7

The Somaesthetics of Touch

> *"The experience of touch is basic to discovering who we are and who is other and how we dance this life together…"*[1]
>
> *"Somaesthetics can be defined as the critical study of the experience and use of one's body as a locus of sensory-aesthetic appreciation (aesthesis) and creative self-fashioning."* [2]

7.1 Introduction

This chapter explores the concept of *somaesthetics* as an approach to the design of expressive tactile interaction. It highlights our sense of touch in relationship with technology, focusing on a technological design and implementation based on Rudolph Laban's Effort Shape analysis. Effort Shape (sometimes referred to simply as Effort) is a theory and taxonomy that describes movement *effort qualities* as an inner bodily attitude toward outer movement enactment.[3] In this way, Effort Shape models and *embodies* a subjective epistemology through its articulation of the connection between inner state and outer movement-behaviour. *The Somaesthetics of Touch* explores the experience of a tactile world where the *quality* of tactile experience can be modeled within interaction design. Rudolph Laban, one of the key movement theorist-practitioners to emerge from the somatics traditions of the twentieth century, states that *all* our senses are a variation of our unique sense of touch. For Laban, touch enables the relationship between movement and space to be discerned within bodily-experience.[4] Maxine Sheets-Johnstone refers to this as our tactile-kinesthetic

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[1] Cohen, B.B. (1993), op. cit., p. 118.

[2] Shusterman, R. (1992). Somaesthetics: a Disciplinary Proposal, in *Pragmatist Aesthetics: Living Beauty, Rethinking Art*, Oxford, UK: Rowman & Littlefield Publishers, p. 267.

[3] Laban, R. (1950). *The Mastery of Movement*. Plymouth, UK: MacDonald and Evans, p. 11.

[4] Laban, R. (1966). *The Language of Movement: A Guidebook to Choreutics*. Boston: Plays Inc., p. 29.

experience, a bodily attitude that enables us to know the world and make sense of it.[5] Other somatics practitioners such as Sondra Fraleigh recognize that touch precedes and informs vision as well as movement through our bodies' evolutionary development of somatic tactile-kinesthetic sensitivity[6]. By attending to the sense of touch, we can develop discernment and skill in accessing our bodies' knowledge. Touch is applied in many somatics techniques such as the work of F.M. Alexander[7], Moshe Feldenkrais[8], Marion Rosen[9], Bonnie Bainbridge Cohen's Body-Mind Centering[10] and Sondra Fraleigh's Somatic Movement Therapy[11].

The case study described in this chapter explores the sense of touch through a *somaesthetic* design framework for technology. This is articulated in the design, development and implementation of the tactile interface for *soft(n),* an interactive tangible art installation exhibited at DEAF07 in Rotterdam, April 2007.

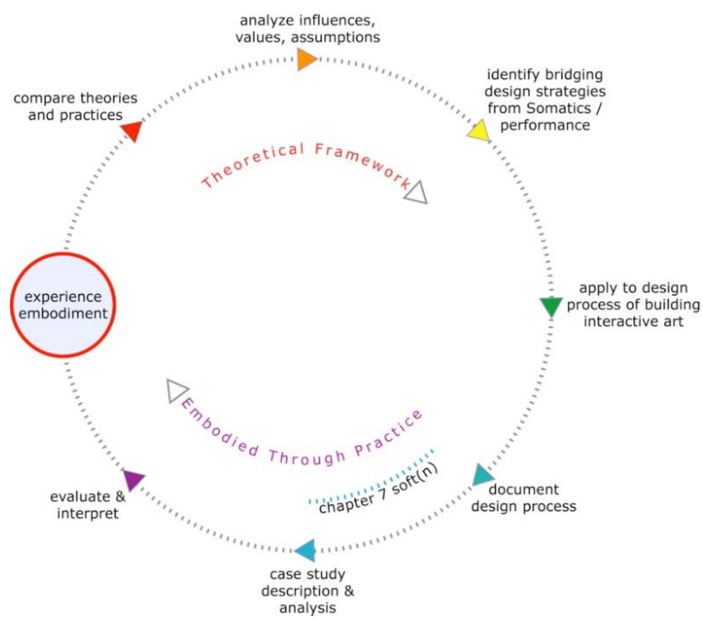

Figure 66. Toward the Implementation of a Somaesthetics of Touch

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[5] Sheets-Johnstone, M. (2009), op. cit. p. 143.
[6] Fraleigh, S. (2004), op. cit. p. 127.
[7] Alexander, F.M. (1932), op. cit.
[8] Feldenkrais, M. (1972). *Awareness Through Movement*. San Francisco: Harper.
[9] Rosen, M., & Brenner, S. (2003). *Rosen Method Bodywork: Accessing the Unconscious Through Touch*. Berkeley: North Atlantic Books.
[10] Cohen, B.B. (1993), op. cit.
[11] Fraleigh, S. (2004), op. cit.

Somaesthetics is a term coined by Richard Shusterman, a philosopher and somatics practitioner following in the pragmatist tradition of Dewey[12] and William James.[13] Shusterman has defined somaesthetics as the development of sensory-aesthetic appreciation that can be cultivated through attention to our bodily experience. He refers to critical practice within somatics and aesthesis (perception) that can support self-agency of the soma[14]. Shusterman's stance has much in common with philosophers such as Maxine Sheets-Johnstone who describes how "self-movement structures knowledge of the world" [15], with Alva Noë[16], whose enactive approach to perception suggests that our ability to perceive is constituted directly by somatic sensorimotor knowledge, and with Mark Johnson[17] who explores aesthetics of human meaning as growing directly from our visceral connections to the bodily conditions of life.

Like Dewey, Shusterman's approach to somatic philosophy has been developed through practice-based experience of somatics that has deeply influenced his philosophical framework. Dewey's somatics practice was articulated through 15 years of working with F.M. Alexander and the Alexander technique, while Shusterman's experience has evolved through his work as a professional practitioner of the Feldenkrais Method[18]. Dewey and Shusterman illustrate the integration of a radical interdisciplinary dialogue within their own research, which provides a leading example for the pragmatist exploration of embodied interaction within technology design.

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[12] Dewey, J. (1934), op. cit.
[13] James, W., (1999), op. cit.
[14] Shusterman, R. (1992), op. cit.
[15] Sheets-Johnstone, M. (1998). *The Primacy of Movement,* Amsterdam: John Benjamins Publishing Company, p. xv.
[16] Noë, A. (2004). *Action and Perception,* Cambridge, Massachusetts: MIT Press.
[17] Johnson, M. (2007). op. cit.
[18] Shusterman, R. (1992), op. cit.

The term somaesthetics has also been referred to in the writings of Yuasa Yasuo, a Japanese philosopher and scholar investigating comparative philosophy and the *science of subjective experience*. Yasuo contrasts this with the epistemological approach taken by our modern science of objective experience. Yasuo, like Shusterman, describes somaesthetics as an approach to the development of self-cultivation, a transformative practice enacted through self-observation within practical lived experience. He argues that somatic techniques are the key to these transformative practices.[19]

This case study contributes to the need for practice-based methods that can provide practical examples of conceptually rich theories of somaesthetics. In this case study somatics practice is applied to articulating aesthetic *qualities* within experience, linking practices of *soma* with the practice of *aesthetics*. This work is positioned within an ongoing sustained and reflective artistic practice that exemplifies technologically mediated design. It demonstrates the application of a somaesthetic framework to tactile interaction for tangible networked technologies. This case study explores the pragmatic articulation of philosophical concepts of embodiment that focus on *touch* and *quality* of experience.

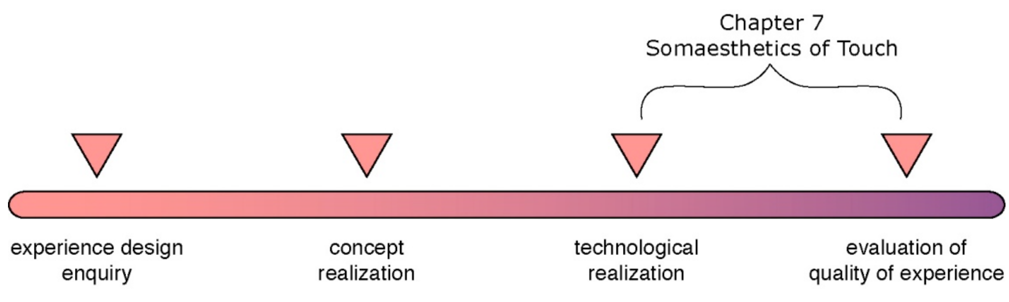

Figure 67. Implementation of a Heuristics to Recognize Touch Quality

[19] Yasuo refers to somatic techniques in which the 'whole of the mind' engages body and matter, which are closely connected with the Eastern tradition of philosophy. Shaner, D.E., Nagatomo, S. (1989). *Science and Comparative Philosophy,* Leiden, The Netherlands: E.J. Brill Publishers, p. xv.

While the case studies *whisper* and *exhale* outlined in Chapters 5 and 6 provided examples of the application of somatic techniques exploring body-state and breath, these techniques were applied to the early stages of technology design in which concept exploration and realization were generated from participant's exploration of felt experience. While *soft(n)* also incorporated early design exploration based on participant experience workshops (as illustrated in Chapter 5) and technology prototyping (as illustrated in Chapter 6), the focus of this chapter is the application of somatics knowledge to a functional *computational model* for technological implementation. These three case studies taken as a whole are intended to illustrate the breadth of approaches that can be used in the application of somatics knowledge and techniques to the design cycle of creating technology. In the case study for *soft(n)*, Laban's Effort Shape system is used as a model to develop tactile input that recognizes *touch effort qualities*. Laban's Effort Shape system embodies experiential knowledge that was tested and iterated throughout Laban's lifetime. The importance of Laban's work is in the development of rigorous theoretical models born directly from empirical observation, testing and practice. These features provide a system that has an inner validity with regard to sensing and moving. My own research is based on an articulation and technological 'intervention' of Rudolph Laban's Effort Shape analysis, a system for defining movement quality within a technological design, as applied to touch.

This chapter introduces the Laban Effort Shape system and provides a rationale for its use and application within a technological design framework. It then provides a context for this approach by positioning *soft(n)* within my artistic practice. This includes the historical development of incorporating touch as an active and interactive sense within a series of artworks leading to *soft(n)*. It outlines the somaesthetic framework that was developed and applied to the design and development of *soft(n),* describes the artistic concept for the *soft(n)* installation, and then articulates the case study in relation to the implementation of a somaesthetics of touch.

It concludes with an assessment and critical analysis of the application of the Laban Effort Shape system to the development of a model for input recognition of touch qualities within a tangible networked interactive art installation, summarizing the somatics values and techniques used in the context of the installation.

7.2 Laban Effort Shape and its Tactile Application to *soft(n)*

Within the field of somatics, Laban was unique in his ability to apply his first-person experience of movement knowledge to a *formalized symbolic* movement analysis system that is both rigorous and expressive. While many somatic practitioners amassed expertise, pragmatic knowledge and mastery that was articulated physically and passed on from one body to the next through physical entrainment, Rudolph Laban was amongst a much smaller number of somatics practitioners that formally codified his system in written and symbolic graphical form. Laban wrote extensively throughout his lifetime, articulating his observation and exploration of movement practice. Laban's legacy included the *symbolic systems* of 1) movement notation called Kinetography (later known as Labanotation), 2) movement's trajectories or *trace forms* in relation to the Kinesphere (the body's reach in space) known as Space Harmony and 3) the expressive *feeling* qualities of movement, known as Effort Shape. These symbolic systems combine to describe a unified whole, in which the body's inner attitude, outer movement expression and connection within space and time form an interconnected harmony where intention, agency, movement and environment continuously effect and shape one another in the greater flow of life.

It is precisely because of the symbolic nature of Laban's system of movement analysis that his work resonates with the application to technological design.[20] Digital technology is based on symbolic and computational systems of representation, and Laban's symbolic descriptions of movement form, movement properties and movement qualities provide a starting point for constructing technological movement models that can be applied equally to user experience and computational design. My own work with technology has sought mechanisms for exploring experiential quality in the context of interaction. Laban's theoretical framework is well suited to its computational modeling.

7.2.1. Laban and Touch

For Laban, touch enables the relationship between movement and space to be discerned within bodily-experience.[21] Laban viewed *touch* as the precursor to our sensory capability, describing touch as the perceived change in the relationship of our bodies to the space-time continuum. Laban describes all of our senses as fundamentally tactile impressions perceiving changes in space: changes in air pressure, in the light spectrum, or in the chemical fluctuation in bodily fluid. Each of the senses and sensory receptors is tuned or 'sensitive' to change within a different range of vibrational frequencies. The modulation of frequency enables the body to perceive tactile impressions or differences in rhythmic changes in space. Laban describes this as:

> All changes in space which we see, hear, smell or taste are literally tactile impressions. All our senses are variations of our unique sense of touch. Two approaching objects touch one another when they finally meet without a noticeable space between them. … This is what happens in any condensing matter in which the outer parts move towards a centre… Each single part of matter approaches its neighbouring part until the two collide, causing an impact or a pressure. It is space, which appears and disappears between and around objects and in the movements of the particles of the object.[22]

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[20] See for example: Loke, L., Larssen, A.T., Robertson, T., & Edwards, J. (2007). Understanding movement for interaction design: frameworks and approaches. *Personal Ubiquitous Computing, 11*(8), December 2007, p. 691-701.
[21] Laban, R. (1966). *The Language of Movement: A Guidebook to Choreutics*. Boston: Plays Inc., p. 29.
[22] Ibid.

Laban refers to touch as a property of condensing matter, the displacement of space within the influx of time. Our body is always in contact with space even as it disappears between our self and another. Within our body, certain movements created by our muscular energy can create condensation (contraction) that generates both inner and outer tactile impressions.

> Intensity, tension, weight and energy which the different contractions of the body communicate to our perceptive faculties are different terms for another fundamental function of space, that of condensation. Condensation in space gives us the impression of a single peak, or selected part, within the infinite flux of time, which is in fact disappearing space. It gives us the capacity to produce new positions, encounters and percussions, new contact and possibilities of tactile experience both within the body itself and in relation to its surroundings. This capacity is muscular energy or force.[23]

Rudolph Laban made an enormous contribution to the systematic application of movement analysis, notation and the symbolic models of movement language. His work combines biomechanics with the underlying qualities, meanings and interpretations of movement in space. Laban perceived all movement as following different rhythms, and the difference in these rhythms relate to varying effort qualities. For Laban effort, rhythm and space are interconnected, and touch is the unifying sensual property within all perception.

7.2.2. Laban Effort Shape

The evolution and development of Effort Shape (also simply called Effort) was born from Laban's early exploration of movement qualities and his migration from Nazi Germany to London in 1938. War-time England marked a new phase in Laban's movement practice and analysis as he moved toward working in industry, introducing work-study methods to factory workers to increase production through humane means.

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[23] Ibid. p. 30.

> Unable to work under the Nazi regime, which looked upon his teachings of harmony and fulfillment through re-educating the sense of rhythm and movement as a threat … Laban and some of his pupils sought sanctuary in the U.K. Remarkable developments followed in that country, where previously little awareness existed of the common basis which movement provides to both dance and work.
>
> During the war Laban turned to industry and established the Laban-Lawrence Industrial Rhythm, which comprised new approaches to … investigating work processes based on his research into the natural rhythm of man's movement.[24]

Rudolph Laban collaborated with F.C. Lawrence, an industrialist, to articulate and define a system, which came to be called 'Effort Shape' Analysis. This rigorous explanatory taxonomy described movement *quality* as the connection between a body's inner attitude and its outer movement expression and flow. Laban linked movement *efforts* with what he named as effort 'affinities', the natural path or trace-form that an effort quality tends toward. An example is the correlation between *Light* and the affinity path of upward motion, and between *Strong* and the affinity path of downward motion.

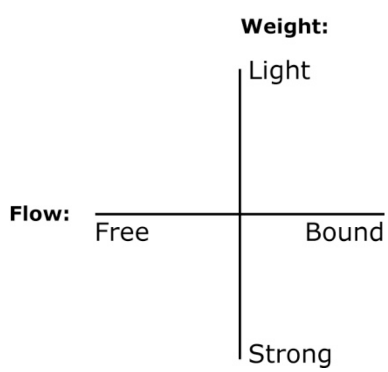

Figure 68. Rudolph Laban's Simple Grid of Exertion (Weight) and Control (Flow)

Light and Strong refer to the poles along Laban's *Weight* motion factor, defining the amount of 'exertion' used in a movement. The *quality* of weight is associated with the body's *intention* in the world, and answers the question, 'what is my impact in the world?'. This qualitative relationship to intention describes meanings such as asserting

[24] Laban, R., & Lawrence, F.C. (1947). *Effort*. Plymouth, UK: Macdonald and Evans, Biographical Note, p. xi.

oneself, creating a strong or light impact, or sensing of self in the world.[25] Laban notes that varying movement effort qualities result from an inner attitude (conscious or unconscious) toward outer movement expression: specifically toward the four definitional motion factors of Weight, Time, Space and Flow[26]. Laban evolved the effort graph illustrated in the figure below. Efforts are associated with a *value* along the four motion factors of weight, time, space and flow.

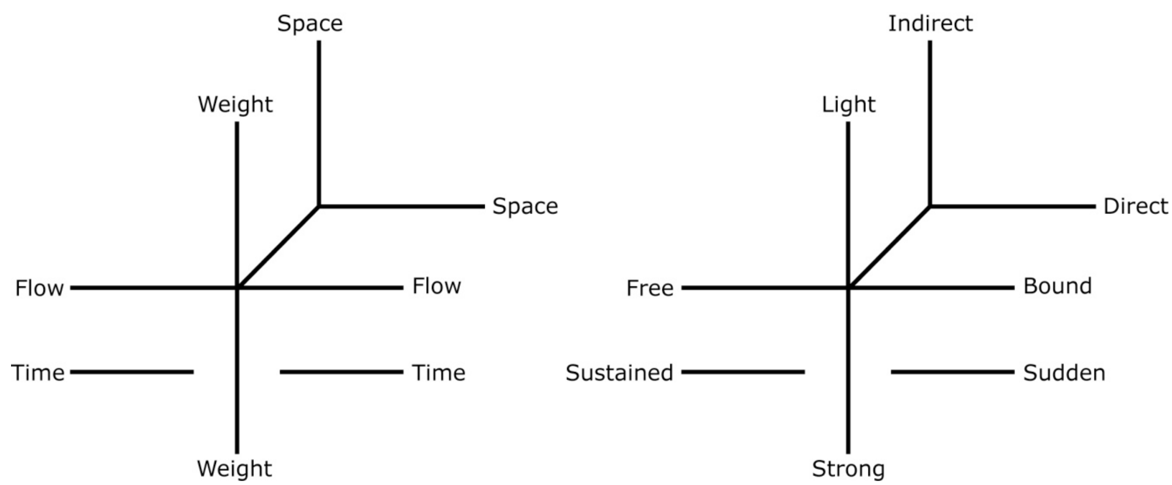

Figure 69. Laban's Effort Graph based on Four Motion Factors of Weight, Time, Space + Flow

For example, weight can be varied along a continuum between *light* and *strong*; time can be varied along a continuum of *sustained* and *sudden [or quick]*[27]*;* space can be varied along a continuum of *indirect [or flexible]* and *direct;* and flow can be varied along a continuum of *free [or fluent]* and *bound.* Combining these motion factors in different ways creates varying movement *efforts* or *experiential qualities*. These inner impulses to move initiate the outward manifestations of our effort qualities.

> Even before any visible movement manifestations, there were inner impulses toward these preparations. First, an inner impulse to *attention* to *space* around [oneself] and what it included; second, to the sense of [one's] own body *weight* and the *intention* of the force of its impact;

[25] Bartenieff, I., & Lewis, D., (1980). *Body Movement: Coping with the environment*. New York: Gordon and Breach Science Publishers.
[26] Laban, R. (1950), op. cit. p. 11.
[27] The different terminology of Effort motion qualities such as sudden or quick, and fluent or free is based on historical evolution of the terms, and the European and American naming conventions that developed through the history of educating and developing Laban's system of movement.

> third, to awareness of *time* pressing for *decision* [choice or agency]. All of this inner participation interrelated with the *flow* of [one's] movement whose inner impulses fluctuated between freedom and control [continuity]. Such inner participation is a combination of kinaesthetic and thought processes that appear to be almost simultaneous at different levels of consciousness.[28]

Bartenieff describes the similarity between "kinaesthetic and thought processes" linking the concept of thought directly to movement (thought *as* a form of movement). Bartenieff also describes Laban's effort qualities as attitudes toward movement that reflect an organism's "urge to make itself known". The efforts have characteristic *qualities* that suggest an inner state of mind, which prepares the mover to act in the world. Each effort has a particular *quality*, which describes its enaction potential.[29]

EFFORT	QUALITY
Space	**Attention**
In what manner do I approach the space?	Thinking. Orienting, specifically or generally.
Weight	**Intention**
What is my impact?	Asserting. Creating strong or light impact. Sensing my weight, myself.
Time	**Choice - Decision**
When do I need to complete the act?	Urgency or non-urgency. Rushing or delaying.
Flow	**Progression**
How do I keep going?	Feeling alive. How to get started and keep going. Freely or carefully.

Table 13. Laban's *Efforts* suggest Inner States that are Enacted Through *Qualities* of Movement[30]

In Laban's definition, the various combinations of the four motion factors produce all legible expressions of movement in life. Laban also describes a property specific to the human use of effort through a concept he called *humane effort*:

> Besides the comparative richness of human effort capacity, one can notice an effort specialty, which might be called the humane effort… Humane effort can be described as effort capable of resisting the influence of inherited or acquired capacities … that is capable of *developing* qualities and inclinations creditable to man, despite adverse influences.[31]

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[28] Irmgard Bartenieff worked with and was mentored by Laban and continued his work through her teaching and writing. See Bartenieff, I., & Lewis, D., (1980), op. cit. p. 51.
[29] Ibid.
[30] Ibid, p. 53.
[31] Laban, R. (1950), op. cit. p. 13.

Laban's concept of *humane* effort is akin to self-cultivation and the ameliorative goals of Foucault's technologies of the self, where the cultivation of inner attitude produces an expression of effort *quality* that increases or improves self-agency. Laban's concept *appropriate* effort, was less concerned with social moral conduct than it was with the graceful, expressive forms of effort that are appropriate for, or have affinity with, a given activity. These affinities are experienced where there is aesthetic recognition, where enjoyment is fulfilled without undue effort and where the *effort* is balanced with the ease of the *outcome*. This form of ecological and sustainable effort is one in which the aesthetic relationship between function and feeling produce eloquence and economy of movement. Laban spoke of the economy of effort, where certain kinds of movement could be more economically performed (without wasted, negative or inordinate effort). When an *appropriate* effort is applied to a movement activity, the result is a fluidity and articulate fluency in movement. Figure 70 illustrates a 'Strong-Free' effort as the most appropriate for a movement example of swinging a heavy object. Other combinations of weight and flow, such as a 'Light-Bound' quality would not support the movement in its most elegant and articulate form.

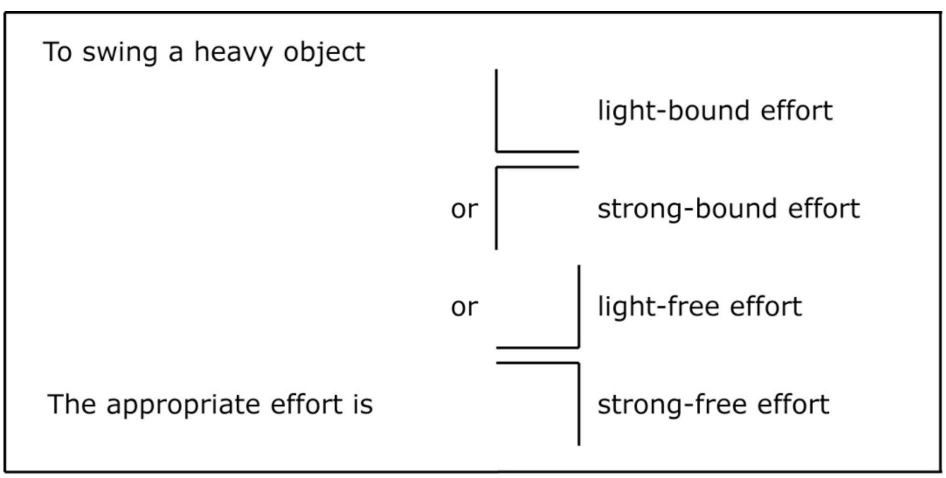

Figure 70. Illustration of Appropriate *Weight* and *Flow* for Swinging a Heavy Object

An appropriate effort is simultaneously aesthetic, elegant and technical. The effort is matched *to* the movement so that an ecological state of harmony is created through its enaction; neither it does require additional expenditure nor does it create wasted energy. This approach to effort is applied not only to large exterior movements, but also the inner movements of our thinking and feeling, which are reflected in our body's exterior attitude. Laban worked with movement quality and effort in relationship to its sense gathering and meaning-making.

Laban, like Delsarte, developed his movement analysis system through empirical observation coupled with practice. His theory of movement was born from the first-person experience of movement. Although his work-studies were historically related to the studies of Taylorism and later to the development of ergonomics, Laban's approach to his work-studies in factories and industrial settings emphasized a whole-body approach. Optimal functioning, normally referred to as movement efficiency, was expressed and *validated* through qualities of grace and eloquence in motion.

The design and development of *soft(n)'s* technological implementation is based on Laban's 8 Basic Effort qualities. These are illustrated in the Effort Graph depicted in Figure 71 below. Each Basic Effort is represented by a combination of line segments that depicts the 'pole' of the graphical effort quality. For example: *Light* Weight uses only the upper vertical stroke of the weight continuum and *Strong* Weight uses only the lower vertical stroke of the weight continuum. The diagonal stroke orients the motion vector between *Space* and *Weight*, so that each effort can be easily identified. The Effort graphical symbols map movement affinities to positions of the line segments, where up, down, left, right, backward and forward are movement tendencies based on an inner-state or predilection toward an outward movement expression.

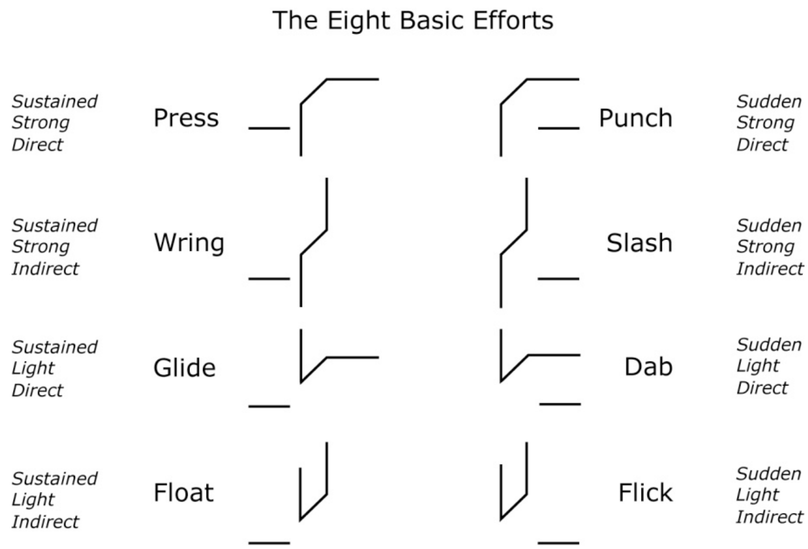

Figure 71. Laban's Eight Basic Efforts Derived From Effort Graph (Illustrated in Figure 69)

Laban's basic efforts are named 'basic' because they *crystallize* effort qualities found in daily movement and activity. As descriptors of the *Action Drive*[32] the crystallization of effort is a 'moment' in movement that punctuates expression and gesture (or action). In everyday life and activity we move through these basic efforts continuously as punctuations that are only sometimes expressed in their heightened, 'crystallized' and most dramatic forms, yet the basic efforts are a part of the rhythm of all movement. In *soft(n)*, these basic efforts are applied to qualities of touch, and are referred to as tactile efforts (or touch efforts). The implementation of a tactile recognition that can differentiate between a Punch, a Flick, a Dab and a Glide are incorporated into the tactile recognition of the networked *soft(n)* objects.

This summary presented a brief overview of Laban Effort Shape as a basis for grounding the movement theory of the *soft(n)* tactile input technology design. Laban also extended this theory to Effort *States* (combinations of two effort Elements that produce mood-like qualities in movement that are also sometimes called *Incomplete*

[32] Each of Laban's Effort Drives combine 3 efforts elements, and leave out a 4th. The Action Drive describes the *8 basic efforts and l*eaves out Flow because it describes a crystallized action movement in which flow 'concludes' a movement thought. The other Drives are the Passion Drive, which is Spaceless, the Vision Drive which is weightless, and the Spell Drive which is timeless. See Bartenieff, I., & Lewis, D., (1980), op. cit. p. 58.

Efforts or *Inner States*), Effort *Drives* (combinations of three Effort elements in which Flow becomes an active element are called *Transformations* or *Drives*), *Full* Effort (combinations of four Effort elements also called *Complete Drives;* these rarely occur because the movements are extreme)[33]; however, the Incomplete Effort and the Effort Drive aspects of Laban's Effort theory are not directly implemented in the *soft(n)* tactile recognition technology.

7.3 An Artistic History of Touch

The sense of touch has been a theme in my artwork since 1995 and in my somatics training since 1984. Its application spans decades and illustrates a range of expressiveness and application. In these artworks, touch and tactile interfaces are used as an exploration of *active touch* within experience[34]– in particular, experience that 'attends' to our inner state through touch. Touch is sometimes called 'the first sense', and is associated with intimacy and empathy. Touch is an important sense in the field of somatics; it functions as an intersubjective channel in which body state and information can be shared, and is associated with empathic connection.

In many somatic practices this empathic connection is used to shift or match body state in order to ameliorate the functioning of the 'soma'. My early tactile artworks remain influential in my research trajectory today. For example, *soft(n)* further articulates concepts that I began to develop in 1995 in the artworks Bodymaps and Felt Histories, and is a historical result of the development and iteration of a *semantics* of caress.

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[33] Ibid, p. 57-58.

[34] *Active touch* is defined by J.J. Gibson in *The Senses Considered as Perceptual Systems.* Gibson identifies that touch can be simultaneously Objective and Subjective "the same stimulating event has two possible poles of experience, one objective and the other subjective. There are many possible meanings of the term *sensation* but this is one: the detection of the impression made on a perceiver while he is primarily engaged in detecting the world". See Gibson, J.J. (1966). *The Senses Considered as Perceptual Systems*. Westport, Connecticut: Greenwood Press, p. 99.

7.3.1 Bodymaps: Artifacts of Touch

Bodymaps: Artifacts of Touch (1995-1997), was the first interactive artwork I created that bridged the tactile aspect of my somatics training with my background in computer design[35]. The interaction concept is autobiographical in nature and has an intensely personal, sensual, sometimes disturbing, experiential quality. At the time of Bodymap's inception the 'hand' in HCI was used primarily as a pointing and clicking device or as a text command-based driver of interaction, remaining conceptually divorced from its tactile nature. I was interested in counterpointing the prevalence of goal-directed interaction, exploring interaction that simply 'made space' for the existence of experience for its own sake.

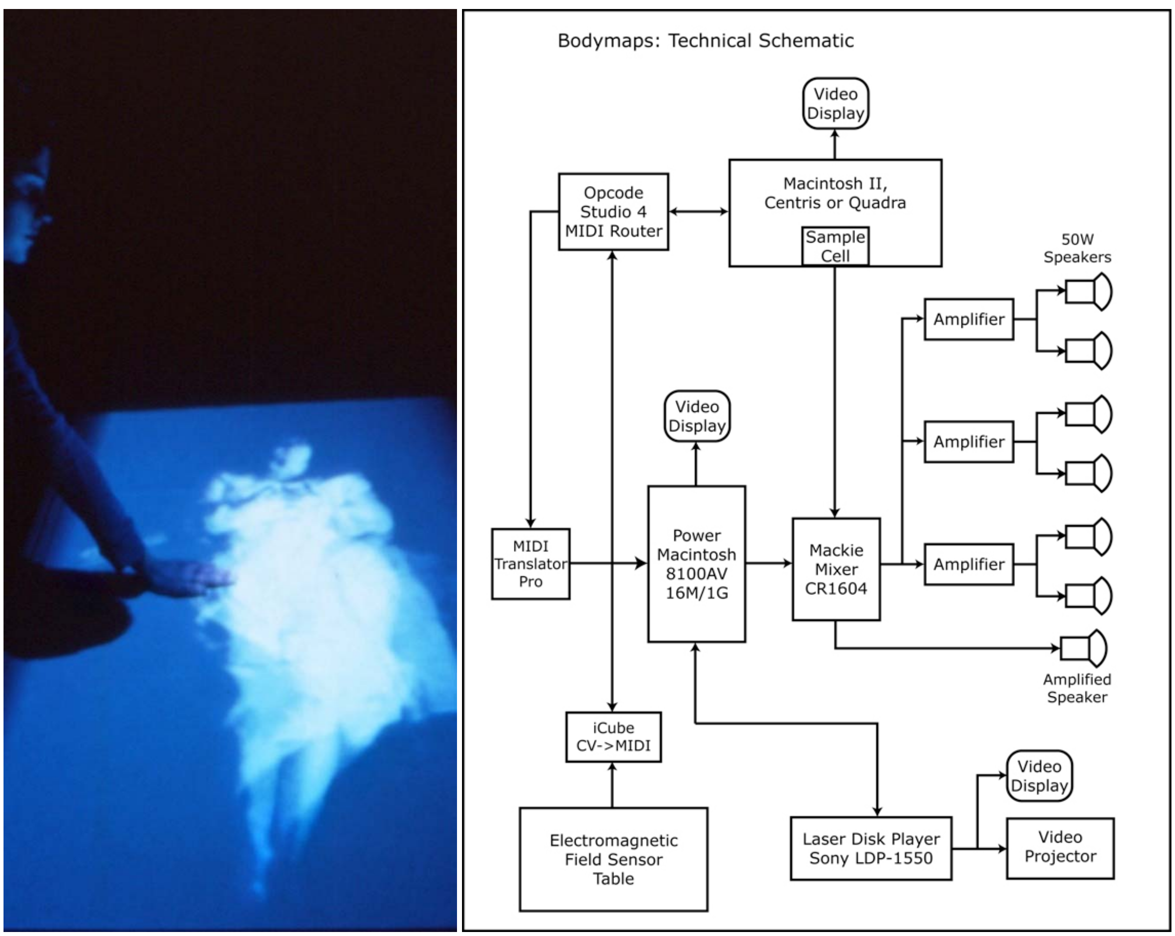

Figure 72. Bodymaps: Artifacts of Touch Installation and Technical Schematic Design (1995-1997)

[35] Video documentation of Bodymaps is contained on the accompanying DVD described in Appendix A.

The intention of the artwork was to explore the sense of touch by inviting participants *into* a state of attending to their own act of touching. In Bodymaps, the treatment of the video and audio content was influenced by Luce Irigaray's book "Marine Lover", an essay written to Nietzsche in a lyrical dialogue form, interrogating him "from the point of view of water"[36]. As such it has a sensual and erotic poeticism and a feminist positioning with regard to gendered qualities within technological design and concepts of agency, control, vulnerability and power. This work used white silk velvet fabric as the top layer of the table surface. Silk velvet has an unexpectedly warm, sensual texture that invites touch through its soft and yielding quality. Its warmth is distinct from the cold metal of computer circuitry and more akin to the temperature of skin. It also imparts a kind of 'tactile history' through the traces left behind from the contact and movement across its surface. This is a feature of its 'fabric nap', a property of the textile weave of velvet[37]. These tactile traces are also reminiscent of Laban's concept of movement trace forms that define the language of movement effort quality. The table itself contained two layers of specially designed sensors, both tactile and proximal. This technological design was attempting to map a *surface intelligence* that I referred to as *skin consciousness*. Our skin is a tactile organ, but can also sense proximity. This notion of surface *awareness* is referred to in Laban's description of tactile impressions created by the displacement of space. The sense of touch does not only come into play at the moment of contact, but also at the moments leading up to the physical contact of skin to surface. Our sensory awareness perceives the approach of touch, as well as the moment of touch, all contained within the range of our bodily tactile impressions through the mechanoreceptors and thermoreceptors within the skin. These tactile impressions are the sensations we receive and are also the basis for our movement intention, our reciprocal act of touching back. It is our attention that

[36] In *Marine Lover*, Irigaray ruptures conventional discourse, writing in dialogue form in a lyrical style that defies distinctions among theory, fiction, and philosophy. A leading French feminist and psychoanalyst, Luce Irigaray holds doctorates in both linguistics and philosophy and is a director of research at the Centre National de la Recherché Scientifique.

[37] A fabric with nap usually has a pile and will have different shades from different angles based on the direction of the short pile. In Bodymaps this enabled the movement traces of the hand to be visible.

enables the reciprocity, the shift in state and the choices to continue or alter our engagement. The technological design of Bodymaps enabled participants to explore active touch, and to *attend to* an inner state through touch. This goal of opening up an interactive space where attention can be explored through touch is common to Bodymaps and *soft(n)*.

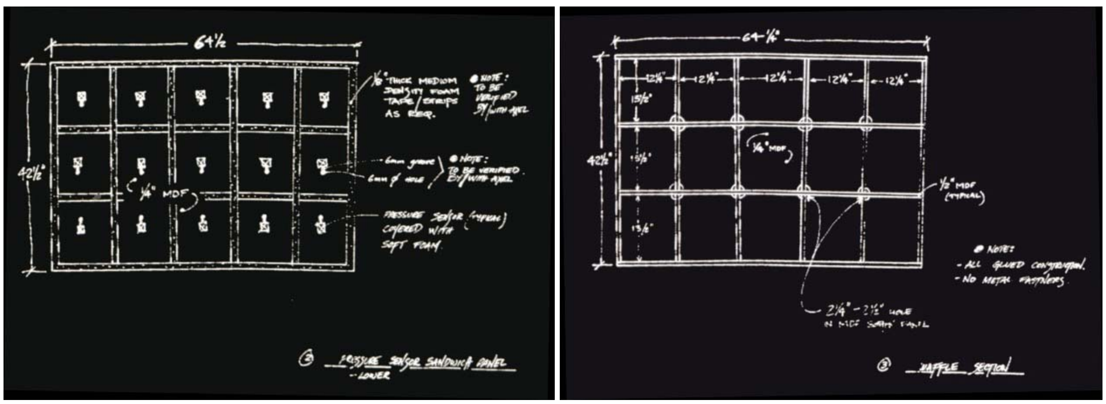

Figure 73. Bodymaps: Artifacts of Touch Sensor Design for Touch and Proximity (1995-1997)

The exploration of tactile semantics began with the layered tactile and proximity sensor grids in Bodymaps, and evolved into the soft flexible sensor grids, or *taxels* that were used in *soft(n).* This technical exploration can be seen as a historical progression that was iterated, tested and evolved over a number of artworks and technological experiments. Like *soft(n),* the sensors used in Bodymaps were hand-crafted, and hand-constructed. This was an interdisciplinary process supported by working with an electrical engineer to design the tactile and proximity electromagnetic field sensors. Figure 73 illustrates the two sensor sandwich layers, the top layer containing 8 proximity sensors mounted at the intersection axis illustrated in the right image, and the bottom layer containing 15 touch pressure sensors located in the centre of each grid illustrated in the left image. The tactile sensors were FSRs (force sensing resistors). The proximity sensors detect our body's electromagnetic field as it comes into contact with (and disrupts) the electromagnetic field of the sensor. This approach uses the body as an antenna, that re-radiates low-frequency electromagnetic energy. In particular, the standard power-line signals (of 60Hz) are picked up by the body and re-radiated in the vicinity of the sensor, which detects the increased amplitude of the signal through our body's reflection. As our body (usually our hand) moves closer to the sensor, the amplification of the sensor's electromagnetic field increases.

Figure 74. Bodymaps: Interacting through Touch (1995-1997)

These experiments were developed in the creation of Bodymaps, but were also the basis for a 'Sensor Product Line'[38]. These interdisciplinary practice-based explorations combine a bodily somaesthetic concept (the tactile nature of perception through our sensory organs at the site of our skin) applied to an experimental technological solution (the concept of tactile impressions that are both proximally and contact sensitive). These interdisciplinary strategies are a common thread in my artistic research and practice. The integration of body and aesthetics in the act of creating experience through technology is another somaesthetic thread in the historical trajectory of this work. In Bodymaps, tactile recognition was mapped to pressure, duration, path and time. These perceptual cues were applied to a rule-based interaction that engaged participant's responses based on variation in tactile qualities. The system 'knew' what video segment was playing and could therefore map tactile quality to the image content. Although the Laban Effort qualities were not incorporated directly into the Bodymaps tactile rule base, the system's attention to qualitative experience was based on the *quality* of touch, and this grounded future directions.

[38] Axel Mulder worked as an electrical engineer on the development of the I-Cube and 'Reach' Proximity Sensor that became part of the product line of sensor-based interaction marketed by Infusion Systems, which was founded by Axel Mulder during the development of Bodymaps. The Bodymaps project was a beta-tester for the development of this technology which continues to be developed and manufactured today. <http://infusionsystems.com/>

7.3.2 Felt Histories

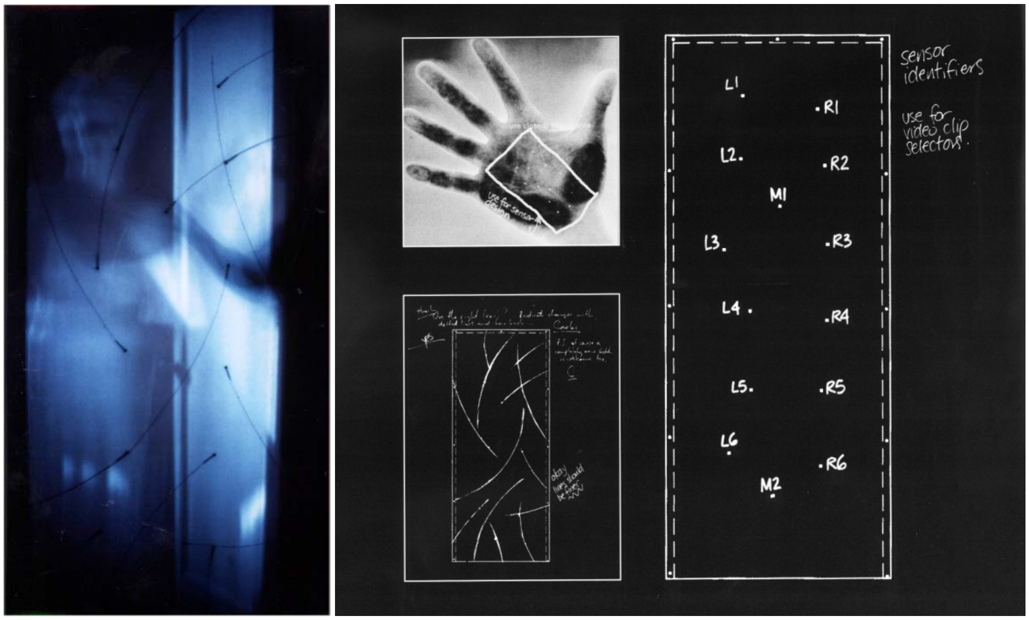

Figure 75. Felt Histories Installation Image and Technical Sensor Surface Design (1998-2000)

Felt Histories (1998-2000)[39], continued the artistic and technological theme of Bodymaps, but extended its technological exploration to include real-time mixing of video and sound through a networked system. Its thematic content was biographic in nature, based on an aural history of my mother's memories of her upbringing as a Dutch child in a large Catholic family, exploring the tensions between her femininity and the physical nature of her body and bodily memories. Felt Histories incorporated a tactile surface of sensor embedded plexiglass on which video images were rear projected. The rear projection created a transparent surface in which the sensors were visible through the projected image. Rather than constructing a grid of sensors connected by horizontal and vertical wires, the sensors were positioned at the end of curved lines that represented a close up image of the lines on the palm of my hand [Figure 75]. These sensor lines and the entire projected sensor surface became a metaphor for the surface of the hand, which held, remembered and transformed video segments through the installation participants' touch. The technological development in Felt Histories included a more 'intelligent' rule-based recognition of tactile

[39] Video documentation of Felt Histories is contained on the accompanying DVD described in Appendix A.

information, which used trajectory, direction and pressure to determine the rule that would select and mix the upcoming video segment. This was structured seamlessly so that caressing the image of the shoulder in a downward motion could cause the image of the garment to drop down from the shoulder, or caressing the open hand could cause the figure to step back or to turn around. The images and episodes were less narrative than poetic. Each episode created a different poetic frame within the physical doorframe. Episodes included a white wooden door that opened and then later, slowly caught fire, a series of transparent curtains moving in a breeze, a set of bars, a glass surface against which rain was falling, and an open black 'hole'. The frame was intended as a threshold space in which installation participants invited the female body to respond *bodily* through her movement and *aurally* through her body's story. The video image was desaturated (by aesthetic choice) and the video playback was not always smooth due to technological limitations of networked video. However, these decomposing features of the interaction supported the aesthetic nature of the work. My mother was 73 years old at the time Felt Histories was created, and the threshold of the doorframe alluded in part to death, aging, decay, and the transformative nature of the body through its own gendered state. Again, Felt Histories illustrated a poetic relationship to touch, a conceptual and aesthetic relationship to the design of the technology, where the sensor surface was hand- crafted and constructed. It became clear from observing participants within the installation that the tactile nature of the interaction created a 'slowing' process and 'sensitizing' to the surface being touched. It was also clear that different tactile qualities were used as both response and initiation. These observations led the continuing research that developed with regard to tactile recognition.

7.3.3 Developing a Semantics of Caress

In the years 1999-2003, I began an exploratory research process that conceptualized, prototyped and tested possible applications for multi-touch surfaces. This research was led by interdisciplinary practice-based explorations that combined a bodily somaesthetic concept applied to an experimental technological solution. The poetics of Bodymaps and Felt Histories had been potent and yet the tactile resolution of the sensors remained limited. The electronic sensors were not yet able to support a more intelligent qualitative recognition of touch. The intelligence in these artworks was created through the video content, compositional construction and poetic layering during interaction. There was still an enormous gap between the tactile nature of perception through our bodily sensory organs and the concept of tactile impressions that could be derived and understood from an input device. This next phase of tactile research began in response to a desire to develop a more qualitative understanding of touch *from within* a technological model. This research was instantiated with a multi-touch optical fibre array surface embedded within in a desktop graphical controller called the MTC Express. It was designed and engineered by Tactex Controls Inc., a company that was innovating multi-touch surfaces. It housed a 12 x 6 optical fibre array with 72 taxels. Each taxel is an intersection point between the X and Y coordinates of an optical fibre matrix. When the touch pad is depressed, the displacement of light within the optical fibres enables the detection of pressure and position over time.

Figure 76. Tactex Multitouch Controller with Embedded 72 Taxel Optical Fibre Array (2001)

When the surface is touched, stroked or caressed, the device creates tactile pressure imprints over time, a metaphor for the skin's surface. This surface has a tactile quality with a far higher resolution than was used in the Bodymaps or Felt Histories tactile grids. The potential lies in tactile data with sensitivity to characteristics of pressure, location and duration that could be correlated to the effort factors used in Laban's 8 Basic Efforts: pressure could be correlated to *Weight* (light or strong), location (including area and path) could be correlated to *Space* (direct or indirect), and duration could be correlated to *Time* (sustained or sudden). These correlations may have noticeable similarities, but they could not be considered literal mappings for a number of reasons. The Laban Efforts are *internal attitudes* to movement, and we could not expect the tactile surface to measure inner state as a result of hand movement. Laban Efforts represent an outward movement of an inner attitude and we need to consider the subtleties of representation within our heuristic scheme.

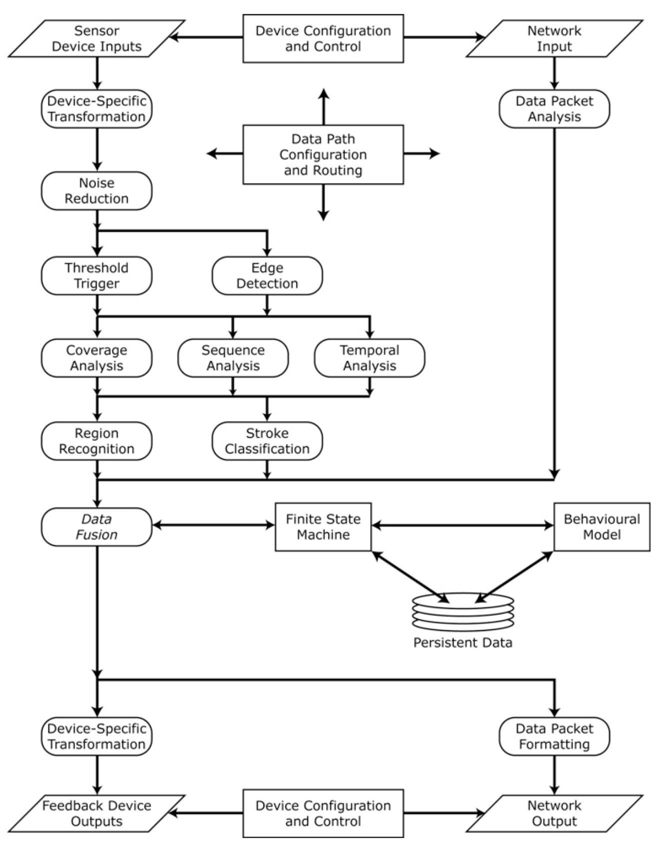

Figure 77. Tactile Effort Recognition Data Flow based on Tactex MTC Express (2002)

For example, the Spatial quality of *Indirect* cannot be literally correlated to an 'Indirect motion path' on a tactile surface since Indirect Space is an *attentional attitude* toward space; nor can the *Sustained* quality of Time be literally correlated to a 'Longer touch'. Effort qualities in movement are evident in their changing states and in their whole body rhythms. However, despite differences in the *measurable* parameters of the tactile surface of the Tactex MTC Express and the *discernable* qualities of movement efforts, the similarities between pressure and *Weight*, duration and *Time*, and location and *Space* were great enough and legible enough to test and iterate a *heuristics* for the recognition of tactile qualities. The value in exploring experiential *quality* through touch and recognizing the meaning-tendencies associated with specific tactile qualities illustrates a means for addressing pragmatic outcomes of somatically based technology design. The potential for extracting qualitative tactile data was the starting point of these explorations. The goal was to generate a computational heuristic model that could recognize expressive tactile qualities based on the Laban Effort grid.

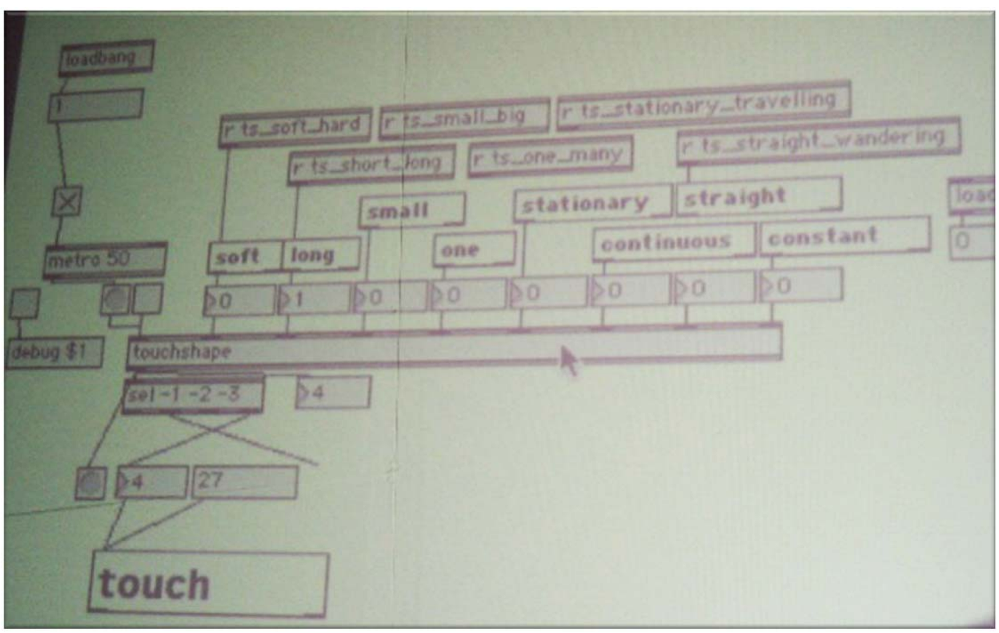

Figure 78. MAX / MSP Tactile Effort Recognition based on Tactex MTC Express (2002)

At that time, most applications for the Tactex multi-touch controller were based on detecting pressure, or alternately mapping areas (grids) of the tactile surface to specific functions such as drum machines or electronic musical instrument controllers. There was little existing exploration of tactile meaning or expressive qualities of touch. I worked with a small interdisciplinary team[40] to develop a heuristics for tactile recognition based on Laban's Effort Qualities, using the 8 basic efforts as a starting point. We were able to develop an interface using the Tactex MTC Controller connected to MAX/MSP[41]. We developed a series of MAX objects that extracted data from the MTC express [Figures 77 & 78]. We used a pressure map as input to image-processing algorithms to extract pressure hills and contact regions. This approach enabled us to successfully recognize a number of touch efforts.[42]

This prototype and the successful recognition of Laban touch efforts became the basis for the exploration of touch within the wearable and tangible artworks conceived and implemented from 2002-2008, including the basis for the tactile fabric exploration that resulted in *soft(n)*. Yet it also remained a technological research thread that continued in parallel to the artistic production. This was due in part to the technological constraints of a graphical tablet as an input device in a wearable or tangible context. Despite the quality of the optical fibre array it required a rigid surface in order to extract usable tactile data. The rigid surface of a graphical tablet was not a comfortable, soft or viable option for textiles. However, eventually this exploration of qualitative recognition and expression through the sense of touch found its way into the material and fabric explorations of soft-circuits for wearable and fabric-based technologies, and became the basis for the *soft(n)* tactile recognition.

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[40] Comprised of Rob Lovell, a Computer Scientist and dancer, and Norman Jaffe, a senior software engineer. Both these collaborators have contributed to a number of the artistic projects described within this thesis.

[41] MAX/MSP is a visual programming language developed by Cycling '74. It is primarily used by composers, performers, software designers, researchers and artists for creating interactive software.

[42] Schiphorst, T., Lovell, R., & Jaffe, N. (2002). Using a gestural interface toolkit for tactile input to a dynamic virtual space. *CHI '02 Extended Abstracts on Human Factors in Computing Systems* (Minneapolis, Minnesota, USA, April 20-25, 2002). CHI '02. New York: ACM Press, p. 754-755.

7.3.4 Working with Fabric Tactile Arrays

Led by the goal of expressing and articulating experiential *qualities* within networked interaction, the ability to work with soft-circuit or fabric-based tactile recognition provided a number of implementation challenges. One of the design concepts was the ability for the body to represent itself within a network. The body-area-network was born from this underlying philosophical concept and required a rethinking of the locus of a networked activity. When the body 'became' the network, and in order to operationalize a body-as-self centre within the network, there was a need for a portable microcontroller or 'pocket computer' that could be easily carried or embedded within a garment, pocket or small object and that was capable of executing the tactile recognition software. In 2003 we ported the tactile recognition software to a small portable computer in the form of the Toshiba Pocket PC PDA, taking our first step towards portable tactile recognition. This was the first of a series of pocket computers or microcontrollers that were used for this purpose.

Figure 79. Tactile Pressure + Location Recognition Ported to Toshiba PDA (2003-4)

The second implementation challenge was to design and build a replacement for the Tactex MTC Express that was capable of recognizing and translating tactile information that could be flexible, soft and sewn into textiles. Along with the growing explorations and developments in artworks *whisper* and *exhale*, this created a radical interdisciplinary shift between the crafts of sewing and engineering, inviting the craft approach of the sewing circle into the engineering paradigm of technological design and implementation. This non-trivial methodological intervention enabled the exploration of and experimentation with soft-circuit, hand-sewn, fabric-based, tactile arrays that explored aesthetic and expressive surfaces for measuring and recognizing tactile impressions. These construction processes required garment designers, electrical engineers and software developers to work side by side and even 'hand in hand'. These experiments in fabric textile arrays were developed in tandem with the wearable technology explorations of *whisper* (2002-2004) and *exhale* (2005-2007).

Figure 80. Touchpad with Conductive Foam as Taxel and Conductive Fabric as Wire (2005)

The first experiments developed from the exploration of conductive foam as a taxel or 'touch pixel'. In Figure 80 the touchpad is constructed from conductive foam. Each taxel is cut and placed in a grid. Conductive Fabric is used as a passive conductor of electrical current, both functional and aesthetic. These explorations incorporated aesthetic materials, poetic response and experiential tactile quality with the goal of developing a semantic tactile model. These processes were later reflected upon in defining the properties of a somaesthetic framework for technology design. The image on the left illustrates one of the first prototypes of the conductive foam taxels. When they are sewn and placed this far apart, they function as switches, rather than as a fluid or contiguous touch surface. The image on the right illustrates the use of silk organza as flexible passive conductive cabling.

Figure 81. Exploratory Research in Fabric Tactile Arrays (2005)

From the initial experiments with conductive foam fabric switches [Figures 80 & 81], we began to build up soft tactile array surfaces. Foam taxels are proportionally larger than optic fibre array taxels. While conductive foam taxels can be 'sewn' and are able to create a soft flexible surface, the number of taxels is reduced for any given surface area. Through a generous amount of testing and prototyping, we discovered that we were able to recognize tactile effort qualities using a grid as small as (4 x 4) and that a conductive foam grid of (6 x 6) enabled a similar precision as we had utilized with the (6 x 12) Tactex grid[43].

Figure 82. Exploratory Research in Fabric Tactile Arrays (2005)

In support of a somaesthetic approach to materials design, conductive silk organza is used simultaneously as an aesthetic selection of material based on sensual and tactile properties, and as a functional 'soft-wire' that conducts an electrical signal, indicating the pressure and duration of a taxel press. These individual tactile 'presses' are the

[43] Video documentation of Fabric Prototype is contained on the accompanying DVD described in Appendix A.

basis of the object's sense of tactile recognition and correspond with the tactile mechanoreceptors of the skin. Various textures and fabric weights were explored as a skin (cover), as a surface (rough, smooth, warm, cold), and as a pocket within a garment or a container (able to be stuffed and hold embedded electronics).

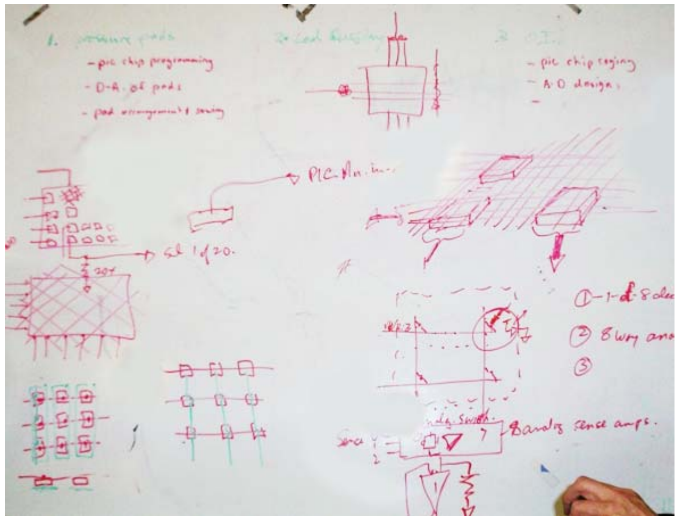

Figure 83. Designing Electronic Functionality of a Fabric Tactile Array (2005)

While the early fabric tactile arrays were constructed with the taxels further apart, the *soft(n)* iterations enabled us to place the taxels much closer together creating a more equalized and unified surface that continued to invite touch.

Figure 84. Exploratory Research in Fabric Tactile Arrays (2006)

In addition, each iteration was explored playfully with both the design team and with users. The image below, on the left, illustrates an early touch pad prototype, where the taxels are arranged in a grid of 6 x 6. Once again, the conductive fabric is used as a passive conductor or soft conductive cable. The image on the right illustrates an early electronic breadboard prototype of a 3x3 touch pad connected to a Gumstix board, the precursor to the *soft(n)* development. These examples illustrate a rich aesthetic and materials component to the craft and engineering of the fabric tactile arrays. Although this section has described examples of creating these arrays so that they could operate as tactile input devices, many participant workshops were also held in order to gather experiential feedback regarding the quality of the experience as well as the quality of the technological implementation.

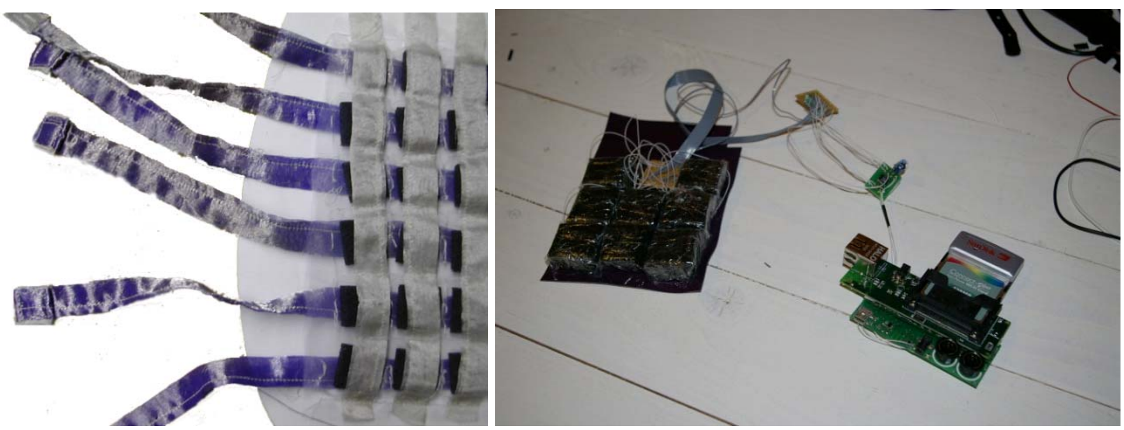

Figure 85. Exploratory Research in Fabric Tactile Arrays (2006)

This section has positioned my artistic practice within an *Artistic History of Touch* that provides a context for the development of a somaesthetic framework for design that resulted in the creation of *soft(n)*. The historical development of incorporating touch as an active and interactive sense within the artworks presented spans over a decade of practice and experimentation, led by concepts of the efficacy of embodiment, while attending to questions of how we can implement concepts of experiential quality within the design of technology interaction. This history of practice represents a continuum of exploration within which *soft(n)* was created.

7.4 Toward a Somaesthetics of Touch

The case study of *soft(n)* explores the pragmatic articulation of philosophical concepts of embodiment that focus on *touch* and *quality* of experience. This research contributes to the need for practice-based methods that can provide practical examples of conceptually rich theories of somatics. In this case study the somatic model of Laban Effort Shape is applied to articulating aesthetic qualities within experience, linking practices of *soma* with the practice of *aesthetics*. This work is positioned within an artistic practice that explores how bodily intelligence can influence and ground technologically mediated design. In *soft(n)* this is demonstrated through the application of a somaesthetic framework applied to tactile interaction for tangible networked technologies. *soft(n)* is an interactive tangible art installation developed in conjunction with V2_Lab in Rotterdam[44].

Figure 86. *soft(n)* an ecology of soft networked objects that respond to touch

[44] V2_ is an interdisciplinary center for art and media technology in Rotterdam. V2_'s activities include research and development of artworks in its media lab, organizing presentations, exhibitions and workshops, publishing in the field of art and media technology, and developing an online archive. <http://www.v2.nl>

Like Bodymaps and Felt Histories, *soft(n)* invites experience that 'attends' to our inner state through touch. *soft(n)* further articulates concepts that were nascent in the artworks Bodymaps and Felt Histories, refining the integration of experience, poetics, materiality and the development of a computational model for a semantics of caress.

7.4.1 Somaesthetics in the context of technology

The term *somaesthetics,* originally framed by Richard Shusterman, explicitly references somatics through the embodied nature of an aesthetics of use.[45] While somatics is a field of practice that references the experience of the lived body,[46] Shusterman's philosophy of somaesthetics couples somatics with aesthetics, while making a case for bringing the somatic embodied nature of aesthetics into everyday experience. Shusterman's somatic philosophy is evident in his definition of somaesthetics, which we revisit here from its introduction in Chapter 3:

> Somaesthetics can be defined as the critical study of the experience and use of one's body as a locus of sensory-aesthetic appreciation (aesthesis) and creative self-fashioning. It is devoted to knowledge, discourses, practices, and bodily disciplines that structure such somatic care or can improve it. If we … simply recall philosophy's central aims of knowledge, self-knowledge, right action, and its quest for the good life, then the philosophical value of somaesthetics should become clear.[47]

Shusterman's concept of somaesthetics brings the practice of somatics into the pragmatics of aesthetic valuation and experience. Based on Dewey's pragmatist work, *Art as Experience*[48] and Shusterman's own somatic practice, somaesthetics reinvigorates the field of aesthetics by reclaiming the lived experience of the body and particularly the notion of cultivating the self through attention to experience. A pragmatic aesthetics gives precedence to enactment by referring to the importance of experience to produce or enact aesthetic response. Like Laban, the philosopher Alva Noë regards perception as a method of *enacting* within a world that is inherently

[45] Within the HCI literature see: Fiore, S., Wright, P., & Edwards, A. (2005). op. cit., Petersen, M.G., Iversen, O.S., Krogh, P.G., & Ludvigsen, M. (2004), op. cit., and also Shusterman, R. (1992), op. cit.
[46] Hanna, T. (1980), op.cit.
[47] Shusterman, R. (1992), op. cit., p. 267.
[48] Dewey, J. (1934), op. cit.

tactile[49]. Somaesthetics embraces the *quality* of attention and awareness and provides an opportunity to explore the self's relationship to experience through technology. Within HCI, previous references to somaesthetics are sparse but include an introduction in Kallio[50] and in Lim, Stolterman, Jung and Donaldson's development of a model for Interaction Gestalt[51]. This case study brings a somaesthetic framework to the design of tactile interaction within human-computer interaction.

Figure 87. *soft(n)* explores a tactile aesthetics of interaction

7.4.2 Somaesthetics within a history of Soft Sculpture

In *soft(n)*, the sense of touch is based on qualities that can 'soften' experience[52]. The *soft(n)* title references the Pop Art and Feminist Art history of soft sculpture that was originally credited to the artist Claes Oldenberg in the 1960s. Oldenberg's work was ripe with satire and humor in its playful and wry commentary on mass culture. Soft sculpture refers to a cultural shift in materials of production that embraced "radically soft things" and that generated a new vocabulary of form that also resisted form,

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[49] Noë, A. (2004), op. cit.
[50] Kallio, T. (2003), op. cit.
[51] Lim, Y. K., Stolterman, E., Jung, H., & Donaldson, J. (2007). op. cit.
[52] Acknowledging the embodied and experiential nature of tangible interaction and highlight the coupling of somatics (Bødker, 2006, p. 1-8) with aesthetics (Kallio, 2003, p. 142-143). Attention to aesthetic qualities is being instrumental to interaction design (Fiore, Wright & Edwards, 2005, p. 129-132; Petersen, Iversen, et al, 2004, p. 269-276).

inventing the concept of the anti-form.[53] Soft Sculptures permeated the Feminist Art movement in the 1960s and 1970s, seeking ways in which these soft anti-forms could bring into play domestic materials and techniques such as sewing, knitting and quilting. These appropriations of domestic process sought to create a material inclusiveness and were often, playful, subversive and cheeky[54]. The concept of the *sewing circle* enters into the methodological rhetoric of *soft(n)* with its emphasis on sewing, crafting and weaving together textiles with conductive materials and conductive concepts born within electrical engineering[55]. In *soft(n)* the physical tactile surface is flexible, warm, pliable and intelligent. Its sensory surface is crafted from conductive strands of fabric and foam that are able to interpret qualitative meaning from tactile gesture. One can think of *soft(n)* as a counterpoint to, or a critique of, the hard: a survival strategy for interaction that allows intimacy, misplaced action, mistake, forgiveness, softness, weakness, stillness, giving in, and letting go.

Figure 88. *soft(n)* references soft sculpture and explores embodied interaction

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[53] Rainforth, Dylan (2009). *Through the Past, Softly,* Editorial Column in artguide Australia online <http://artguide.com.au/features/through-the-past-softly/>

[54] Ibid.

[55] The concept of the *sewing circle* was originally introduced in the *whisper* concept development and was influenced by collaboration with Susan Kozel an artistic collaborator and partner in the whisper[s] project.

Rather than aligning with a contemporary 'edge', *soft(n)* gives in to the liminal centre within subjectivity. *soft(n)* situates its critique within the computational act of *quality*. Tactility and kinesthesia are rich, intricate, and full of resolution and expressivity.[56] Like its Pop art predecessors a poetics of interaction allows for the playful imagination of participants. The somaesthetics of tactile interaction emphasizes a concern with creating meaning through 'softening' experience. *soft(n)* follows in the tradition of soft-sculpture through the critical practice of somaesthetics.

7.4.3 Four Themes of Somaesthetics

soft(n) explores somatic approaches to design aesthetics that highlight the senses, body, and movement through critical physical inquiry.[57] This approach to *somaesthetics* forms the bases of an underlying design framework that encompasses four themes: 1) Experience, which frames questions of cultivating embodiment, sensory perception and links to techniques of somatics; 2) Poetics of Interaction including meaning-making and open interpretation, which explores perception and cross-modal relationships between touch and other sensory expression; 3) Materiality, which emphasizes the importance of the physical body as well as the physical material, texture, shape, and form that support experience within the installation; and 4) Semantics of Caress, investigating the meaning of touch as applied to tactile interaction (how models for tactile meaning may be applied to a computational model of interaction). This framework has been developed historically through ongoing artistic inquiry and practice spanning over a decade. Each of the four thematic elements in the somaesthetic framework of Experience, Poetics, Materiality and Semantics are present in prior artistic work. In the first theme of *Experience* the artworks of Bodymaps and Felt Histories create a resonant space for developing attentional 'skills' through

[56] Gibson, J.J. (1962). Observations on active touch, *Psychological Review*, *69*(6), p. 477-491.

[57] Within the HCI literature, see: Gaver, B. (2002). Provocative Awareness, *Computer Supported Cooperative Work* (*CSCW*), *11*(3-4), September 2002, The Netherlands: Kluwer Academic Publishers, p. 475-493; Hansen, L. (2005). Contemplative Interaction: Alternating Between Immersion and Reflection, *Proceedings of the 4th decennial conference on Critical computing: between sense and sensibility* (*CC '05*), p. 125-128.

interaction. The second theme of *Poetics of Interaction* is incorporated in the poetic and lyrical framing of aesthetic interaction. Bodymaps evoked a poetics rich with sensual, contemplative, and tactile attention where participants were invited to observe and affect their response. Felt Histories explored the poetics of dissolution and decay and the volitional act of a tactile voyeurism that was enacted through interaction with the Felt Histories ‘doorframe’. The third theme of *Materiality* is grounded by a history of artistic exploration where the selection of material properties and tactile quality enabled interaction experience to be drawn toward the human senses: 1) in Bodymaps the tactile quality of the velvet and its property of memory traces, 2) in Felt Histories the transparency of the sensor surface and its hand-crafted metaphor of the palm of the hand, and 3) in the fabric tactile array research with its lush saturated color and raw textures using conductive thread, fabric and foam. The fourth somaesthetic theme of a *Semantics of Caress* has enabled experience, poetics and materiality to be understood and executed through *technological* models that could invite response, reaction and interaction. These *qualities* of experience, of touch and of movement continue to compel and develop the research within *soft(n).*

7.5 A Somaesthetics Framework Applied to *soft(n)*

The four themes of the somaesthetic framework are experience, poetics of interaction, materiality and semantics of caress. The first theme in the somaesthetics framework presented here, is that of experience. In Shusterman’s conception of somaesthetics, bodily experience is inextricably tied to the meaning of our sensory selves. Experience is at once sensory and aesthetic.[58] Other philosophers such as Dewey have defined art itself *as* experience[59] and, more recently, the field of HCI has recognized the centrality of experience within technology design,[60] exploring concepts such as gestalt[61] and

[58] Shusterman, R. (2008), op. cit.
[59] Dewey, J. (1934), op. cit.
[60] McCarthy, J., & Wright, P. (2004), op. cit.
[61] Lim, Y.K., Stolterman, E., Jung, H., & Donaldson, J. (2007), op. cit.

empathy[62] within a focus of interaction. The design of *soft(n)* explores experience from the perspective of embodied interaction, incorporating Laban's somatic concepts of experiential quality of movement and touch within its somaesthetic framework. The theme of *Experience* is described from the perspective of the participant's interaction with *soft(n)* and is also defined through the poetics, materiality and semantics of interaction. The *Poetics* of *soft(n)* supports the participant's experience through its lyrical metaphors. The *Materiality* theme describes the construction and design of textile and electronic materials that support the aesthetics of interaction. The *Semantics of Interaction* theme describes how meaning is encoded and extracted from a tactile interface to support the participants' experience.

7.5.1 *soft(n)* Experience within the Installation

The *soft(n)* installation is an intelligent tangible network comprised of 10 soft physical objects that exhibit emergent behavior when touched or moved about in the space. Aesthetic qualities that engage the senses (feeling, listening, observing, moving) reflect the embodied nature of user experience design. Each of the 10 interactive soft objects contains a specially designed and custom-engineered multi-touch soft input surface and accelerometers that detect motion. Tactile recognition is implemented using Laban Effort Shape analysis[63]. Participants' tactile quality is recognized and communicated through a wireless network as 'meaning' to other participants. Each soft object has an ability to actuate vibration, light and sound in response to its tactile induced state. The actuation patterns enable a specific proximal layer of communication: local, mid-range and distant. Vibration (movement) is a local or intimate sense.

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[62] Wright, P., & McCarthy, J. (2008). Empathy and experience in HCI, *Proceedings of the Twenty-Sixth Annual SIGCHI Conference on Human Factors in Computing Systems* (Florence, Italy), CHI '08. New York: ACM Press, p. 637-646.

[63] Schiphorst, T., Jaffe, N., & Lovell, R. (2005). Threads of Recognition: Using Touch as Input with Directionally Conductive Fabric, *Proceedings of the SIGCHI conference on Human Factors in computing systems*, April 2–7, 2005, Portland, Oregon.

Figure 89. Vibration is a local or intimate sense that is felt through direct contact

Vibration patterns can only be felt when a participant is in direct contact with the soft object, holding it, or placing ones' hands or head or body in direct tactile contact with the object. While vibration is the most proximal sense requiring contact through touch, sound is mid-range, and light is the most distant sense. Sound output is relatively quiet, and can be heard in the near vicinity of an object without physical contact with the object. A lower sound volume is designed to maintain a need to be in close proximity to the object. For example, if objects are 'sleeping' but not being interacted with, a specific 'wheezing' and 'teasing' sound can be heard that is quiet, relatively local, and intended to invite contact.

When an object is thrown in the air, the soft object sings out an elongated 'wheeee' sound reminiscent of a small child being thrown in the air [Figure 90]. The participant who has thrown the object and others in the near vicinity can hear this sound. The state of the 'thrown' soft object is communicated to other objects and the sound is then shared between and amongst objects that are 'listening'. Sound is a 'mid-range' sense, localized, but not requiring one-on-one tactile interaction in order initiate or to witness the sonic response.

Figure 90. Accelerometers trigger the sound of '*weeeeee!'* as soft objects are thrown into the air

The *light* pattern output of the soft objects is perceptible as the most distant sense. Light patterns move through the objects in groups much the same as sonic patterns. However, light patterns can be seen and recognized from a greater distance, and can therefore illustrate and communicate group dynamics and behaviors from a more non-local perspective.

Figure 91. Moving Light Patterns Communicate the Inter-relationship of a Group

Movement is actuated in the form of continuous vibration and intensity, light in the form of color, pattern and intensity, and sound in the form of simple tones and sequences. Communication between the soft objects elicits behaviors such as sighing, humming, shaking-shivering, and a shared ‘glow-on’: moving light patterns that communicate the inter-relationship of the group. The output patterns that move between the objects illustrate the physical path of the communication of state-qualities. A computer screen displays their interaction and communication, which is both effected and disrupted by participants.

7.5.2 From Embodiment to Poetics of Interaction

The second theme is poetics of interaction. A poetics of interaction supports a somaesthetics framework because it acknowledges that meaning is simultaneously constructed on multiple levels: conceptual, experiential, material, and computational (or technological). Meaning derives from our experience and the imaginative interplay between our self and our environment.

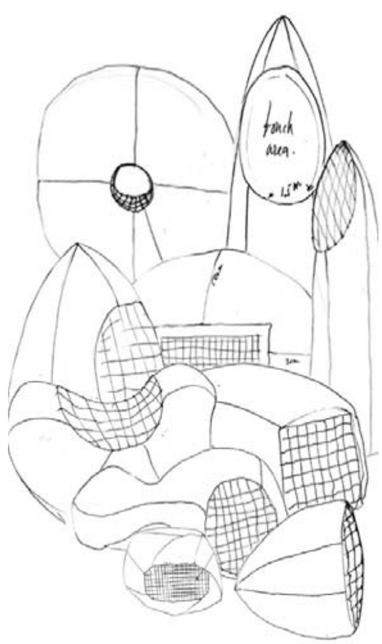

Figure 92. Concept illustration of soft(n) family of tactile objects each unique in form

A poetics of interaction allows for a critical and playful approach to design and affords access to the imagination of users, allowing both feeling and thought to be engaged.[64] Tactility and kinesthesia are rich, intricate, and full of resolution and expressivity.[65] Patterns and movement of light, sound and vibration purposely allow an open interpretation, multiple meanings and associations.[66] This design strategy is commonly used in artistic practice as a way of poetically evoking experience, thoughtful reflection, and resonance.[67]

Figure 93. a *soft(n)* family portrait illustrating the 10 interactive soft objects each containing a hand-sewn tactile array

7.5.2.1 Poetics and Metaphors

soft(n) encompasses a number of poetic metaphors. These include the notion of ‘past lives’ of objects, cherishing and memory, the impression of softness and pliability, and emotional attributes contained within objects such as forgiveness, stubbornness, resistance and glee. Touch is a proximal sense, and combined with the soft pillow-like object can ‘arrest’ us, creating a window of stillness, creating a space to be held, to bolster, to cushion, to dream.

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64 Blythe, M.A., Monk, A.F., Overbeeke, K., & Wright, P.C. (eds.) (2003), op. cit.
65 Gibson, J.J. (1966), op. cit.
66 Sengers, P., & Gaver, W. (2006), op. cit.
67 Hummels, C., Overbeeke, K., & van der Helm, A. (2003), op. cit.

Figure 94. *soft(n)* a poetics of interaction

Other artists have explored poetics in objects such as pillows[68] and have acknowledged the importance of open interpretation, interaction that is resonant, contemplative or that provokes awareness through ambient approaches to design. The installation is also contained within a poetic frame of space. It takes place within a social setting where the space of a room holds a soft tangible network. The network lives through its own interaction, and is intervened by its audience. The network can be 'troubled' or 'held' by its visitors.

These poetic concepts create a set of somaesthetic markers[69] that we used in a design process to construct possible experiences for participants within the system. The use of somaesthetic framing through poetic forms allows for flexible, meaningful, value-laden design choices that support experiential outcomes.

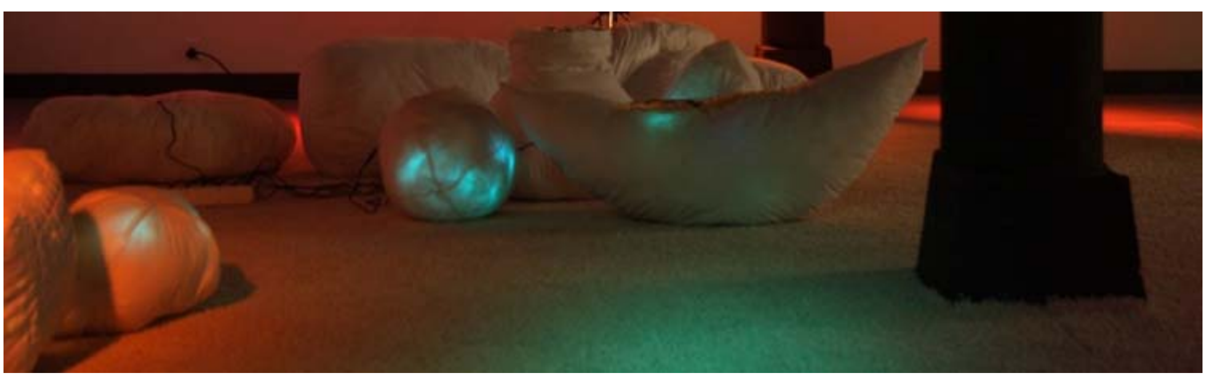


Figure 95. *soft(n)* a poetics of space

[68] Dunne, A., & Gaver, W.W. (1997). The Pillow: Artist-Designers in the Digital Age, *CHI Proceedings*, March 1997, p. 361-362.
[69] Kallio, T. (2003), op. cit., p. 142-143.

7.5.3 Materiality: Sewing the Pieces Together

The third theme of the proposed somaesthetic framework is that of materiality. This theme emphasizes the importance of embodiment and its application to physical materials; the texture, shape, fabric and form that support experience within the installation. Recent work in HCI has recognized the value of exploring textiles to investigate computational technology as design material.[70] *soft(n)* contributes to this investigation with an emphasis on materiality of the physical form designed to enhance the experience of touch. The theme of materiality is dependent upon and inter-connected with the somaesthetic framework as a whole: sustaining experience for the participants (theme 1), the poetics that frame its meaning and sense perception (theme 2), and the soft objects technical design, or 'semantics of caress' that can recognize and respond to tactile states (theme 4). This research integrates custom engineering to enable tactile quality recognition.

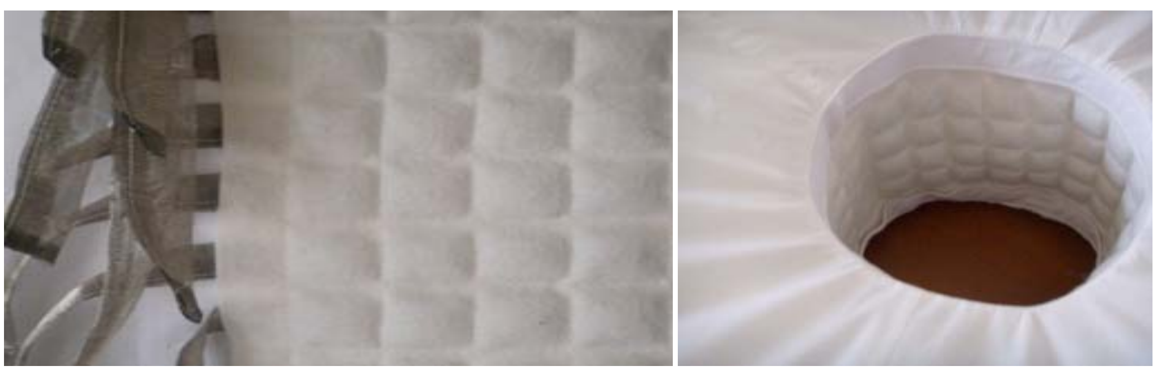


Figure 96. Tactile Interaction Surface Custom Sewn

The scale of each soft object ranges from 0.6 to 1.0 meter, an almost human scale. This scale of the soft objects does not overwhelm the participant's own body, thereby

[70] Recent explorations in wearable technologies and properties of material and textile within HCI include: Berzowska, J. (2005). Memory Rich Clothing: second skins that communicate physical memory, *Proceedings of the 5th conference on Creativity and Cognition* (*C&C 05*), London, April 12-15, p. 32-40; Hallnäs, L., & Redström, J. (2002). From Use to Presence: On the Expressions and Asethetics of Everyday Computational Things, *ACM Transactions on Computer-Human Interaction, 9*, p. 106-124; and also Post, E.R., & Orth, M. (1997). Smart Fabric, or Washable Computing, *First IEEE International Symposium on Wearable Computers*, Cambridge, Massachusetts.

bestowing each object with a sense of conviviality. The shapes are intended to be somewhat abstract or non-literal (not shaped like people, not like animals, not like known living things) yet reminiscent of large vegetables or perhaps human organs. They can be moved, thrown, or placed, so interaction is flexible and various scenarios may emerge based on participants' imagination.

7.5.3.1 Materials Exploration and Conductive Fabric Cables

The *soft(n)* materials exploration was based on preliminary research that was constructed in prior technological explorations of fabric tactile arrays (see Section 7.3.4). These prior experiments used conductive foam and conductive fabric and were enhanced during the development of *soft(n).* In particular, the construction and hand-crafting of the tactile fabric arrays was refined both aesthetically and technically. The *soft(n)* conductive silk organza cables send data signals from the fabric touchpad to the embedded processing unit. The soft object serves mainly as an affectionate sensory transmitter that provides a basic analysis of the signals, using pressure, temporal and spatial location to parse tactile qualities, which are then shared within the network. Each *soft(n)* object has a custom-made fabric exterior pouch filled with soft material and embedded with a small gumstix controller that coordinates and interprets the data communication.

Figure 97. Materials Exploration in *soft(n)* tactile fabric arrays

There are several small circuits that control embedded transducers – which include light array(s) and vibrating motors – that are mounted on individual circuit boards, called 'islands'. Connections that cannot be made wirelessly are made using conductive fabric 'wires' made from silk organza, a transparent directionally conductive fabric along one axis, woven through a non-conductive fabric in the other axis. The silk organza is sewn directly into the soft object tactile surface to form portions of the soft object itself.

The following page illustrates how a fabric array is hand-sewn to create a flexible tactile surface. The description of the construction and buildup of the fabric tactile matrix is contained in Table 14 below. These steps correlate to the images in Figure 98. Each of the soft objects contained a distinct tactile surface individually designed to match the soft object's form, size and shape.

Construction and Buildup of Fabric Tactile Matrix
1. Each cell of the Touch-matrix consists of a square piece of resistive foam, in series with a Schottky diode sewn into the fabric between the row- (outputs) and column-electrodes (inputs). Schottky diodes were used for isolation between the cells because of their low forward voltage. Here we see one row of the diodes.
2. Here we see the top layer of the grid, after the diodes have been inserted.
3. To make better contact with the foam squares, the leads of the diodes are 'curled'.
4. The leads on the side of the diodes away from the foam squares are also 'curled' for ease of connection.
5. Another view of the top layer, prior to adding the foam squares.
6. Placing the foam squares in contact with the diodes, using silk organza as a conductive layer.
7. The external connection to the foam squares is made via a ribbon of silk organza, here being attached to a column of cells.
8. Here we see all four columns with their silk organza 'wires' attached.
9. The cells are protected from mechanical damage by a fabric layer over the silk organza 'wires'.
10. Here we see the bottom side of the assembly, ready to have the bottom silk organza 'wires' attached.

Table 14. Description of Construction and Buildup of Fabric Tactile Matrix

The following illustration shows how a fabric array is hand-sewn to create a flexible tactile surface.

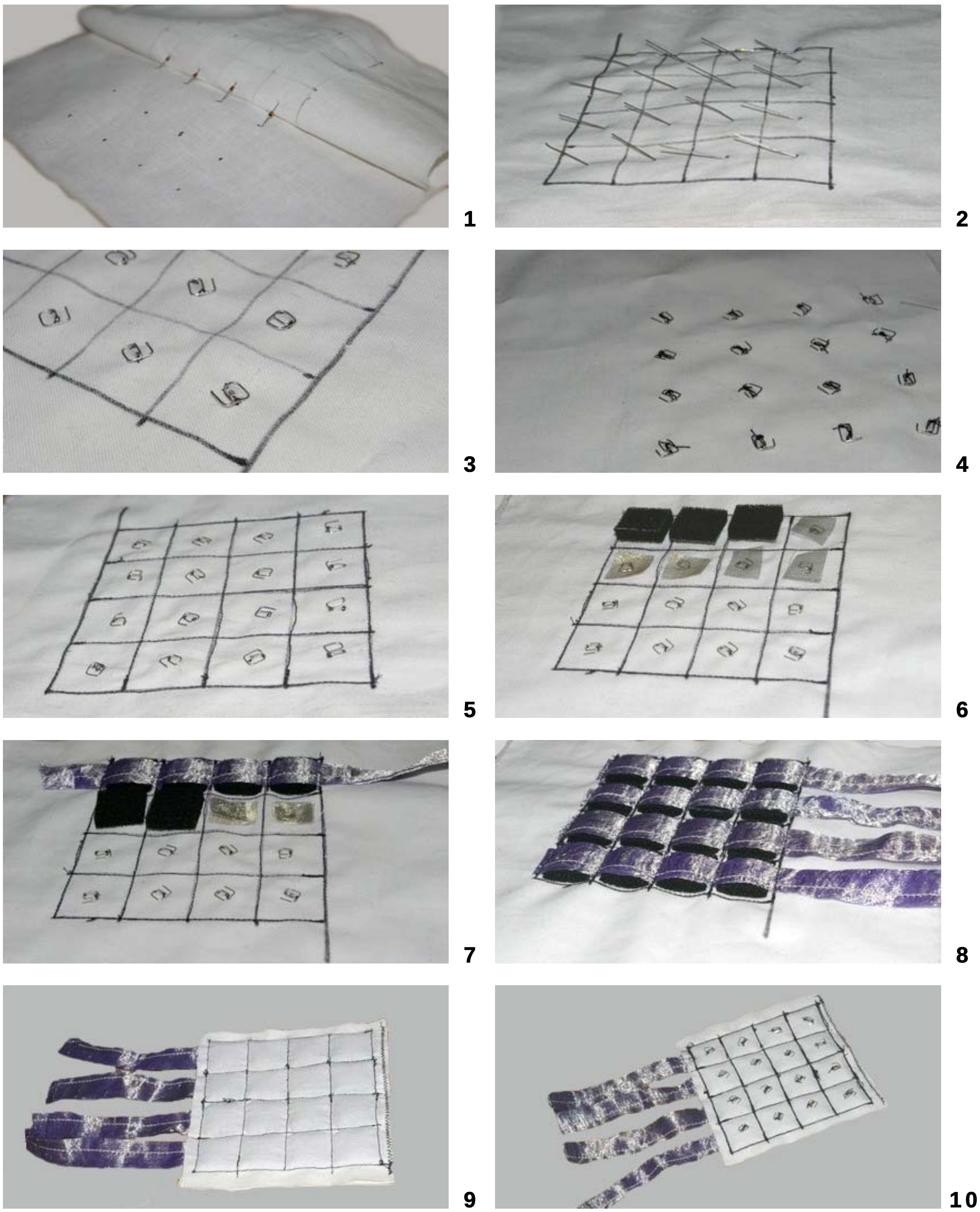
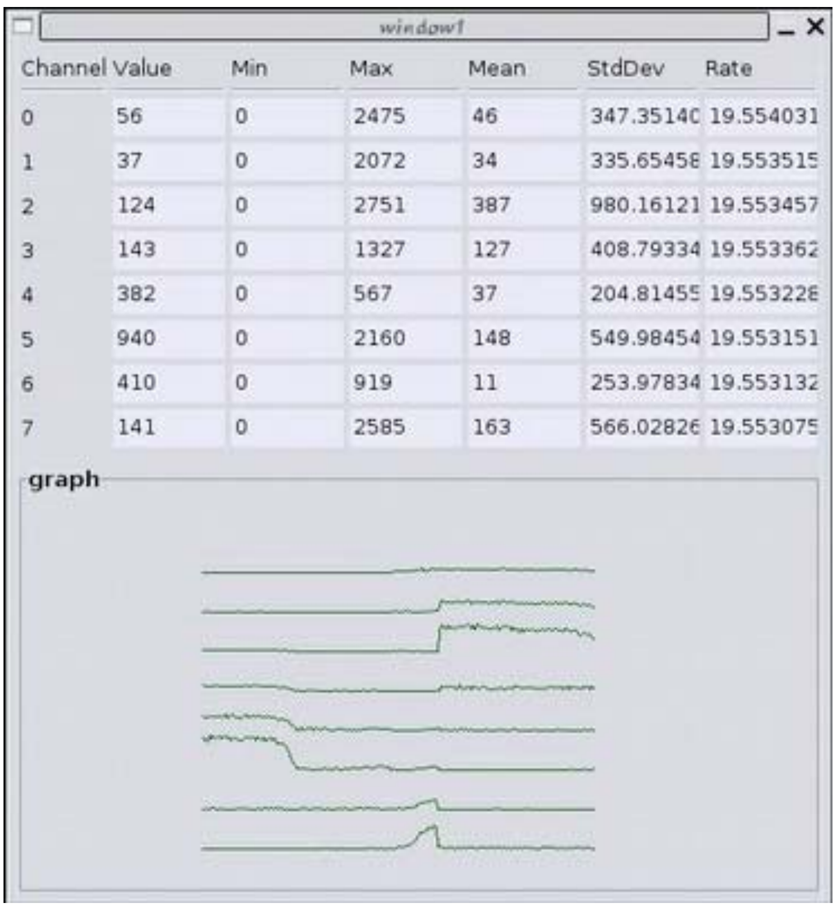


Figure 98: Illustration of Buildup of Hand Sewn Conductive Tactile MultiTouch Surface

The material exploration presented in the support of a somaesthetics of interaction was guided by the goal of expressing and articulating experiential tactile qualities based on Laban's 8 Basic Efforts. The proposition is that if one's movements or tactile gestures can be *recognized* and if that recognition can be used to create a space for *self-recognition* and if this language of recognition can provide a source of rich interplay between movement and sensory expression then our technologies can support the development of our *skills of experience* including self-awareness in a shared ambient space in which an installation could invite an 'attending to' our state of being. Although this proposition may appear quite general (and perhaps therefore unattainable), the specific example presented in the *soft(n)* installation is one particular instantiation of an exploration which fulfils and articulates some of these properties.

7.5.4 *soft(n)* Semantics of Caress

The fourth theme of the somaesthetic framework presented is the Semantics of Caress, which investigates *how* the meaning of touch can be applied to tactile interaction. Once again this continues from prior work implemented on the Tactex MTC Express that was outlined in Section 7.3.3, Developing a Semantics of Caress. In *soft(n)* the tactile meaning is implemented based on data extracted from a soft fabric tactile array, following a similar model based on Laban Effort Shape analysis which describes qualitative tactile *impressions* in a computationally definable form. In the construction of the fabric tactile array, pressure is an essential data value extracted to define a caress and its effort. Figure 99 illustrates the data extracted while a tactile surface is being caressed, stroked, or touched. Touch qualities are extracted based on pressure, number, size, speed and direction of the touch data. Table 15 correlates these tactile parameters with their features and describes how the parameters are used to parse specific effort qualities. Using a simple set of heuristics, up to 12 tactile qualities can be recognized, and differentiated.[71] These tactile qualities are based on Laban's 8 basic efforts as defined in section 7.2. Tactile qualities remain a qualitative indicator of meaning and of the *soft(n)* object's state. These touch-efforts [see Table 16] can suggest soft states expressed through various mappings to actuators including vibration, sound and luminous qualities. Touch efforts are derived from the parameters extracted from the tactile data in the fabric array. In the *soft(n)* installation the touch-efforts are the basis of shared network communication between soft objects. This shared 'state data' exhibits emerging behavior between the *soft(n)* family as participants hold, flick, slash, dab, or stroke these soft objects.



Channel	Value	Min	Max	Mean	StdDev	Rate
0	56	0	2475	46	347.35140	19.554031
1	37	0	2072	34	335.65458	19.553515
2	124	0	2751	387	980.16121	19.553457
3	143	0	1327	127	408.79334	19.553362
4	382	0	567	37	204.81455	19.553228
5	940	0	2160	148	549.98454	19.553151
6	410	0	919	11	253.97834	19.553132
7	141	0	2585	163	566.02826	19.553075

Figure 99. Pressure data over time from a 4 x 4 *soft(n)* fabric tactile array

[71] Schiphorst, T., Jaffe, N., & Lovell, R. (2005), op. cit.

‘Touch qualities’ are derived from parameters extracted from the input sensors. Parameters derived from the touch pad are shown below. The description in the table shows how the parameter is mapped to a touch quality. From the parameters illustrated in the table, touch qualities are extracted based on pressure, number, size, speed and direction of the hand’s moving tactile impression. Up to 12 tactile qualities can be recognized. These tactile qualities are based on Laban’s 8 basic efforts. The key to this system is that movement qualities can be measured, but they themselves are not quantitative but qualitative. In that sense, the extraction of a quality is a fuzzy extraction, and can suggest soft states that can be expressed through various mappings to actuators including vibration, sound and luminous qualities. These concepts are founded on an implementation of a system that represents touch and movement as meaningful, and can network and communicate on the level of quality sharing.

Parameter	Description	
pressure	soft, hard	The intensity of the touch. (light, strong)
time	short, long	The length of time a gesture takes. (quick, sustained)
size	small, medium, big	The size of the part of the interaction object that touches the pad. (light has affinity to small)
number	one, many	The distinction between one finger or object and many fingers.
speed	none, slow, fast	The speed of a touch-effort. This is the overall velocity of movement. This parameter is not used directly to distinguish efforts, but is used to determine space. (Laban Space is flexible [indirect] or direct)
direction	none, left, right, up, down, diagonals	The direction of movement. This parameter is not used directly to distinguish efforts, but is used to determine space and path. (direct, indirect)
Secondary		
space (speed)	stationary, travelling	A function of speed. If speed is zero then the gesture is stationary, otherwise it is travelling.
path (direction)	straight, wandering	If the speed is not zero and there is only one direction registered, the gesture is straight. (direct, indirect)
disposition (pressure)	constant, varying	If the pressure maintains a single value after an initial acceleration the gesture is constant, otherwise it is varying.
pattern (gesture)	continuous, repetitive	If a gesture is unique in relation to the gestures immediately before and after, it is continuous. Any repeated action or gesture is classified as repetitive.

Table 15. Parameters derived from pressure pad data

Laban Basic Effort	Touch-Effort	Description
Dab	dab (tap)	A soft (light), short (quick), small, touch (direct), usually rendered with a single finger.
	dab (pat)	A bigger version of "tap" and a soft version of "slap". Usually rendered with an open hand or palm. (light, quick, direct)
Glide	glide (hold)	A lingering (sustained), soft (light), big, touch. A "hold" has an encompassing feel. (direct)
	glide (touch)	"Touch" is a small version of "hold". It is an indication of comfort and is rendered with the fingers, hand, or palm. (sustained, light, direct)
	glide (stroke)	A traveling (sustained) touch, soft but directional (direct), rendered with fingers, hand or palm.
Float	float (caress)	A traveling (sustained), meandering (indirect), touch. Soft (light) and directionless and rendered with the fingers, hand, or palm.
Flick	flick (jab)	A brief (quick), short, small (light), hard (direct) touch. A direct poke by a finger or blunted object. Also known as "poke".
Punch	punch-thrust (knock)	A medium-sized, fist against, rapping hard (direct, strong, quick). In our scheme, it is different than "jab" and "slap" in size only.
Slash	slash (slap)	An open-handed, fast (quick, light), short (direct), touch. In our scheme, a large version of "jab" and "knock".
Press	press	This is a long (sustained, strong), hard (direct), touch.
Wring	wring (rub)	This is a moving (sustained), hard (strong), touch (indirect).
	wring (knead)	Kneading involves many fingers moving hard (strong) and in a slightly wandering (sustained, indirect) fashion.

Table 16. Touch-efforts as derived from Laban Basic Efforts with Description

This section has illustrated the development of a somaesthetics framework and provided a detailed description of its implementation within *soft(n,* proposing the inclusion of design criteria that articulate a concern with experience, poetics, materiality and semantics of interaction. An underlying somatics concept is that by attending to the sense of touch we can develop discernment and skill in accessing out bodies' knowledge.

7.6 Summary of *soft(n)* Values and Somatics Techniques

The somatics values of self, attention, experience, and inter-connection outlined in Chapter 2 are incorporated into the somaesthetics framework described. Although the somatic system of Laban Effort Shape has been highlighted with regard to technological implementation, the design of *soft(n)* also included participant workshops and experience prototype sessions similar to those described within Chapter 5 and 6. This case study explored a specific somatic implementation used as a proof-of-concept to exemplify the articulation of Laban's Effort Shape system in a technological system. Laban Effort Shape and somatic techniques and knowledge can be applied to many access points within a technological design process.

	Chapter 7 Somaesthetics of Touch ***soft(n)***
VALUE	
Self	Self-through-touch Active touch Tactile intention
Attention	Tactile Attentions • Intention • Sensation • Quality - Meaning • Content: Pressure, Duration, Path
Experience Qualities	Sensuality Intimacy Pleasure Play
Inter-Connection	Tactile Relationship • To object • To self • To other participant • To space
Somatics Systems Applied	Laban Effort-Shape Movement Analysis applied to technological design • Effort - Quality • Space - Attention • Weight - Intention • Time - Decision/Choice • Flow - Continuity/Progression

Table 17. *soft(n)* Somatics Values and Techniques

7.7 Conclusion

This chapter has explored the concept of *somaesthetics* as an approach to the design of expressive tactile interaction. It has highlighted our sense of touch in relationship with technology, focusing on a technological design and implementation process based on Rudolph Laban's Effort Shape analysis. Because Laban describes movement effort qualities as an *inner bodily attitude* toward outer movement enactment, his approach has tremendous value in modeling experience within HCI. The exploration of felt-life within HCI holds a nascent and yet-to-be fulfilled place within the design of technology. There is a continued need for such a discourse to develop and flourish within HCI. I revisit McCarthy and Wright's statement articulated in Chapter Two:

> A radical approach to the mediation of our subjectivity by technology requires us to linger in the gap between inner life and external behaviour, where our subjectivity or sense of self is created, and *we have not yet done that in reflecting on our practices with technology*.[72] [italics mine].

Laban's Effort Shape is an example of a model that *embodies* a subjective epistemology through its articulation of the connection between inner state and outer movement-behaviour. Within the field of somatics, Laban was unique in his ability to apply his first-person experience of movement knowledge to a *formalized symbolic* movement analysis system that is both rigorous and expressive. It is precisely because of the symbolic nature of Laban's system of movement analysis that his work resonates with the application to technological design. Digital technology is based on symbolic and computational systems of representation, and Laban's symbolic descriptions of movement form, movement properties and movement qualities provide a starting point for constructing technological movement models that can be applied equally to user experience and computational design. Laban's theoretical framework is well suited to its computational modeling. For this reason, the exploration and

[72] McCarthy, J., & Wright, P. (2005 op. cit.p. 267.

implementation of Laban's Effort Qualities can support "a radical approach to the mediation of our subjectivity by technology that allows us to linger in the gap between inner life and external behaviour."

Soft(n) was positioned in three ways in this Chapter: within an *artistic* frame, as an example of a soft sculpture that creates a poetic and tactile intervention in a technological aesthetics of use; within a *somaesthetic* frame, highlighting the somatic knowledge within Laban's Effort Shape system; and within the frame of *human computer interaction*, illustrating how somatics knowledge can be applied to technological design for interaction.

The Somaesthetics of Touch explored the experience of a tactile world where the *quality* of tactile experience can be modeled within interaction design. Rudolph Laban, one of the key movement theorist-practitioners to emerge from the somatics traditions of the twentieth century, reminds us that *all* our senses are a variation of our unique sense of touch, which enables the relationship between movement and space to be discerned within bodily-experience.

Somaesthetics can provide a critical study of bodily experience as a focus of sensory-aesthetic appreciation and agency, and can offer a bridging strategy between embodied practices based in somatics and the design of aesthetics of interaction within HCI. The design and implementation of *soft(n)* exemplifies a process of designing within a somaesthetic framework where embodied techniques are proposed within the design method (process) as well as the design outcome (goals).