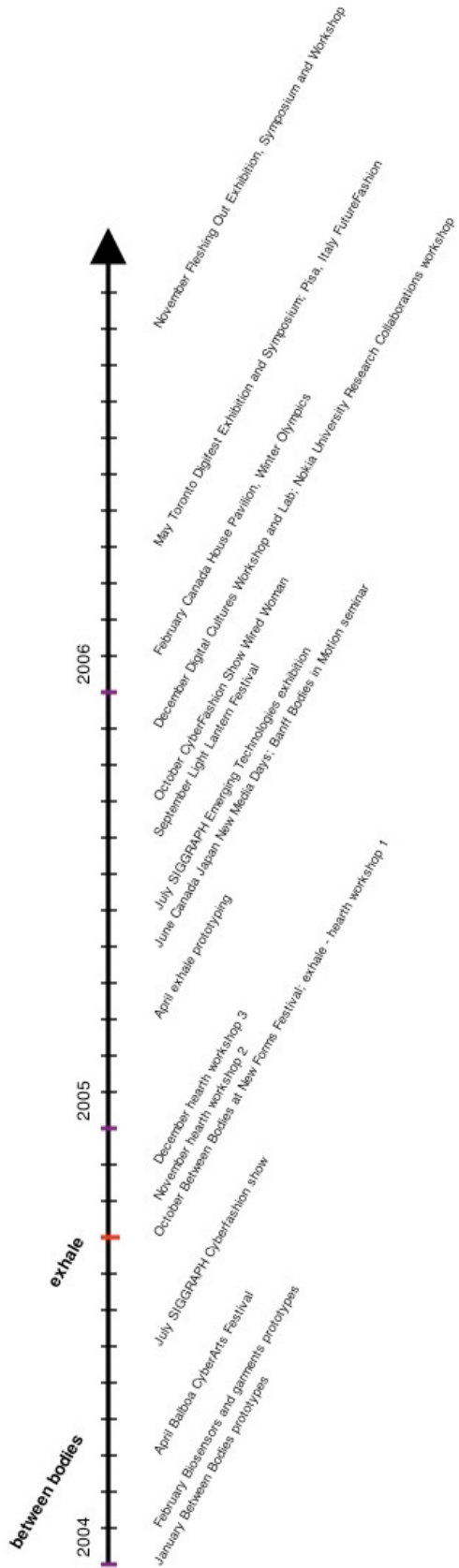


Figure 52. Design Timeline for *exhale* development (heart[h] workshops Fall 2004)

### 6.2.1 Breath

The artistic concept of *exhale* is based on the act of 'wearing our breath'. Revisiting the simple act of 'paying attention' to one's self, and using this sense of self or body-state to connect and exchange with another, the play between self and others in *exhale* creates a group 'ecology of breath'. Breath lives within the body and is *worn* on the body, shared from self to others through the garments within the network. Breath expresses a state of rhythm and intention. Breath is a marker for representation: mapped through navigation, selection and interaction. Breath is used as a metaphor for synchronizing and coordinating the giving and receiving of data.



Figure 53. Workshop Participant exploring Breath and Sensing in heart[h] workshops

The importance of 'concepts of breath' has been acknowledged throughout Eastern and Western History. Eastern concepts of *care of breathing* are central to the cultural and religious practices of Tibet, China, India and Japan. Breath practice was important to the ancient Egyptians. Ancient Hebrew uses the word *wind*, the breath, in the context of *soul*. The Latin verb *spinare*, to breath, is contained within words such as *respiration*: continuous breathing, and *expiration*: our last breath, and in the words *spirit* and *inspiration*. The ancient Greeks used the word *diaphragm* to indicate the mind in addition to its use to indicate breathing. The pneuma (breathing) theory dominated the healing arts and philosophy during the first century A.D. In the West, interest in breathing was renewed through the teaching of Francois Delsarte in Paris. As introduced in Chapter Two, Delsarte lost his singing voice through poor training and turned to the exploration of movement. Simultaneously, he undertook the study of breathing which became an integral part of his system of movement education.<sup>4</sup>

Within our bodies, breath is a source of information, as well as a pattern in which to communicate that information. Our bodies' respiratory system is directly connected to the body's sensory nerves, so that any sudden or chronic stimulation coming through any of the senses has an immediate impact on the force or speed of our breath. It can stop it altogether<sup>5</sup>. 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 connected breathing.

We can – within limits – intentionally hold our breath, lengthen or reduce our inhalation and exhalation, breathe more deeply, and consciously alter our respiratory patterns. Breathing is both autonomous and conscious, and can move between these

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<sup>4</sup> Carola Speads, a student of Elsa Gindler who brought Gindler's work to America. Speads focused on breathing techniques, as quoted in *Carola Speads*, Johnson, D.H. (ed.) (1995). *Bone, Breath and Gesture, Practices of Embodiment*. Berkeley: North Atlantic Books, p. 38-39.

<sup>5</sup> This is documented widely across neuro-physiological, psychological and contemplative practice with breath, see for example: Rama, Ballentine, R., & Hayes, A. (1979). *Science of Breath: A Practical Guide*. Honesdale, Pennsylvania: The Himalayan Institute Press.

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 respiration cycle.

Breathing in concert with another physically shifts and synchronizes body state, enabling an inter-subjective sharing of state-data represented through physiological signals, and synchronized through attention. At times of physical duress or trauma such as death, illness, emotional distress, and states of intimacy, human bodies can instinctually connect with another by synchronizing breath. This is evident in birthing and dying processes, during high-performance athletic physical training, in meditation techniques that calm and quiet the body and in the work of pain therapists that use attention to re-direct the body's proprioceptive state. It is an instinctual response for infants, parents or lovers to synchronize breath to share state information.

The neurophysiologist, Antonio Damasio has studied the connection of 'feeling states' and asserts that a given state is associated with specific physiological patterns (such as breath rhythm) along with a set of processes including thought patterns and emotion. His research indicates that body-state is an inter-connected set of feeling, thought, emotion and physiological functioning: each of these being present and affecting the other<sup>6</sup>. The induction of 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, and conversely, attention to other associated patterns, such as the occurrence of certain thought patterns can also induce the body state<sup>7</sup>. This inter-connectedness between physical data, and the state of the body creates a complex but coherent set of body-data.

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<sup>6</sup> Damasio, A. (2003). *Looking for Spinoza: Joy, Sorrow, and the Feeling Brain*. New York: Harcourt.

<sup>7</sup> Ibid.



What does this mean in the context of the design of technologically mediated experience? Designing with the concept of body-state enables us to initiate 'state conditions' from physiological patterns of the body. Breath can be an access point for contacting and sharing state data between bodies. In their rigorous exploration of the technical practice in 'On Becoming Aware', Depraz, Varela and Vermersch<sup>8</sup> provide examples of using breath as an initiator of 'epoche' in the suspension-redirection-letting go cycle of directing attention within the body. Augusto Boal describes the exercises of bringing attention to breath as working to bring health to a system "that has fallen into neglect, so that one isn't aware—[it has] become mechanized"<sup>9</sup>. Synchronizing breath enables a tuning of the natural and proprioceptive systems of the body, as breath is both autonomous and consciously controlled. We synchronize breath in order to align communication non-verbally.

Poetically, breath has been attributed to the notion of life force or the presence of life in non-organic objects. In William Goyen's novel, *The House of Breath*, memories 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."<sup>10</sup>

*William Goyen, House of Breath*

The beauty of this poeticism is that it is also echoed in concepts occurring in disciplines 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.

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<sup>8</sup> Depraz, N., Varela, F.J., & Vermersch, P. (2003), op. cit., p. 216-219.

<sup>9</sup> Boal, A. (1992), op. cit., p. 101.

<sup>10</sup> Goyen, W. (1999). *The House of Breath*, Triquarterly Books.

## 6.2.2 Wearing Ourselves



Clothing is peculiar in the sense that it conceals in its very conspicuousness and reveals what it appears to hide...<sup>11</sup>



Figure 54. *exhale* Networked Skirts Illustrating Breath Sensor, RFID and LEDarray

Another central artistic concept in *exhale* is that of *wearing ourselves*. In *exhale* we *literally* wear our breath beneath the linings of our skirts. The breath-band adorns the ribcage creating a physical caress through a textured cut of fabric that is sensed and felt as it *captures* our breath through its presence. Individual breath is revealed in the linings of the skirts. When two or more participants breathe 'in concert' with one

<sup>11</sup> Guédon, J-G., op. cit.

another it is revealed on the LED-array on the skirts surface, as it shimmers in brightness and dims with each exhale. Our clothing expresses properties of adornment, revealing, concealing, sensuality, pleasure, intimacy and containment.



**Figure 55. Actuators such as Vibro-tactile Motors and Fans are Sewn Beneath the Lining**

An artistic goal is to develop a flexible, pliable, material interface that can support 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. These technologies are metaphorically drawing us closer to ourselves. Mobility sustains movement.

Clothing is like a language's lining... Language and clothing are intimate technologies indeed.<sup>12</sup>

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<sup>12</sup> Ibid.

Our colloquial language uses phrases such as “she wears herself well”, “he wore a smile”, and the 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. They are often intimate and personal aspects of the self: affective and feeling states that express the concept of *wearing the self*. To wear the self is the body’s way of communicating its own knowledge and being.



Figure 56. *exhale* Explorations with Fabric, Texture and Movement

### 6.3 heart[h] workshops: Exploring Breath, Skin and Clothing

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Many design attributes of *exhale* were founded upon the successful outcomes of *whisper*. In *exhale* these features have been used as a basis for strengthening and developing practice. For example, the *whisper* experience workshops presented an enormous resource for structuring, documenting and extracting methods of designing for experience. The *exhale* workshop processes (which were given the name of heart[h] workshops) borrowed from the ‘best-practices’ of the *whisper* experience.

### Best Practices Applied to heart[h] Workshops

- Workshop sessions are formatted to contained two segments: a ‘first-half’ and a ‘second-half’ that complemented each other in terms of content and context, and were structured through a ‘script’ which enabled a flexible yet directed session.
- Rigorous documenting of workshop processes to include video, photographs and exit response cards.
- ‘Experience-focused’ exercises from Somatics and Performance such as slow-motion walking, stillness, attention to senses and sense-states, attention to body-data such as breath, heart-rate, temperature.
- Directed improvisational movement to evoke relationship and inter-connection.
- Props such as blindfolds and breath-sensors to elicit attentional attitudes within the body.
- ‘Imagination’ and ‘visualization’ engage suspension of disbelief and to engage participants in their own ‘stories’.
- Costumes and garments as a mechanism for movement expression. In *whisper* these were men’s oversized white shirts. In the *exhale* heart[h] workshops these were the skirts that had been constructed and tested prior to the heart[h] workshops.

**Table 9. Best Practices Applied to heart[h] Workshops**

The heart[h] workshops also included additional material that was not addressed or included in the original *whisper* experience workshops.

### heart[h] Workshops Material Differences from *whisper*

- Additional documentation including participant observation drawings and written observations as well as video-exit interviews.
- In addition to participants that represented 'every-day bodies', the heart[h] workshop also included dancers, who were considered 'expert-users' of movement and body-based techniques.
- The use of partially operational prototypes including breath-bands connected to a network that could sonify and visualize breath data.
- The heart[h] workshops position in the *exhale* design cycle enabled them to be used for concept refinement and technological implementation, rather than 'ideation' and 'concept discovery'.

**Table 10. heart[h] Workshops Differences from *whisper***

In addition, one of the key observations resulting from the *whisper* installation was that the visual nature of the output (projected in light pools), although highly sensualized, has a propensity to draw attention out of the self and into the space. For this reason, one of the design goals of *exhale* became an exploration of ways to express body-data in a palpable yet non-visual way. This was not intended to remove visual pleasure, but to explore other forms of physical output that could engage the more proximal and intimate senses: the sense of touch and hearing. This goal also aligned with the concept of 'invisibility' and the legibility of state data that can be represented in a non-visual form.

There were three heart[h] workshops, held on October 12<sup>th</sup>, November 9<sup>th</sup>, and December 7<sup>th</sup>, 2004. Workshop participants were a group of undergraduate fourth year



students at the School of Interactive Arts and Technology at Simon Fraser University, and a second group of dancers and performers from the Vancouver dance community. Each of the three student workshops had approximately 25 participants that were divided into documenters and workshop 'performers'. Documenters had the following tasks: video-taping, photographing, participant observation 'drawings', and participant observation 'hand-written' observations. All participants were briefed for approximately 15 minutes prior to the workshop. All workshops began with a stillness session in which participants were simply very quiet.

The heart[h] workshops employed partially operational prototypes including garments and breath sensors that could support greater understanding of the technical processes and constraints involved in designing with breath. Technical processes included embodied techniques of the self as well as the computational processes of technology. The workshops incorporated reflection-in-action in relationship to experience, validation and critique.



Figure 57. Workshop 1: Exploring Experience Using *exhale* Skirt Prototypes



Figure 58. Workshop 1: Participants Putting On *exhale* Skirts

The first heart[h] workshop used *exhale* skirt prototypes along with 'directed improvisation' to explore participant movement and interaction in the skirts. The two components of the workshop were 'Something Living in the Skirt', and 'Something Living Between the Skirts' which used skeins of elastic as props for 'making connections'. The purpose of these workshops was to explore participants' responses to 'invisible' yet palpable inner activity in the linings of the skirts, and the concept of networked connections between skirts. The workshop explored movement and interaction that was born from these two propositions.



Figure 59. Workshop 1: Exploring Experience of Something Living in and between the Skirts





**Figure 60. Workshop 2: Exploring Sensory Experience of Resonance Within**

The second heart[h] workshop extended the experience of the skirts to exploring sensory body-data experience including breath, and was called 'resonance within' and 'resonance without'. The workshop structure mirrored the original *whisper* experience workshops, incorporating blindfolds, sensory imagination, and 'breath-band' placebo props that participants explored as a mechanism for sharing data.

The third heart[h] workshop explored breath data between participants using digital breath-bands that were networked and connected to sonification software.



**Figure 61. Workshop 3: Breath Sensing with Breath-bands: Partners back to back**

The following summary of the heart[h] workshops data is explored through the lens of the embodied *values*, identified in Chapter Two: the values of self, attention, experience, and inter-connectedness. These are only a small sampling of responses that illustrate the experiences elicited by exploring breath and ‘wearing the self’ but are indicative of the richness and imagination of experience.<sup>13</sup>

### **6.3.1 heart[h] workshops: the Value of Self**

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The participant responses illustrated the richness of the experience of the self, and the fullness of imagination at play within these short timeframes of exploration. The self is related to identity, and to a sense of oneself as a ‘continuous’ experience. The Varieties of User Experience are evident here with qualities that range from peaceful and serene, to verging on ecstatic, to uncomfortable, and sometimes even distressed.

Workshop participants commented about their shifting sense of self:

*Self-awareness, my sense of being; calm and insight towards myself*

*Inside brings out the individual and the private. Your own individualism swayed the masses.*

*Singularity inside a group; the ability to retreat and reflect*

*Emptiness. Maybe I’m not alive. Was I alive? Was it just a dream and I’m just afraid of losing data? Wasn’t afraid/scared of doing anything because I don’t even feel myself anymore. It’s great. It felt like I was glowing and I push the air away. Or I glow bigger and brighter and stronger when I hold on to myself. It was from within, spreading out flowing from inside me. I think people can see it.*

*My brain went empty and I all I could hear was the sound (NOT MUSIC!) I held myself together or find my most comfortable position to help the data grow. I think if it glows enough it’ll transmit to somewhere. Or not transmit, just, like a watercolor. It spreads like water. I move like I’m a paper with watercolor all over me.*

*When I took the blindfold off, I still wanted to close my eyes, to stay within – I noticed a feeling of ‘home’ in the skirt – of having the skirt hold me in ever-loving arms – my pulse was safe inside the skirt, my movements became larger – easier – I felt at home in the space.*

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<sup>13</sup> For a complete set of response cards, observations, data transcriptions, and workshop analysis, see Appendix D: heart[h] workshop data.

### 6.3.2 heart[h] workshops: Attention, Awareness

The workshops were scripted to draw attention to the senses and to sensory experience, which often created an opening of experience and space. In the participant responses the focus on breath evoked the most notably expansive experiences. The following participant comments are all in relationship to working with breath and breath sensing:

*Awareness*

*Relaxing; centered*

*I felt as though I was in an endless space. There was nothing on my mind aside from the occasional itch that I would feel.*

*A sense of suspension; the illusion of singularity in a group of people;  
A unification of breathing tempo*

*A moment of peace, just for a moment*

*A feeling of resistance and occasional acceptance and lapsing in and out of relaxation; self-awareness*

*Seemed like an extended sense of self-awareness moreso than just listening to breath*

*A sense of relaxation traveling up my spine an eerie experience*

### 6.3.3 heart[h] workshops: Experience

The second workshop focused on sensory experience through the body. Participants described the moment of 'letting go' and the state of flow and connection that Depraz, Varela and Vermersch describe.

*Uncertainty and questions arose. Then tolerance came and "let go" more free, careless; senses enhanced with curiosity instead of uncertainty and questions. With curiosity came exploration.*

*The data flows in my body as if it is a stream, a stream that wants to explore and contact to another stream*

*I felt a flow, a counter clockwise spinning from the base of my spine. I spiraled around and inside my body. At time it felt hot, this happened when I concentrated on it.*

*It flows like a river*

*Focusing on my body data I felt the urge to spin with the flow. I would turn counter clockwise as I walked.*

#### **6.3.4 heart[h] workshops: Inter-connectedness**

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The three workshops explored different aspects of inter-connectedness based on sensing, movement and their relationships with the garments. These first responses are from the first workshop in which participants explored the connection between themselves as a 'network' in the skirts:

*I felt some kind of connection between myself and others; It was a connection not only between two people, but also the entire group.*

*The connection between me and other participants; couldn't control myself freely so I simply let go*

*It seemed like commotion; one action would trigger a whole chain of other actions; the interconnectivity grew and shrank to its own will, guided by reactions from within*

The next responses are selected from the third workshop in which participants explored the connection between themselves and breath:

*Loneliness, only not lonely because of the connection to the other person behind you*

*A sense of suspension; the illusion of singularity in a group of people; A unification of breathing tempo*

*Calmness, unification*

*Concentration, oneness*

*Again, just a sense of boundary-less space. I just felt more light physically*

*Completeness, sense of being full; expanded*

#### **6.4 *exhale* Workshop Outcomes: Supporting Implementation**

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We opened this chapter by describing *exhale*'s focus on designing with breath, shifting the experience of breath data to inner private sensing so that the 'physical' sense of data created an intimacy that was unseen by others, yet felt palpably by the self.

The exploration of breath as experience was developed through a design process that included the heart[h] workshops which supported concept development and technology implementation. Specific outcomes of the workshops included choices for a technological implementation, which included vibro-tactile motors placed in the linings of the skirts, and localized sound data to focus an inner connection with the self through the skirts. Another outcome of the workshops was to implement an RFID system in the skirts so that data could be exchanged and shared between participants.



**Figure 62. *exhale* skirts awaiting participants at Siggraph 2005 Emerging Technologies**

Like *whisper*, the heart[h] workshops explored numerous somatics and performance values and techniques which were critical to the design process of *exhale*. These are summarized in the table below.

	Chapter 6 Designing with Breath <i>exhale</i>
VALUE	
Self	Body-state Breath Inner awareness
Attention	Attention to Breath Kinaesthesia Fullness - Emptiness Inter-subjectivity & awareness through shared breath
Experience Qualities	Imagination Stillness Connectedness Empathy
Inter-Connection	Breath Relationship <ul style="list-style-type: none"> <li>• To self</li> <li>• Receive from other</li> <li>• Choice to “hold” or “contain”</li> <li>• Create Larger Whole</li> </ul>
Somatics Systems Applied	Eastern and Contemplative Practice <ul style="list-style-type: none"> <li>• Slow motion walking</li> </ul> Kinetic Awareness (Gindler) <ul style="list-style-type: none"> <li>• Directed Attention to self</li> <li>• Heightening sensory awareness, blindfolding</li> <li>• Attention to breath (Redirection)</li> <li>• Slowing movement (Suspension)</li> <li>• Expansion (Letting-Go)</li> <li>• Wholeness</li> </ul> Arsenal of Theatre – (Augusto Boal) <ul style="list-style-type: none"> <li>• De-specialization</li> <li>• Sensing self</li> <li>• Listening to what we hear</li> <li>• Internal Rhythms</li> <li>• Moving self</li> <li>• Placebo Objects, props</li> <li>• Clothing/Costume as extension of self</li> </ul> Movement Improvisation (Blom & Chaplin) <ul style="list-style-type: none"> <li>• Speaking Body - Body Parts</li> <li>• Building Trust and Sensitivity</li> <li>• Movement Quality</li> <li>• Silence</li> <li>• Group Work – Multibody movement</li> </ul>

**Table 11. Summary of Somatics Values and Techniques used in *exhale***

One of the primary outcomes of the heart[h] workshops was the technical functional design of *exhale*. This included the design of a body-area-network, using detachable Bluetooth 'islands' that could be positioned in various places on the garment. This enabled a flexible prototyping system for testing various output actuators, particularly in adjusting their position on the garment. The following diagram and table illustrate and describe the technical functional components of *exhale*.

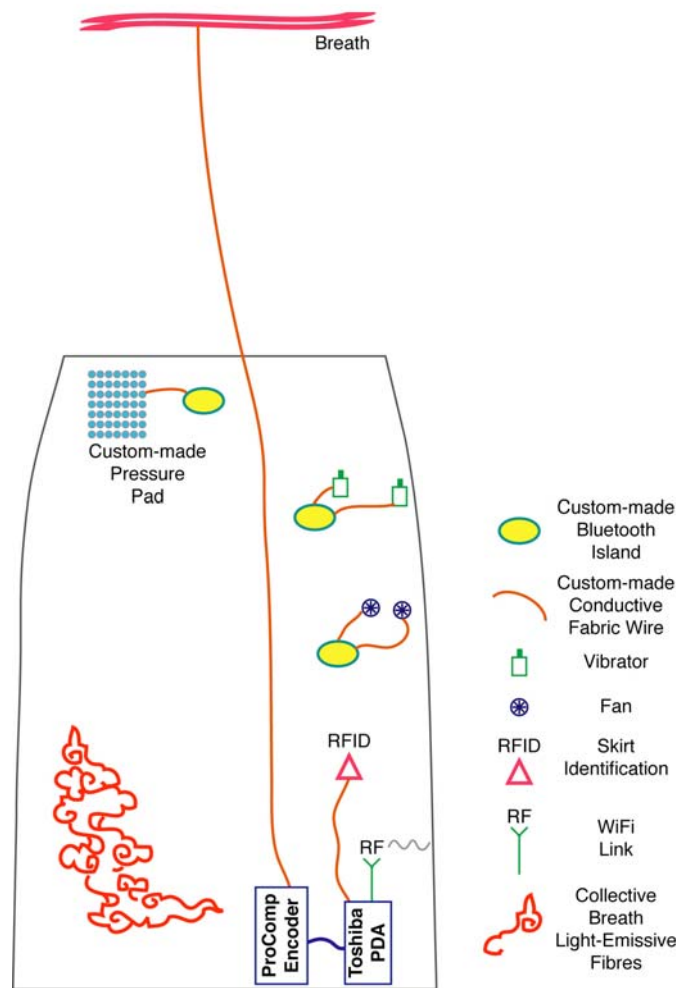


Figure 63. *exhale* Technical Functional Diagram



## *exhale* technical attributes

- 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 analyzed; 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.

**Table 12. Summary of Technical Functionality of *exhale* Body-Area-Network**





**Figure 64. *exhale* in Performance in Torino for the 2006 Winter Olympic Games Festival**

This chapter has explored *Designing with Breath*: the design process of *exhale*, an interactive wearable art installation that was prototyped in Siggraph 2005 Emerging Technologies Exhibition. In *exhale*, breath, skin and clothing come together within a set of evocative and sensual skirts that are embedded with body-area-networks that exchange and elicit breath within a shared network. The workshops explored the two central design themes in *exhale* summarized by the concept of 'wearing our breath'. These themes are: 1) the use of breath as a somatic indicator of state, and 2) the exploration of material, movement and fabric within interactive garments that move with us, that express our selves through strategies of hiding and revealing, and that work with breath to support identity, connection and communication. As has been evidenced in the experiences of the workshop participants, the underlying concept of *exhale* is cultivating self-observation in such a way that body-state can be observed and shared with others in a networked environment.

This work resonates with the many physical techniques in somatics and performance that use breath as a mechanism to direct attention to our own physical processes. Within these frameworks, attention to breath is experiential, and can increase self-efficacy.

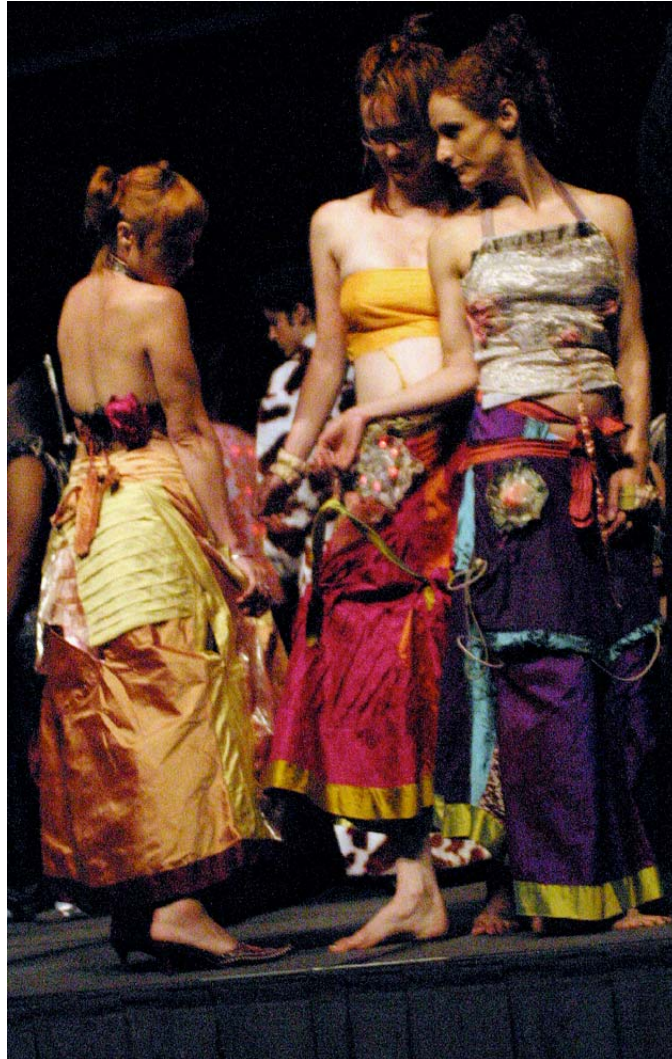


Figure 65. *exhale* at Siggraph 2005