
Giving Form to a Hedonic Haptics Player

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DIS 2017, June 10-14, 2017, Edinburgh, United Kingdom
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DOI: <http://dx.doi.org/10.1145/3064663.3064792>

Abstract

In this pictorial we present the form-giving process of a Hedonic Haptic player, a wearable device that plays vibrotactile patterns on the body. We depict how we explored the aesthetics of the vibrotactile design space, how we constructed a platform as body of a hedonic experience, and how we developed different vibrotactile compositions. These activities collectively show how combinations of experiencing form, composing form, and materializing form can contribute to the aesthetic form-giving practice in interaction design.

Author Keywords

Vibrotactile; Haptic Interfaces; Aesthetics; Pleasure.

ACM Classification Keywords

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

Introduction

The aesthetic potential of vibrotactile sensations in interaction design is relatively unexplored. The project presented here is the start of such explorations in a wearable set-up through what we call the Hedonic Haptic player. We have explored different compositions of vibrotactile sensations on the body. This pictorial gives insight into the aesthetic form-giving process of the Hedonic Haptics player as a response to the observation that complex processes of designing should be better represented in the HCI literature [1,4].

To manage the complexity of our design process we framed the process in correspondence with the trinity of forms, being physical form, temporal form, and interaction gestalt [6]. This framework has proven useful because of its explicit take on temporal form. It is helpful to talk about vibrotactile sensations in these terms, as vibrations inherently bring together temporal form aspects (e.g. the shaping of the kind of vibration), physical form aspects (e.g. the shaping of the source of vibration), and interaction gestalt (e.g. the embodied experience of the vibration). To guide acts of design in our process it was meaningful to interpret these form elements in terms of *composing* form, *materializing* form, and *experiencing* form (see Figure 1). With composing form we mean those activities that support the shaping of vibrotactile patterns and state changes. Materializing form refers to those acts of design that aid the shaping of the three-dimensional artefact. And with experiencing form we mean those design activities that bring forth the effects of the design on the body and in the environment. Talking in terms of these verbs, we emphasize the act of designing and design practice.

Vallgård argues that *interaction design practice is about forming a whole through an ongoing negotiation between the three form elements* [6, p. 578], and that *we may address them separately but it is where they overlap they create intriguing and challenging interdependencies* [6, p. 591]. This pictorial resonates with this argument, yet provides concrete illustrations of how such form-giving practice in the overlap between elements can look like to support the crafting of aesthetic interactions. We thus offer collections of design activities that we employed in the design of the Hedonic Haptics player, and highlight how they emphasized combinations of composing, materializing,

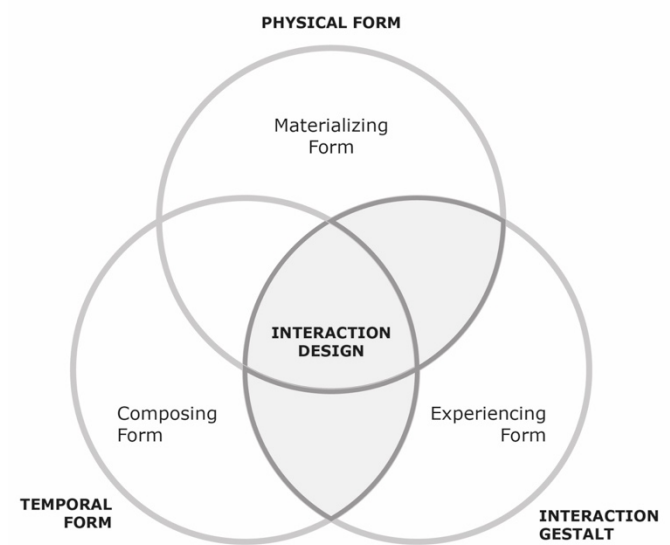


Figure 1. The form elements in interaction design [6]: temporal form, physical form, and interaction gestalt, and our way of working with these in the design of a Hedonic Haptics player, respectively: composing form, materializing form, and experiencing form.

or experiencing. The grey areas in Figure 1 depict the overlaps that were most prominent in our process. These all include experiencing form, as the design of vibrotactile *sensations* was pivotal in our explorations.

Our intention with this pictorial is to contribute to the larger research agenda of developing the aesthetic form-giving practice in interaction design.



Figure 2. Experiments with modified off-the-shelf vibrators from a sex shop (a) embedded in elastic and cotton bands. The vibrating sensations were explored on different parts of the body, among others the chest (b), the ankles and elbows (c), the forearms and the diaphragm (d), and head (e).

Experiencing Vibrations

We set out to explore the aesthetic qualities of the technologically mediated haptic design space with a specific focus on vibrotactile stimuli. Generally, working from an aesthetic perspective in this research through design project we were in a constant back-and-forth between technological development and explorations of how the changes affects us – our senses – our experiences. Our own bodies and our reflections were thus used in a manner of embodied ideation. In a first design activity we simulated a vibrotactile experience to familiarize with the design space. We bought off-the shelf vibrators of various shapes and sizes from a sex

shop (see Figure 2a) and we proceeded to strap them on to different places on the body (see Figure 2b-e). To give us flexibility we would sew pockets in a range of fabric bands so we could move around and adjust the vibrating sensations. It quickly became clear that while the experience was intriguing and fun in all its novelty the repetitive vibration patterns that were pre-programmed in the devices were tedious to experience for longer periods of time. Nonetheless, this first hand experience enabled us to familiarize with vibrotactile stimuli and helped imagine compositional aspects could be considered in its shaping.

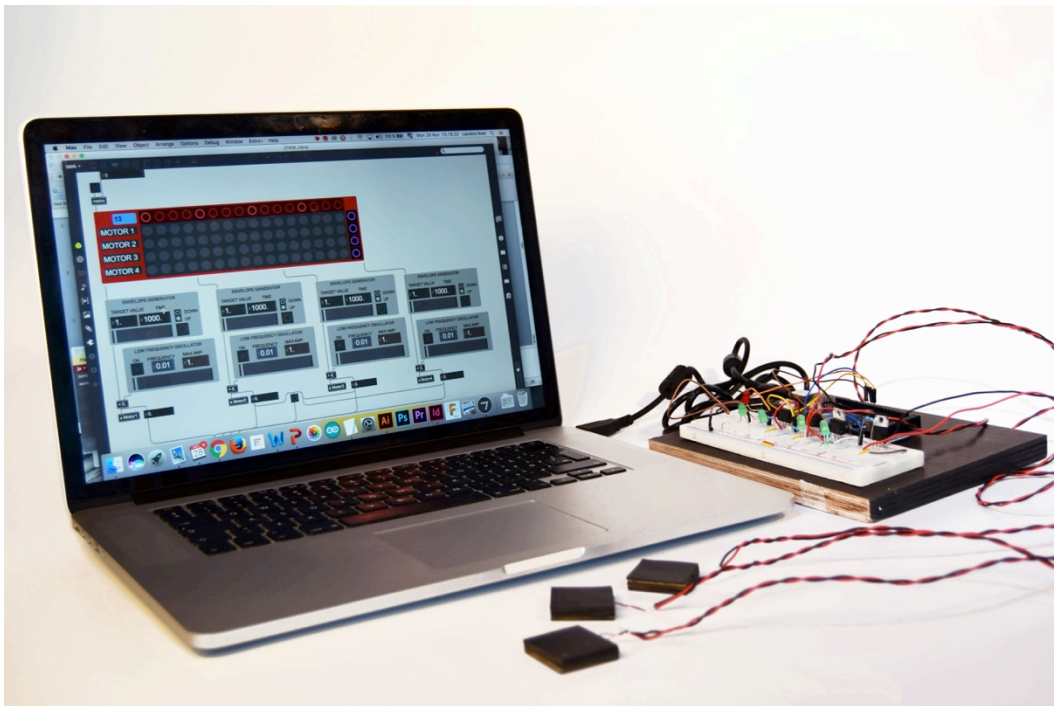


Figure 3. Max/MSP, an Arduino, and three coin cell vibration motors that were embedded in layers of rubber were used to explore haptic compositions



Figure 4. The rubbers were mounted in cotton patches and attached to elastic band to explore vibrations on different places on the body (a,b,c).

Experiencing Compositions

To explore compositional aspects further required a shift from off-the-shelf products to Arduino, Max MSP, and basic coin-type vibration motors incased in a resonating material (see Figure 3). Much like the previous design activity we used up to three motors strapped to the different places on the upper body with elastic (see Figure 4). This technical set-up enabled explorations with vibration events (in terms of vibration wave form, amplitude, and frequency), time interval between events, and patterns in repetitions of events. As such we were able to create a much larger set of vibration compositions. We experienced that the closer the vibrotactile expression came to recognizable rhythms the more annoying it tended to become. Yet, with a degree of variation and randomness the experience could be quite appealing.

Through embodied explorations we were inspired to explore whether or not we could create a sensation of a rhythm that traveled around the body by alternating between the three motors. Such expression showed to be somewhat complex compared to the early stage we were in. Yet, it also raised the question on which part of the body such rhythm would be played.

By alternating between acts of composing and experiencing we had become familiar with the building blocks of a tactile composition and had gained an understanding of how different vibrotactile variations would feel like on our body.



Figure 5. Sensing pleasantness of vibrations on different parts of the body.

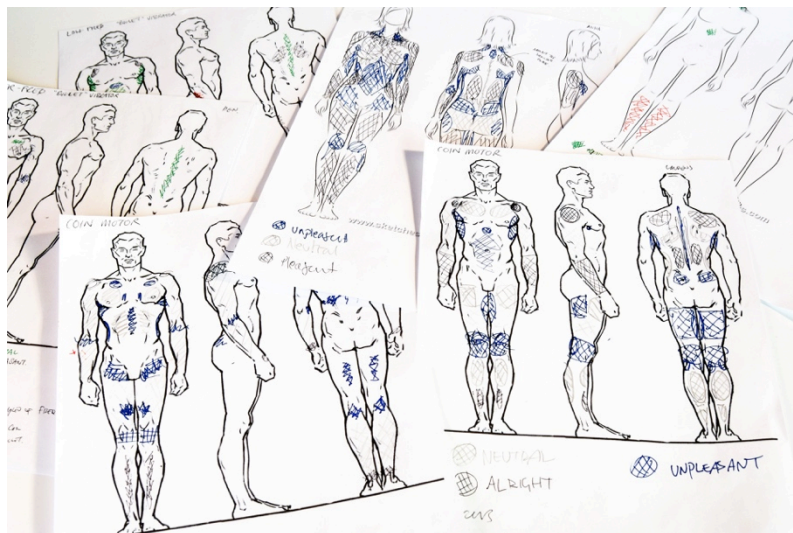


Figure 6. Mappings of experienced pleasantness of vibrational sensations on different parts of the body.

Mapping Vibrotactile Experiences

Triggered by the previous embodied explorations we realized the importance of the variations in vibrating sensations on different parts of the body. Basically, the skin consists of receptors but those vary on different parts of the body. Also, the size and density of the receptor field determines how well a recipient is capable of sensing and distinguishing a series of closely spaced stimuli [3]. With this in mind we took a more systematic approach to exploring how vibrations felt on different places on the body (see Figure 5).

With a simple drawing of a body we mapped out whether a vibration felt good, bland, or annoying (see Figure 6). We used a stable vibration but we varied the pressure applied on the body to maximize potential effects of the vibrating stimuli. We found some variations but mostly commonalities in our experiences. For example, vibrations in the armpit and knee area were unpleasant, while right above the shoulder blades and lower back were perceived as pleasant. Our intention with these explorations was not to come up with generalizable result but rather to get a better feel for good locations for the vibrators. And to create a material manifestation in the form of maps to more systematically discuss our experiences.

With this in mind, and due to the sensorial variations and the obvious differences in height and girth, we decided to begin explore ways to strap on the vibrators in ways that would enable flexibility and give as much freedom to place and adjust as possible.

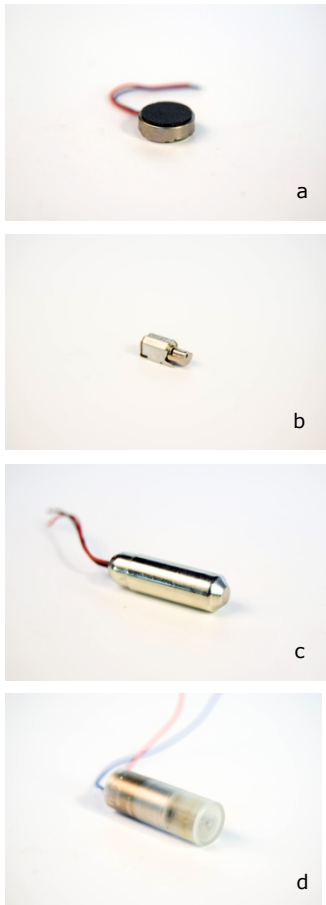


Figure 7. Coin-type motor (a), eccentric mass motor (b), encapsulated eccentric mass motors (c,d)

Materializing Vibrations

The vibrotactile experience is highly influenced by the type of actuator used, the mediating materials that go between actuator and body, and their physical forms. Thus, in this activity we explored different types of vibration motors and their encasings. In previous experiments we used a coin-type low current motor that provides a of high pitch vibration, yet prohibited short, percussive actuations due to a smeared time-domain performance (see Figure 7a). We proceeded to explore motors that were even smaller in size yet also less powerful (see Figure 7b), and motors that would provide more force and precision. Two encapsulated eccentric mass vibration motors provided a greater dynamic range and higher maximum amplitude (see Figure 7c,d), yet one showed shorter starting and braking times (see Figure 7c). A quick remake of the systematic bodily explorations with this new low pitch vibration motor showed that places that were bland and uncomfortable before could turn into bland and pleasurable respectively.

Further, the motor had to be incased in another material to diffuse the vibration. In the early explorations we used 3D printed PLA shape tightened around the motor (see Figure 8a,b) and thin layers of laser-cut rubber in one (see Figure 8c,d) in another. This showed that the rubber muffled the vibrations too much and the PLA form too little. The casing had to fit tight, to avoid the resonating material producing noise upon vibration. Molding the motor in silicon showed to both reduce noise and diffuse the vibration well without muffling the effect too much. These acts of materializing sat between composing and experiencing, moving closer to an integration of the three form-elements.

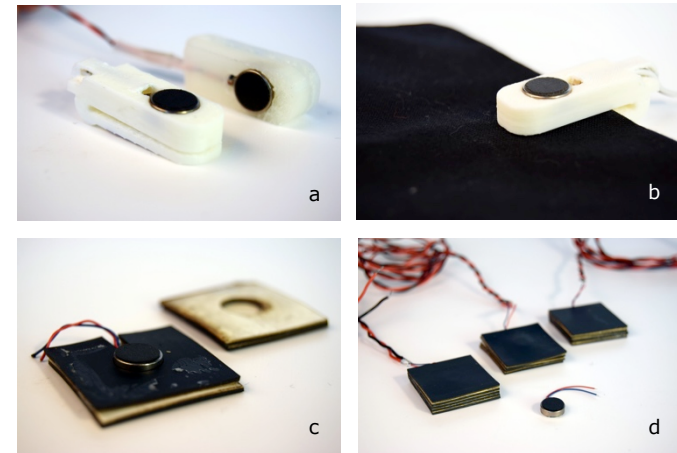


Figure 8. Enclosures of a coin type vibration motor in two kinds of 3D printed PLA (a,b), and lasercut layers of rubber (c,d).

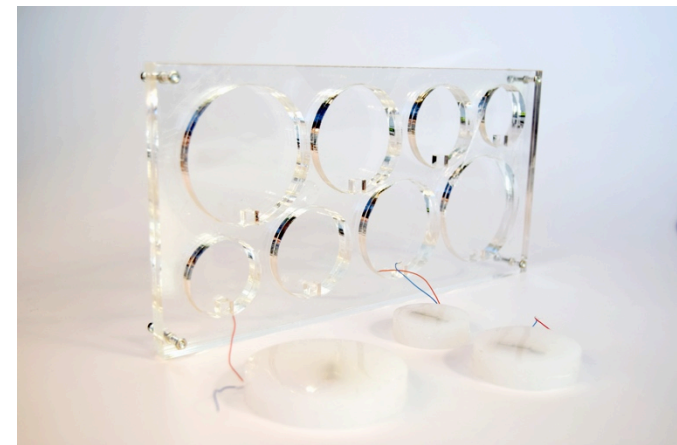


Figure 9: Molding vibration motors in silicon to reduce noise and diffuse the vibration.



Figure 10. The conceptual qualities and look and feel of the Walkman (a), combined with the appearance of the Beoplay speaker series (b) and enormous headphones (c) inspired the conceptual qualities and form factors of the Hedonic Haptic player (d)

Materializing Cultural References

A cultural reference can support the unfolding design process in envisioning form and materials much like a generative metaphor [5]. Thus, we framed our object of design as a kind of wearable technology that could offer an everyday hedonic experience, not unlike listening to music. As a wearable mobile device we were much inspired by Walkman as cultural reference (see Figure 10a). At the time of their introduction, the Walkman represented a new way of enjoying music while on the way, with a form factor that was bulky yet acceptable. By experiencing the look and feel of the Walkman it became apparent that we do not really accept the bulky casing today yet do accept enormous headphones (see Figure 10c). In reference, this would allow for apparent statement encasing for the vibrators. Experiencing the cultural reference inspired conceptual development of physical form of what was now named the Hedonic Haptic player.

Much like a Walkman and headphones, the Hedonic Haptic Player consists of a main unit that acts like a hub to which the vibration motors can be connected (see Figure 10d). We deliberately spend effort on the material appearance of the player, as the aesthetic experience cannot easily be isolated to the vibrotactile stimuli alone. Therefore we did not choose to design a vibrotactile suit [cf. 2], but chose for three motors, as this would enable affective compositions with graspable complexity. The motors would be embedded into domes as a nudge to headphones, and come in three different sizes as a clue for where to place them on the body and potentially how to compose for them in the future (see Figure 11). Overall we have tried to mimic current consumer products as means to set the scene of a hedonistic experience, such as B&O’s new series called Beoplay designed by Cecilie Manz studio (see Figure 10b).



Figure 11. Explorations of materializations of the vibrating domes for the Hedonic Haptic player. Previous experiments showed that the placement and adjustment of the encased motors should be flexible and that the motors had to be fastened with a relatively tight fit to enable the best sensations of the vibrations. We explored elastic strap-on mechanisms and found that a round elastic band (a) in combination with cord lock (b) would be a least intrusive solution (c). To attach the vibrating domes to the elastic band some tolerance was needed, as the motion of a moving body would cause dispositions of statically attached vibrating elements. A ring shaped mechanism that could be pulled over the vibrating domes would provide some rotation freedom. We then explored leather materials (d), and Perspex and rubber materials (e) to find the right stretch, tolerance, and aesthetic of these rings. Different dimensions of the domes were explored (f), as well as a color scheme close to the Beoplay look (g). This resulted in one all black version of the Hedonic Haptic player with black leather and elastic band, and one in dark petroleum with brown leather and elastic band (i), with metal details in the cable (h). Here, materializing the domes dynamically worked together with experiencing physical form elements.

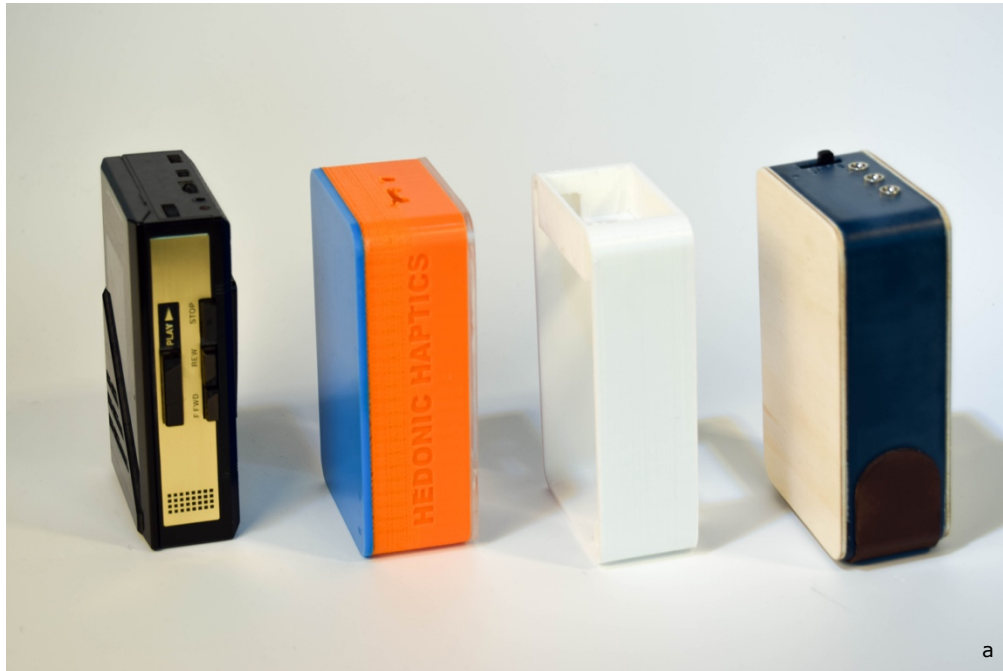
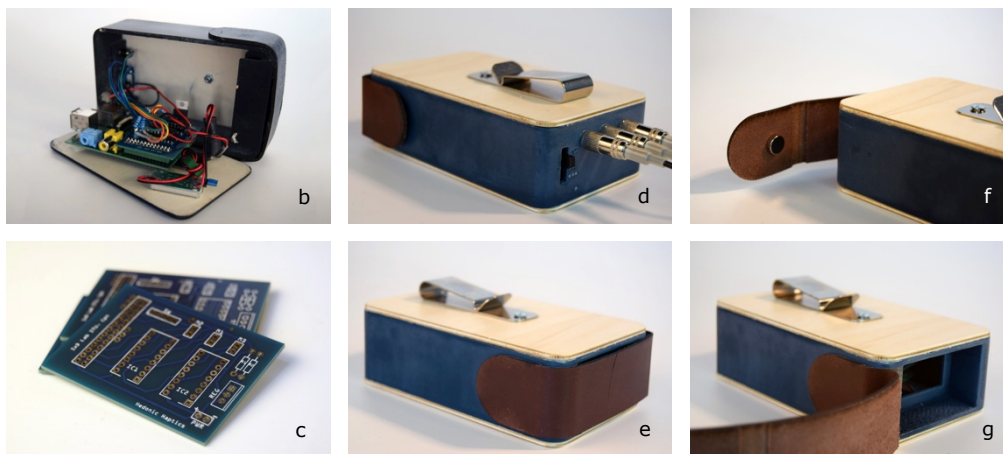


Figure 12. We moved from Arduino and Max/MSP to a Raspberry Pi and Python to support more complex compositions and to allow for compositions to be played back from an SD card to be more suited for a stand-alone portable device. Besides the Raspberry Pi (b), the main unit houses a motor driver board (c) and a battery pack, the latter which can be accessed by opening a magnetically locking leather strip (f,g). It can be worn on the wearer's pocket or belt with a metal belt clip that is mounted on the backside (e). A 4-position switch next to the three audio jack slots could be used to select a composition (d). The main unit was developed in steps from the Walkman reference, to a housing of electronics, via a rough physical shape model to the final physical form (a).

Composing for Experiences

Given the previous explorations we had begun to form an idea about what kind of compositions we could create for the Hedonic Haptic player (see Figure 14). Our aim was to create different forms of pleasurable experiences targeting different moods and situations of the wearer. We chose to give form to one composition that would be soft and mellow – an ambient composition, one composition that would be more upbeat – a rhythmic composition, and one composition that would be a combination of the two.

The Python script outputs a pulse wave to one of the three outputs for the motor control with their duty cycle modulated to create various haptic effects. The nature of these modulations is what defines the differences in the compositions. For example, short high-amplitude pulses at regular intervals forms rhythms. The system is based on a list of events that are executed sequentially to form an entire composition. Events are cycles of a pattern that repeat over a composition-



dependent number of iterations. An individual event is determined by the application of weighted-random parameters at the time of creation (see Figure 13a). The choice for working with an aspect of randomness came from our early explorations where discernable repetition quickly became annoying and thus defies the pleasurable aim. However, we easily foresee how this can be omitted with imagination and mastering of the expression space.

The ambient composition only made use of gradual waveforms (sine or triangle), low amplitude, long transitions, and a fair number of silent events (see Figure 13b). Based on a continuous back and forth between experiencing and composing the ambient composition was tightened to a desirable balance between silent events, event variation and amplitude.

The rhythmical composition was made out of a combination of ramp and saw tooth waveforms but with full amplitude, short events and rarely any silence. The experience was not really rhythmical yet. We decided to include square wave with instantaneous transitions (see Figure 13c). This immediately changed the experience from a semi ambient to an experience with clear and distinct rhythms, with an emphasis on percussive “hits” with a common time base.

Figure 13. The building blocks of the vibrotactile composition: waveforms, event length, amplitude, length, silent events, and modulation frequency (a), an example of a possible ambient composition (b) and a rhythmic composition (c).

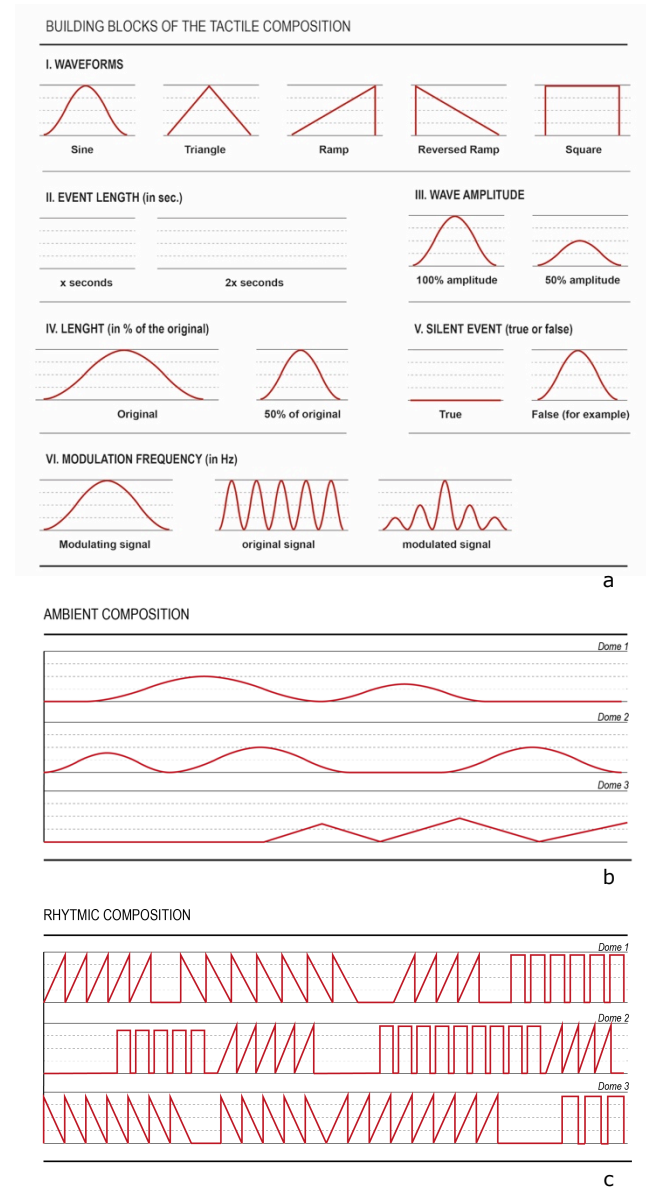
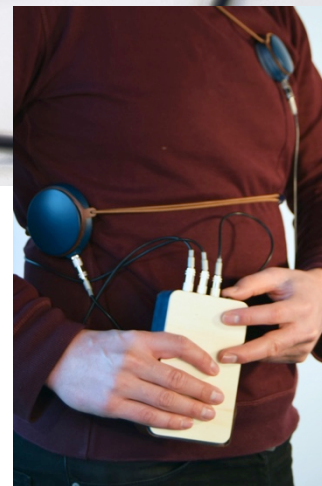




Figure 14. Impression of a Hedonic Haptic player, a design research artifact to explore the aesthetics of the vibrotactile design space.



Discussion

In this pictorial we have depicted the design process of a Hedonic Haptic player to explore the aesthetic potential of vibrotactile stimuli in design. In the first three activities we set out to explore the aesthetics of the vibrotactile design space. This entailed the initial rather crude exploration of merely putting vibrations on different parts of the body without regard for the quality of the vibrations. That the temporal form of the vibrations was key to the aesthetic experience prompted us to setup a more elaborate platform to explore different compositional possibilities. Both of these activities lead to the rather obvious realization that placement on the body was equally important for the aesthetic experience as some place were pleasant and others clearly not. In the fourth activity we more systematically explored the qualities of different vibration motors and found one with a bigger range of pleasurable vibrations than the one we had used before. Together these first four activities can be seen as different ways to explore the aesthetic qualities of the vibrotactile design space – albeit still at a very rudimentary level. With an outset in the embodied temporal form we had developed a clear sense of what could be done with this kind of hedonic haptics. Next step was to build the platform – the body of the experience. Playing around with cultural references, and contemporary materials for fashionable electronics we developed a platform we believed would fit into the hedonistic experiences we wanted to create. Finally, the last action composing three different vibrotactile compositions is probably the yet most underexplored part. This is where we will pick up and continue. However, the three compositions have given us a pretty good sensation of the span of the aesthetic experiences possibly through the Hedonic Haptic player.

Since this project was developed as an aesthetic-first approach every action was carried out with our own judgment of the sensations as the key driver. We could have made use of other's experiences but did not see the need nor value at this stage. By using our own bodies we developed a deeply rooted and shared knowledge of the design space we were working within. Which gave us the necessary clues to find and define the following actions as well as a common language among the three researchers involved.

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