hipDisk: using sound to encourage physical extension, exploring humour in interface design

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Figure 1. *hipDisk*, worn by the author at the launch of the WearNow Symposium at the Australian National University School of Art Foyer Gallery in Canberra, Australia (ANAT 2007b)

ABSTRACT

This article discusses the *hipDisk* and its development. The *hipDisk* (see Figure 1) is an interactive sonic system triggered by core-body gesture that highlights and responds to the dynamic relationship between the wearer's hip and torso. The resulting interface turns the body into an instrument by augmenting it with instrumental capabilities.

hipDisk sits within a broader research framework that explores how technology can be paired with the body to poeticise experience. In order to discuss this, the process that led to the emergence of *hipDisk* is elaborated; this is followed by a statement of design goals; a detailed description of the instrument, its construction and behaviour; and an analysis of outcomes and audience response to date. Within this, a discussion of the role of interface, extension, tangibility, and what is afforded by the use of soft as opposed to hard electronics is undertaken. In addition, the limitations and affordances of the *hipDisk* as an instrument are discussed.

Through this article questions are raised about the role of the creative process in the design of interactive, wearable elements and systems, and the value of considering non-functional outcomes such as addressing the inner life of the wearer. I contend that a focus on these issues can provide added value, beyond intended functionality and that, with such a focus, novel yet meaningful applications of technology could be created that poeticise experience and enhance quality of life – for both wearer and also, possibly, observer.

Keywords

Interaction design, extension, wearable, full-body interaction, body-instrument, gesture-control.

Author Biography

Danielle Wilde is an artist researcher based in Melbourne, Australia, investigating how technology might be paired with the body to poeticise experience. She creates wearable interfaces and body extensions that inspire people to move. The aim is to illicit deep emotional responses and to prod people to consider their relationships to their bodies and technology in society. Wilde has an MA in Interaction Design from the Royal College of Art in London and a large body of work that encompasses

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wearable interactive interfaces, performance, installation, still and moving image, design for theatre and architecture, documentary film research, large and small scale project management, and interaction design.

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INTRODUCTION

The *hipDisk* is a self-contained wearable system for performance and play that augments the body with instrumental capabilities. The interface extends the body on two horizontal planes, one at the hip and the other above the waist. The wearer can trigger simple tones within a one-octave chromatic scale by tilting their hip and torso towards each other until the two disks touch. Through repetition of this action on different angles tunes and melodies incorporating any of the twelve notes of the chromatic scale may be performed.

hipDisk was designed to inspire people to swing their hips and explore and extend the full range of movement available to them, whilst undertaking a simultaneous, interdependent exploration of sound. In creating *hipDisk*, the objective was to move beyond limb- and digit-triggered switches and explore full-body movement for actuation. The resulting body-instrument creates an interdependent relationship between choreography and composition.

While *hipDisk* is intended as a performance instrument, an interface for play, it has also proven to be a highly effective exercise interface.

RELATED WORK

A parallel can be drawn between the *HipDisk* and Benoît Maubrey's *Audio Tutus* (Maubrey 2005). The two interfaces share a visual and material aesthetic, and translate body movement into sound output during performance. However the interfaces differ in a number of fundamental ways. The *Audio Tutus* use body movement to affect and change different parameters of sound samples that are either pre-recorded, or collected during the performance. The data used for sound manipulation is collected from arm movements, as well as changes in light that result from shadows cast by both the wearer and the environment. The *hipDisk* does not allow the wearer to record sound, nor does it allow the wearer to affect any of the qualities of the sound output other than duration. The sonic output of the *hipDisk* consists of simple tones that are triggered through core-body positioning only – the movement of limbs are not measured and only affect sonic output insofar as their position supports the required gestural extension of the body's core. The environment in which the *hipDisk* is worn also has no effect on the output of the interface, except perhaps to render it more or less audible as a result of ambient noise. The *Audio Tutus* are visually striking and draw focus to the performer because of this, but their functional aim is to afford the production of sound in a mobile, wearable form, not to highlight the body's functionality. The *hipDisk*, in contrast, pointedly draws the attention of both wearer and viewer to the body's gestural position. This is a conscious function of the interface and an aim that conditioned its form from the outset. It achieves this by extending, so magnifying, the tilt of hip and torso, and providing sonic accents once extremes of position are reached.

Gesturally controlled sonic interfaces

Bardos et al's *Bangarama* (Bardos 2005) – a head-banging controller, provides a surprising, albeit obvious example of a gesturally controlled sonic interface that uses the body's physical affordances to go beyond digit- and limb-triggered interaction. Also of relevance is Zigelbaum et al's *Ringalings* from the *BodyBeats Suite* (Zigelbaum 2006). *Ringalings* allows different body positions to trigger different sounds. It also allows individual users to map specific gestures to trigger pre-recorded sound samples on a case-by-case basis before performing or experimenting. The *hipDisk* does not allow this kind of flexibility or individual influence on the system's output. *Bangarama* and *Ringalings* also differ from the *hipDisk* in that neither system uses body movement to trigger fixed musical notes, nor do they extend the body physically into space.

The input/output relationship of *hipDisk* is simple and direct. A correlation can be made to non-wearable physical interfaces such as Dance Dance Revolution, or DDR (known as Dancing Stage in Europe) (Konami 1998, Smith 2004). DDR is an interactive dance interface that allows the user to perform music by pressing panels in the floor in a dance-like way while following a score on a computer screen.

By allowing the wearer to trigger individual tones and so build or play simple melodies, *hipDisk* also relates to traditional acoustic instruments such as the piano or xylophone, though it's not possible to play multiple notes at any one time on the *hipDisk* unless an ensemble of *hipDisk*-ed performers work together.

Physical extension

As mentioned, the *hipDisk* physically extends the body into space. A related example is *faceClamps* (Wilde 1998) – a system of levers that extend and magnify measurements of the movement of the mouth on a horizontal and vertical axis, so that these measurements can be used to trigger and manipulate pre-recorded sound samples.

Also of relevance is Kei Kagami's Head Holder, a dress that explores dynamic structures by means of rods and strings that cause exaggerated movement of the garment by the motion of the wearer (Kagami 2006). The *hipDisk*, though, is not dynamic. Its relationship to the wearer does not change. It is a simple and direct extension of the hip and torso on horizontal planes that serve to visibly and tangibly magnify the position and tilt of these two body parts. In this way it is perhaps more closely related to the costumes of Leigh Bowery that exaggerate his body through abstracted physical extension (Bowery 2005).

Gestural extension

If we look to theatre and performance research we can see much interest in the idea of extending, as well as distorting or turning gesture in order to focus attention. According to Anne Bogart, Agnes de Mille described the use of distortion or turning in dance, for example, as the extension of effort, the prolongation of stress beyond the norm, saying that it can be arresting or remarkable, and it can help fix a gesture in memory (Bogart 2001:52-54). Brecht in his articulation of *Alienation* (the A-effect, or, from the German *Verfremdungs-*, or V-effect) states that 'What is 'natural' must have the force of what is startling. This is the only way to expose the laws of cause and effect.' (Brecht 1964:70-71)

When applied to the present discussion, this suggests that a device can focus our awareness on a gesture if it renders it startling or remarkable, that the wearer or observer of the device will then be able to fix the gestures in memory, and the underlying mechanisms and motivations can thus be exposed

Interaction Design – considering physical pleasure and emotion

Bill Gaver and the Interaction Research Group at Goldsmiths University in London emphasise the need to consider people's values, aspirations, fears and desires when developing interactive devices. Gaver cautions that 'as computing has emerged from the office and laboratory, it seems to have brought along values of the workplace: concerns for clarity, efficiency and productivity' but that 'we do not just engage with the world in the form of problems to be solved and tasks to be pursued. We are also playful creatures' (Gaver 2002, 2006). This suggests that enhancing a garment's ability to fulfil its functional requirements is simply not enough.

Similar concerns are expressed in the work of Dunne and Raby, in their ongoing speculation about the cultural function of electronic products. With Michael Anastassiades, for example, they created Prescription Products: Designs for Fragile Personalities in Anxious Times (Dunne 2003-), and Placebo, a collection of electronic objects which explore mental well-being in relation to domestic electromagnetic fields (Dunne 2000-2001). Brendan Walker, with his work at Aerial, tries to understand and replicate the thrill experienced on high-velocity fairground rides. In his words, 'Aerial is a design practice specialising in the creation of tailored emotional experience.'(Walker 2005)

The work of Gaver et al, Walker, Dunne and Raby and Anastassiades suggests that another kind of relationship is possible with interactive objects. While none of the projects cited focus on wearable technologies except Walker's monitoring devices, they all raise the importance of a consideration of the inner life of the user, and in Walker's case focus expressly on physical immersion and visceral experience, albeit from an observational perspective.

The intended aim when creating *hipDisk* was to find a way to inspire people to move their hips and to explore and extend the range of movement available to them in this part of the body simply because it can feel good.

Projects that appear to share this concern include Rinotchild's *Laughing Swing,* Bernie Lubell's *Cheek to Cheek* and Grace Kim's *Twirl Skirt*. While *Laughing Swing* is not wearable it is a tangible interface – a modified swing – that enhances a physically immersive experience – that of swinging – and encourages the user to physically extend themselves, through the addition of sound – in this case laughter – the nature of which changes in direct relation to the user's physical engagement (Rinotchild 2005). *Cheek-to-Cheek* does not work with sound, and is only partially wearable, but again it is a physically immersive experience that seems intimately related to the physical, visceral and inner life of the wearer. With *Cheek-to-Cheek* the user sits on a stool that is connected with pneumatic tubing to a headpiece. By moving their buttock cheeks they can momentarily inflate cushions that are held in place against their facial cheeks, so 'dance with themselves' (Lubell 1999). Like *hipDisk*, this relationship is one-to-one. When one buttock cheek moves, one cushion against the facial cheek is filled momentarily with air. Grace Kim's *Twirl Skirt* extends this into a fully wearable space (Kim 2005). *Twirl Skirt*, an augmented woman's skirt, is an autonomous, wearable system. It has three electro-luminescent panels that illuminate in reaction to how fast the wearer is spinning. It seems to inspire people to spin and twirl in ways that they usually haven't since they were children through a direct coupling of feedback and visceral pleasure with the velocity of the wearer's spin. The addition of sound to the *hipDisk* clearly differentiates it from the *Twirl Skirt*, as does the fact that the *hipDisk* interface is neither soft nor dynamic, whereas the *Twirl Skirt* is both. It seems clear though that the two interfaces share their desire to inspire the wearer to move.

HIPDISK

Preliminary Ideation

The following is an anecdotal account of the context and conceptual development underlying the creation of the *hipDisk* interface. This has been included because *hipDisk* emerged from a process of open exploration that was affected by a number of limiting constraints.

Context

The *HipDisk* was created during Reskin – ANAT[3] and Craft Australia's wearable technologies lab – a three-week workshop set up to explore attributes and potential uses of conductive fabrics and inks in wearable applications (ANAT 2007a). Prototypes created in the final week of Reskin were intended for public display in a number of high profile events including the WearNow Symposium, a live webcast international symposium on the future of wearable technologies, held at the National Museum of Australia (ANAT 2007b). The requirement for a fully-functioning prototype to be conceived, realised and demonstrated within a single week, in a very high-profile context, had a clear impact on the development of the *hipDisk*.

[3] The Australian Network for Art and Technology (ANAT 1998-)

Initial exploration

My ongoing research is focused on the body as an expressive instrument, and what it feels like to inhabit our individual 'body-instruments' as we move through our lives. It was natural, within the context of Reskin, to maintain and extend this focus.

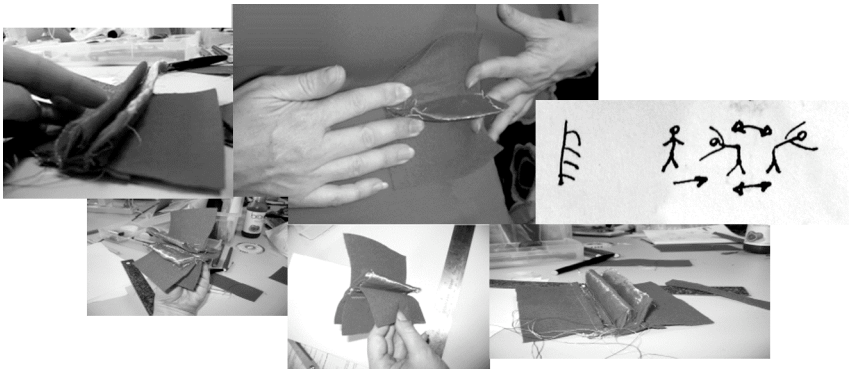

Figure 2. experimenting with conductive fabric

Initial investigations explored different ways conductive fabrics could be used to measure or track physical movement, or changes in the body's dynamic, so that these changes could be used to actuate digitally mediated events. Experiments included weaving conductive thread into three-dimensional ridges or channels that could be placed against the sides of the torso to measure bend; and the creation of small wing-shapes that extended out from the body in a similar manner (see Figure 2). These experiments were concerned with the body's movement along a single axis. Whilst not problematic in and of itself, a physically responsive system limited to raising the arms and bending from side to side seemed inappropriate for the context in which the work would be shown.

Education to practice

A person's view of the world is informed by their cultural background, education and experiences. My education, training and experience is in the performing and fine arts, architecture and Interaction Design. My work has been shown in large and small festivals, museums and performance venues around the world. I have also created performance interventions and demonstrations of interactive costumes at events ranging from unpublicised public interventions and staid academic conferences through to large-scale cultural events. This experience has allowed me to develop a sensitivity to the range of expectations a particular audience may have and an understanding of what may or may not work in different contexts.

It seemed clear to me that for Reskin a wearable interface that was visually arresting, satisfying and fun to use would be ideal. In addition, if the use of technology was relatively simple it would be achievable in the short timeframe. So if a physically responsive system demonstrated by raising the arms and bending from side to side was not only limited, but in the context of the planned public demonstration would seem somewhat ridiculous, the investigation needed to shift focus in order to generate a different outcome.

Conception

It is well known that a change of task can bring a fresh outlook and new ideas, and that physical activity can free up the brain to think in different ways. A common activity, under such circumstances, is to go swimming.

Like many people, I have a personal, somewhat idiosyncratic swimming style. As I extend my arms forward, when swimming Freestyle, and turn my head to breathe, I roll my hips and torso in opposition and support of the rotation of my head. This motion is technically unrefined, but is particularly pleasing kinaesthetically. While counting laps and vaguely considering the conundrum with which I was faced, I found myself focusing on the physical pleasure I was experiencing through this extended rotation of hip and torso. This raised the question: 'If a single-axis exploration was inappropriate for the intended presentation context', and it seemed only natural to shift the focus to an investigation of a more fundamental, dynamic and fuller-body movement, 'why not shift the focus to the changing relationship between hip and torso?'

Different parts of our bodies have varying degrees of freedom. The relationship between the hip and torso is particularly dynamic, as this area of the body allows movement on its axes in a relatively unconstrained fashion. It also provides a fundamental reflection of core strength and flexibility. My ongoing research aim, as previously mentioned, is to explore how technology might be paired with the body to poeticise experience. To explore this idea I am trying to create wearable interactive interfaces that inspire people to move, and that by doing so trigger and stimulate different emotions. I clearly experienced deep, kinaesthetic pleasure rolling my hips whilst swimming. I became curious to see if I could replicate this pleasure through the creation of a performative wearable interface that focussed on this part of the body.

Design Goals

In consideration of the above, the design goals in creating *hipDisk* can be summarized as:

1. To inspire people to swing their hips and explore and extend the full range of movement available to them
2. To explore ways of using conductive fabrics to measure or track physical movement, or changes in the body's dynamic, so that these changes could be used to actuate digitally-mediated events

After initial experiments, the following aim was added:

3. To make a musical instrument that was at once simple, so able to be played by a novice, and sufficiently complex, so that mastery would afford musical complexity.

The reasons for the choice of sound as the output modality will be discussed below.

Interface Details

Input

To facilitate a focus on the relationship between hip and torso, two disks were attached to the body – one above the waist and one below. These disks extended the hip and torso on a horizontal plane, so provided an input that was easy for the wearer and viewer to 'read' and easy, at the level of interface, to measure.

I then undertook further experiments with the conductive fabrics. I originally thought that the soft switches would provide variable resistance so provide detailed information about how and where the disks touched – including information about the speed and pressure, or quality of touch, but this was quickly determined to be impractical from a technical standpoint. The disks were held separate at the body, so could only touch at their outer rim. The conductive qualities of the fabrics available at the time, when incorporated into this design, did not allow a high enough resolution of electrical signal to read pressure, or surface contact area. As the development time-frame was limited, the device was thus constrained by material properties and the *poetic intent* retained as best as possible within these constraints:

$$\frac{\textit{time}}{\textit{material}}$$

Accordingly, the interface was limited to a series of binary switches that would give information about where, when and for how long the disks touched, but no further information about the quality or nature of the touch.

'Soft' vs. 'Hard' Electronics

A number of assumptions are made about the use of 'hard' and 'soft' electronics in wearable interfaces. 'Hard' and 'soft' electronics are both used in the *hipDisk*, because of their particular attributes, but not necessarily in an obvious way.

'Hard electronics', a name given to traditional electronic circuits and components, are typically constructed of hard plastics, metals, silicon, etc. The components are literally hard, in a tactile sense, rigid and angular. They are often brittle and are unsuitable for any use that requires flexibility or stretch.

'Soft electronics' replace wires and other conductive surfaces with conductive fabrics and threads that incorporate metal filaments into their grain or weave yet remain flexible and soft. This flexibility and softness make them ideal for use on the body in that they can be worn, rather than merely attached or placed on or next to the body. Soft circuits, clearly, have different properties to traditional hard circuitry.

The use of soft switches in *hipDisk* was conditioned by the need to ensure contact between two surfaces that would meet at an angle, in a system where the central, vertical axis (in the case of *hipDisk*, the spine) allowed for horizontal displacement. So while soft electronics are considered ideal and in fact are being developed expressly for use on the body, their use in *hipDisk* is somewhat unconventional. The hard interface attaches to the body and its functionality is facilitated through particular qualities made available through the use of conductive fabrics, or soft electronics, which are placed at a distance from the body.

Output – The choice of Sound

Any form of output could have been deemed appropriate for an interface designed to explore core-body gesture. The choice of sound was conditioned by a number of considerations, first and foremost was that the system's input was simple, yet visually powerful. The output needed to support and further strengthen this, not detract from it or muddy this clarity in any way.

Sound is an independent sensory modality. It has no obvious tactile or visible component, so provides an ideal contrasting support for the highly visible, movement-based input of the *hipDisk* interface. Through the use of sound, a clear, identifiable separation between input and output – as perceived by the audience or viewer – can be achieved. The moment of contact of the disks can also be enhanced in a non-visual way, and so punctuated for both wearer and observer.

Sonic output can be quite simple or highly complex while still allowing for complexity of use. The interface was to be a simple on-off triggering system, which clearly affected the range and quality of possible output for the *hipDisk* system, so this attribute of sound was particularly attractive. In addition, if sound was to be the output modality minimal physical interface construction would be required beyond that already conceived – the addition of speaker/s, amplification and the expected electronic circuitry would be all that was needed. The tight production timeframe made this a valuable attribute.

To clarify thinking about *hipDisk* as a sonic interface, consultation was undertaken with a number of practitioners who had undergone traditional musical training. Though they didn't necessarily agree, the choice of a twelve-note interface was based on the following determinants:

- The need to place the switches evenly around a circular formation, in an easily recognisable and actionable pattern.

Immediate and simple socio-cultural associations can be made between the number twelve and a circular formation, such as the hours spread around a circular, analogue clock face and the 30° divisions on a protractor that inform, for example, the divisions of cakes, tarts and other circular forms. These common associations suggest that people would be able to easily distinguish a resolution of twelve switches.

- The familiarity of musical possibilities provided by a chromatic scale in the key of C, in contemporary Western cultures, as opposed to other keys or modes or alternate tunings
- The physical precision required to bend the torso into twelve distinct positions, as opposed to eight positions, or any other number

This final point is driven by the desire to create a system that could be played by a novice, yet through mastery, allow greater complexity – a quality that seems intrinsic to many musical instruments.

The Interface

So twelve simple, soft, digital switches were positioned at equidistant intervals around the perimeter of the disks – one part of each switch on the upper disk, the complementary part of the switch on the lower. The switches could then be activated when the corresponding parts of the upper and lower disks contacted, as achieved through bending the body at the waist. (see Figure 3).

Figure 3. triggering different notes

The Sound

The sounds output by the *hipDisk* are simple electronic tones generated by the Basic Stamp 2 microcontroller. Each of the switches actuates a different note in a descending chromatic scale, beginning centre front with *middle C*. The quality of the generated tones is unrefined, electronically primitive, harsh and reedy. While one of the stated aims was to make a musical instrument, the prime focus of the interface is to encourage people to swing their hips and explore and extend the full range of movement available to them in this part of the body. Refining and developing sound quality was seen as a secondary task – to be explored in future iterations perhaps, though only if it were to further the primary aim of the interface by augmenting the pleasure experienced by the wearer, and so increase their desire to engage.

That said, the ability to make sound with the *hipDisk* is incredibly important – both to the wearer and the audience. The presence of sound provides valuable feedback. It not only indicates that contact has been made, it also gives specific feedback about what part of the disks has touched. This allows complex goal oriented play. The wearer can improvise or play existing tunes. They can also invent tunes that they then try to physically replicate. The audience can involve themselves by providing melodies to be played, and they can engage with the wearer's struggle as well as the resulting sonification.

If there were no output for the *hipDisk* there would be no feedback to indicate whether or not, and where the disks had touched. The interface would be reduced to being a rather odd exercise device with no clear or immediate reward for achieving contact at any resolution.

Issues

There are number of issues with the interface in its current form. The biggest problem is that the precision of physical positioning required to trigger the individual switches is not consistent. The centre-front, centre-back and side switches are easy to isolate and trigger, but consistent identification and triggering of the other eight switches – in particular those at the rear of the interface – has proven to be extremely difficult. Though I am the only person to have used the *hipDisk* to date, it is not unreasonable to imagine that this problem would also exist – to greater or lesser degrees perhaps – for other wearers. As a result of this inherent difficulty, the interface in its current form clearly requires commitment to achieve mastery. An eight-note system would perhaps be more viable, simply because it would be a little easier to use. Another alternative would be to have minimal separation between notes so that no matter how the body is positioned, a note would be struck, and then an investigation undertaken into appropriate resizing of each of the switches in order to augment and equalise the facility with which each note can be played.

Key Features

The *hipDisk* interface consists of:

- Two disks – one above the waist, one below. By extending these core body parts on horizontal planes the *hipDisk* draws attention to their position and relative tilt.
- Twelve contact switches that represent the twelve notes on a chromatic scale, evenly spread around the perimeter of the inner face of each of the disks. The notes descend in an anti-clockwise direction, beginning centre-front with *middle C*.
- Microcontroller generated audio tones, output through a speaker discretely positioned in the upper garment of the wearer.
- An older-style one-piece swimming costume and bathing cap.
- The interface is an autonomous body extension system. It is completely portable and wearable. It does not require additional computation or amplification external to the device, and does not require the hands or arms of the wearer to hold or engage with it in any way.

Construction

The materials used to build the prototype were conditioned by what was immediately at hand. The disks are made of polypropylene sheets, cut and connected with rivets and reinforced with aluminium strips in order to maintain a perpendicular relationship between the waist- and hip-bands and their corresponding disks (see Figure 4, left). Attached to the exterior of the waistband, on the upper disk, are two transparent plastic boxes that contain two traditional (hard) electronic circuits. The box on the right hand side of the image contains the Basic Stamp 2 (exposed in the image), that on the left a 9V battery, a small amplifier and an on-off switch. All wires are normally either enclosed or are held down with a combination of white electrical tape and white duct tape – except where they enter into the boxes containing the circuitry.

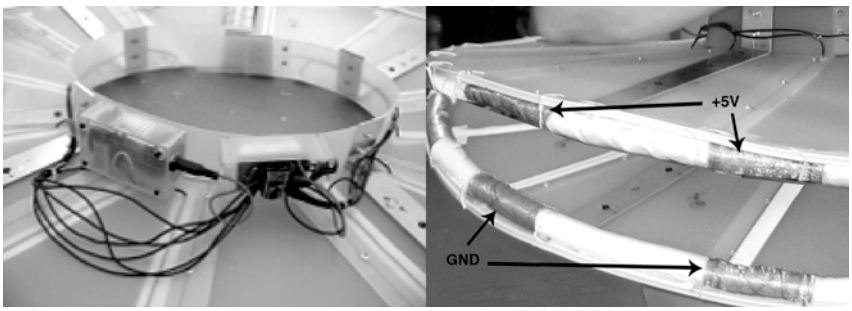

Figure 4. The *hipDisk* interface, detailed views: Upper disk with semi-exposed circuitry (left). Soft switches (right)

Sketch marks and construction notes remain visible on the surface of the discs. The original idea was to cover both discs with fabric – electric blue, identical in colour to the swimming costume, on the outer sides; and bright golden-yellow on the interior sections. The intention was to highlight the physically extending aspect of the discs, as well as the dynamic spatial relationship between them as the interior colour would only and always be visible, in an expanding ellipse, opposite where the two discs were touching. This idea was abandoned due to time-constraints and a belief that the raw materials were interesting in and of themselves. If pursued the aforementioned relationship to the costumes of Leigh Bowery (Bowery 2005) would be clearer.

The soft switches (see Figure 4, right) consist of two layers of conductive fabric sewn together with conductive thread, wrapped, at specific points, around a lycra tube filled with cotton braid and wadding. These tubes are mounted on the interior faces of each disk. The three-dimensional form of the soft switches increases the potential for contact between the two disks by maximizing their surface area, as their softness allows partial collapse under pressure and a resulting horizontal expansion.

The sounds generated by the *hipDisk* are simple tones created digitally using the Basic Stamp 2 microcontroller, triggered by the custom-built, soft, binary switches. The sound is amplified electronically, then output through a speaker mounted into the bodice of the costume of the wearer. An unexpected outcome of this was that the cleavage of the wearer acted as an amplification chamber for the speaker, so enhanced sound output capabilities. This aspect of the interface would necessarily vary with each performer.

The majority of circuitry is housed on the upper discs, with a single grounded wire connecting the switches on the lower disk to the upper circuit. As mentioned, the microcontroller used is the BS2 Basic Stamp. The entire system is self-contained. (see Figure 5).

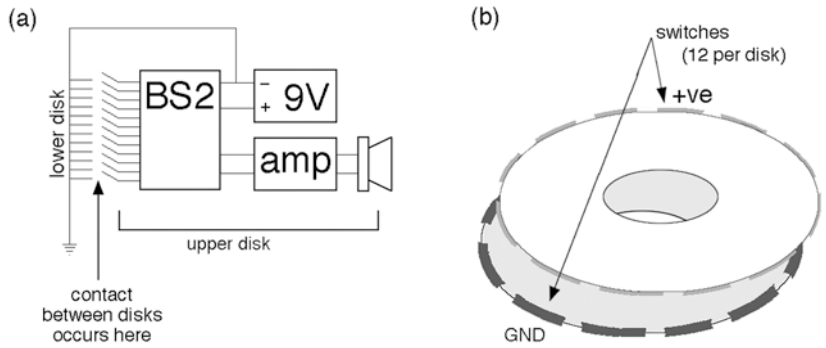

Figure 5. (a) circuit schematic. (b) placement of switches around the disks

Outcomes

A number of surprising outcomes have resulted from the creation of the *hipDisk*. The interface was designed with the aim of inspiring people to swing their hips and explore and extend the full range of movement available to them through a simultaneous, interdependent exploration of sound. The intention was to engage the wearer (and, vicariously, the audience) in an intensely physical experience with the hope that they would be able to access a similar pleasure to the pleasure I experience when I roll my hips while swimming.

As I am the only person to have worn and performed in the *hipDisk* to date, the comments and analysis herein are based purely on personal experience. Whether these observations hold for other wearers will be explored more concretely once further iterations of the interface have been realised. The contexts in which the interface has been worn are discussed in 'Audience Reception and Analysis'.

The Wearer's Perspective

The interaction afforded by the *hipDisk* is direct – the interface is both input and output (though they are embodied in different modalities). Unlike a blind person's cane or a computer mouse the *hipDisk* cannot be manipulated independently of the body or put down, casually, and taken up again. It extends the core of the body, physically, into space. It is affixed to the body, like an exoskeleton, or a prosthetic device, but to a part of the body that is not normally extended. This leads to the experience that it is directly coupled with the body. When improvising or realising tunes, it is difficult to ignore the choreographic repercussions of this coupling as it results in a clear link between body motion and sound production.

When wearing the *hipDisk* I consistently perform at the outer limits of my physical capabilities. In 'reaching' for contact to be made by the two disks, my body is thrown almost unconsciously into a variety of positions that exist purely in order to support the necessary physical extension that will result in a sound being produced. Without thinking I seem to bypass usual customs of self-censorship and self-constraint, and willingly place my body into bizarre postures, poses, gestures in order to trigger a desired sequence of tones. I have a background in physical performance, so am comfortable with physical extension and abstraction and have a highly developed sense of proprioception, but it has never been my intention to create highly stylised postures or gestures when wearing the *hipDisk*. My focus always remains fixed on achieving a sequence of tones.

The first time I presented the *hipDisk* I was shown a short piece of video footage of me performing and I found it shocking – I had truly had no idea of how I behaved physically and how unconventionally unconstrained I appeared to be (and in fact was) when wearing the device. I was embarrassed to see myself so exposed, unfiltered. I burst out laughing as did the people around me who had seen the performance and/or could see the footage. Later, I experienced a similar sense of shock when I saw photographs of me performing.

I noticed also that I smiled broadly, continually while wearing and using the device. While I am not known as a particularly sad or depressed person I do not generally smile without pause for no reason. I found wearing and playing the *hipDisk* to be immensely pleasurable. The satisfaction associated with successfully executing both individual tones and complete tunes is enormous. The interface also requires intense physical engagement, which in and of itself is not unpleasant. As the video still below shows (see Figure 6), my back muscles were highly engaged whilst performing the dynamic movements that are necessary to achieve the desired contact and tempo. The day following performances I also experienced the kind of muscular tension that indicates that a strenuous workout has been undertaken. At the same time, it was surprising for me to realise that playing the *hipDisk* interface was so physically demanding as I was not particularly conscious of any great effort or exertion while performing. When I wore the *hipDisk*, I was totally immersed in the act of playing. I did not think of my external physicality, of smiling or achieving any aesthetically driven pose or posture. I did not think of the physical engagement the device required. I didn't actually think of doing anything other than hitting the next note. Using the *hipDisk*, in my experience, results in what Dr Mihaly Csikszentmihalyi describes as 'flow'. In his words:

> [Flow means] being completely involved in an activity for its own sake. The ego falls away. Time flies. Every action, movement, and thought follows inevitably from the previous one, like playing jazz. Your whole being is involved, and you're using your skills to the utmost. (Geirland 1996)

In his seminal work, *Flow: The Psychology of Optimal Experience* (Csikszentmihalyi 1993), Csikszentmihalyi theorises that people are most happy when they are in a state of 'flow'. My beaming smile attests to my positive feelings and I also feel incredibly happy when I am wearing and playing the *hipDisk*, which is not inconsistent with his theory.

Figure 6. Back of the wearer while performing with *hipDisk* (video still).

Insert provides highlights of engaged muscles

Because of the physical engagement required, the *hipDisk* can also be considered as a rather novel exercise device. My ability to move from one position to another in a timely manner was enhanced through use. Core strength and flexibility were also clearly positively affected as evidenced by an extension of the outer limits of my physical capabilities. The *hipDisk* interface thus moves beyond the functional concerns of a musical instrument by providing health benefits on a physical plane. In combination, the *hipDisk* goes beyond the expected aspects of either musical instrument or exercise device. The resulting physically immersive emotional pleasure experienced when performing or playing with the *hipDisk* suggests a compounded enhancement of the quality of inner life of the wearer.

Audience Reception and Analysis

HipDisk has been shown in three different formats. The first, as a lecture/demonstration in conference auditoriums and lecture/meeting rooms, where I stand in front of a seated audience in a formal relationship and talk about the interface while wearing it and demonstrating its functionality. The second as a performance intervention where I wander around and through a crowd of people who are drinking and talking at a cultural event such as a gallery or exhibition opening. In the third format I do not wear the interface, rather I talk about it and show slides and video footage of it being worn. I have presented the *hipDisk* in this way in artist talks at a number of Universities and Arts Festivals and at two different academic conferences (ACMC 2007, (re)Actor2 2007).

In all three formats, almost without exception, audience members begin to laugh the moment they see the *hipDisk*, whether it be worn in front of them or presented as photographic images on the screen. When the interface is demonstrated – either live or through video footage – the laughter has, in some instances, become completely hysterical. Despite the humorous aspect of the *hipDisk*, and the importance of humour in my work, I found the strength of people's reactions surprising. It is difficult to unpick exactly why the *hipDisk* is so funny, but I would suggest that the fact that it is uncommon to see someone in such an unfiltered, unconstrained state is a contributing factor. Further analysis of the humour that seems inherent in the interface will be presented below.

As previously stated, the design goals, in creating *hipDisk*, were:

1. To inspire people to swing their hips and explore and extend the full range of movement available to them
2. To explore ways of using conductive fabrics to measure or track physical movement, or changes in the body's dynamic, so that these changes could be used to actuate digitally-mediated events
3. To make a musical instrument that was at once simple, so able to be played by a novice, and sufficiently complex, so that mastery would afford musical complexity

I do not believe that the second goal has impacted on audience response as it has been driven by purely functional concerns, and the use of soft conductive substrates is not actually evident to an audience member without a detailed inspection of the interface.

The impact of the third goal can perhaps only be fully explored once a level of mastery has been achieved, though it should be noted that during presentations of the interface the suggestion of playing known tunes with the *hipDisk* does elicit much laughter and encouragement. In performance there is no clear discussion, or developed evidence, of this aspect of the interface's potential, unless we accept that any audience member who has ever heard a simple tune played on a piano, keyboard or recorder could arguably extrapolate the potential for more complex musical output from the available

information. As a consequence it's difficult to argue the tangible impact of this goal until further development has been undertaken.

The first goal, to inspire people to swing their hips and explore and extend the full range of movement available to them, seems to be that which has impacted most favourably on audience response. It is difficult to qualify why with any certainty, but the following attributes have been identified as relevant:

The *hipDisk* focuses the attention of both wearer and viewer on the wearer's physicality. The interface itself is visually arresting, as is the gestural extension required for use. An incredible amount of effort is required to play the *hipDisk* – the wearer is required to perform at the outer limits of their physical capabilities for the simple result of a single audible tone that is primitive, harsh, reedy and unrefined. The lack of sophistication of the sound output by the *hipDisk* is far below what one would normally expect in these days of sophisticated sound equipment and high quality sonic reproduction available even on a limited budget, and is hardly of a quality that one would consider worth an inordinate amount of effort to achieve. The resulting imbalance between input and output energy seems to be quite humorous. Added to this, the rhythm of the output is closely linked to core strength and flexibility – the tempo of the resulting melody is physically constrained by the wearer's ability to move from one position to another. The physical difficulty presented by this task at times seems to compound the imbalance in input and output energy. Finally, in 'reaching' for a particular tone, the wearer's body is repeatedly thrown into bizarre positions to achieve the physical extension that will result in contact.

The combination of strange body positions and extreme imbalances in input and output seem to be of prime importance when trying to understand the overwhelmingly positive reception of the *hipDisk*.

Other attractive aspects of the interface seem to be:

- The choice of costume and persona – reminiscent of a character from a circus
- The rings, and the associated movement, which reference the hula hoop – a device common to many from childhood.
- The fact that, when wearing the interface, the wearer smiles broadly, continuously, throughout.

These elements all engage the audience first visually then through memory, association or emotion. In combination they add to the humour of the overall experience. The aim in creating *hipDisk* was not necessarily to be funny, but as explored in previous work (Wilde 2004), humour can help us to engage an audience, particularly when a work is concerned with the body.

In live performance all aspects of a work that engage the audiences' sense modalities are of prime importance. In a work such as the *hipDisk*, where there is no theatrical context, so no need for coherency with other characters, text or environment, the costume and persona benefit from being highly stylised. A formal costume can provide a strong context where no other context exists, and a persona can then be communicated or adopted very easily. Such strong choices allow the audience something clear against or with which to position themselves. In the case of *hipDisk*, the source of the costume and persona are not made clear to the audience. The costume directly references the moment of inspiration when I was swimming at Dixon Swimming Pool in Canberra, and the persona emerged organically from the combination of this costume and the interface, which was a functional response to the need to magnify the tilt of hip and torso. In informal discussions with people when I mentioned replacing the swimming costume with something more simple, neutral and perhaps elegant – such as dressing entirely in black – I was met at all times with dismay and strong resistance and informed in no uncertain terms that the costume is part of what makes the *hipDisk* so wonderful!

As discussed previously, and evidenced by my beaming smile, it seems clear to both audience and performer that the *hipDisk* is highly enjoyable to wear and use. The *hipDisk* demands, conditions and requires total freedom of physicality on the part of the wearer. It cannot be used in a restrained manner. In fact, the effort required to use *hipDisk* effectively removes any thoughts of appearance, as well as conscious thoughts of the external realities of physical displacement at the time of use. This is not generally problematic for children. Unfortunately, while the health and emotional benefits of the use of *hipDisk* may seem clear, it is not clear how many adults would volunteer to use a device that would take them beyond socially conditioned self-restraint in this way. Many adults asked if *hipDisks* would be made for children. Though it's beyond the scope of this article it would seem that being unconstrained can be equated with freedom, the kind of freedom readily experienced by, and perhaps equated as only being possible for children.

Activities that require total freedom from physical constraint, as a rule, seem to be outside the boundaries of most people's limits. Perhaps the desire to exist in an unconstrained manner is what is particularly compelling about the *hipDisk*? For is this not what leads many people to undertake extreme sports and other physically demanding, extreme or dangerous activities? Perhaps what is compelling is being able to see someone at close range, in such an unconstrained state, clearly enjoying themselves immensely?

Future Directions

Future directions include creating an adjustable version of the *hipDisk* to fit different sized wearers. Performances will then be developed for a *hipDisk*-ed ensemble. Four *hipDisks*, for example, would make it possible to play Jazz chords, or to provide back-up for solo vocalists or players, to harmonize, etc. thus opening up further areas of exploration. Questions to be addressed include: How would a *hipDisk*-ed ensemble play standard tunes? What would compositions for *hipDisk* sound like? What would they look like? Would the notes be in the same position for each of the *hipDisks* or would they be located to allow complementary positioning when creating chord structures? If body motion is largely harmonic would music for

hipDisk also be harmonic? And what would happen if the tangible interface, and so the haptic feedback, were removed? How would this change the experience and the sonic output?

Other directions for the research associated with the *hipDisk* interface are aimed at exploring different ways of measuring core-body gesture for the control of sound, as well as investigating how a focus on core-body gesture can add value to the creation of technologically mediated interactive devices – no matter what the output. The overarching aim is to investigate how technology might be paired with the body to poeticise experience, and what this might mean.

Conclusion

The *hipDisk* interface was conceived and realised over a seven-day period. It is a necessarily simple input-output system. If the context for creation had been different, many of the surprising outcomes that have resulted from the *hipDisk* project may not have been realised or discovered. The overwhelmingly positive response to the interface led me to question what could give such a simple device so much power to excite, enthuse, captivate.

It seems clear that the focus on gestural input, the body, its dynamic and affordances have contributed in no small part to the success of the work. It also seems clear that the dramatic imbalance evident in the effort required to generate such a modest output is also highly compelling.

It should be noted that much of the discussion on outcomes can only be clarified with further development of the *hipDisk* and associated interfaces. Until this work is realised, analysis necessarily remains speculative.

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