# Extending body and imagination: moving to move

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## ABSTRACT

We present a range of body-worn devices that have evolved from a common design intent: 'to move the body through real and virtual extension'. These devices encourage people to move in extra-normal ways, and thereby view and experience their bodies from perhaps hitherto unknown perspectives. They provide a rich playground for self-expression, as well as learning opportunities that we believe might be relevant for people with physical challenges and unconventional or altered abilities. Our desire in presenting this work to the ArtAbilitation community is to open up a dialogue and examine opportunities for engagement.

## 1. INTRODUCTION

*Swing That Thing: moving to move* is a practice-based doctoral research investigation into the potential of technologically supported gestural, physical and sensorial extension to poeticise experience by encouraging physical engagement (Wilde 2007-2011). The praxis outcomes discussed here encourage people to explore and move in playful ways. They open up a free-form expressive space that affords insight into how our bodies can move and what this feels like; individual body-centric learning preferences; and the idiosyncratic nature of personal, corporeal expressiveness. The different approaches taken are outlined and discussed in relation to ArtAbilitation. Our expertise is not in disability research, so our suppositions in this area risk being naïve. Nonetheless we see many applications for this work in the area of disability. Embodied communication and the notion of a poetics of embodied engagement are integral drivers of this research. We believe they are also highly pertinent for people with disabilities, including physical and other challenges related to self-expression. We will discuss the praxis outcomes in relation to these ideas, touching upon possible therapeutic applications. We hope to find opportunities to explore the potential benefits of extending this research in deep and seriously playful ways into an 'abilitation' context.

## 2. MOTIVATION & METHODOLOGY

### 2.1 Art • Science • Everyday Life…

All products are cultural, yet art has the closest association with culture. Bringing art into the development of products, no matter what they're used for, can bring those products closer to people. This research foregrounds body and imagination in a quest to consider what a poetics of embodied engagement might be. It is motivated by a desire to get people moving, because moving feels good. Conception and the development of the praxis has been guided by art and design ideation techniques and intuitive processes. The desire has been to encourage people to explore and extend the range of movement they have available to them, by providing unusual and engaging opportunities for them to move in extended, self-directed ways. The results are idiosyncratic, open systems for expressive engagement that encourage different qualities of attention. There is no right or wrong way to proceed, no required or desired outcome. Participants are free to create their own dynamically evolving frameworks for use. This allows for the generation of activities pitched at an

appropriate, or desired level. It also allows the difficulty to be increased or decreased at the participant's will. Outcomes are uncontrolled, and benchmarks are set by participants, so the devices can be used by novices, experts and elite movers, as well as by people with different challenges and unconventional abilities. Specific characteristics and potential applications of the different systems are described in Section 3.

*2.1.1 Evaluation.* Evaluation has focused on creating a common language and shared experience as a prelude to more formal qualification. Observation, open interview and subjective reporting of participant experience have been integral. Researcher participation has also played an important role. As participants attempt to translate pre-reflective (non-observational) subjective experiences into language, these reports must also be compared. Having personal non-observational experience of using the interfaces seems to enhance the researchers' ability to ask relevant questions, to gain clarification of what participants might mean. The common experiences act as a support for the development of an appropriate articulation of something that is extra-discursive.

*2.1.2 Technology and Design.* The research is arguably neither art nor science, rather it sits somewhere in between and has applications in both. In the Meta Perception Group at the Ishikawa Komuro Laboratory we develop interactive systems for applications in new media art and altered ability contexts[1], as well as examining the ethics of advanced technology systems. The Advancing Human Performance Theme at CSIRO undertakes empirically-driven research into technical- and intelligent-textile devices for sport, entertainment and health. They develop increasingly rigorous evaluation techniques with which to characterize the devices' performance, looking at accuracy, precision, robustness and repeatability, as well as the tangible experience of using sensory augmentation technology. The desire is to ascertain if a device yields a desired outcome, consistent with a hypothesis. The *Swing That Thing...* research contrasts with, complements and is informed by the different approaches of these contexts, leveraging many of the outcomes to link the practical, tangible aspects of body-worn technologies to the highly subjective feel of their experiential use.

## 2.2 Methodology

*Swing That Thing...* is a systematic examination of technological extension of the body (see fig.1). On a practical level, different forms of extension have been conceptualised, crude working prototypes made, and the ideas examined experientially. Consideration has been given to the impact of choices throughout the development cycle, including the aesthetics of the interface, as well as of the interaction. Prototypes are developed sufficiently to understand the impact and affordances of each approach, and to identify potential applications. Early insights are used to explore how and why different approaches might impact experience, and what this means for movement. Field-testing is undertaken with as broad a variety of individuals as possible, and includes prototype development if necessary. Extreme case scenarios are of particular interest (Moggridge 2006). People with a range of skills, as well as individuals with varying interests in personal and physical expression are encouraged and supported to test the devices. As potential applications are identified, prototypes may then be developed into more robust systems (for an example, see Wilde et al, 2010).

## 2.3 Reporting / Results

It is important to note that we are reporting outcomes that suggest a range of applications, without having yet fully tested our hypotheses. Our methodology supports emergent outcomes that are not discipline specific. We have an open way of working that affords the emergence of surprising outcomes, including unexpected opportunities to undertake empirical research. Under these circumstances, evaluation is based on fragmentary information.

Nonetheless, participants have consistently been engaged with the devices for extended periods of time, have expressed a desire to 'have one for themselves', or to share it with friends or children, even though the devices are not fully developed. Participants have also repeatedly suggested a broad range of applications, particularly in the area of disability[2]. We therefore feel that reporting at this stage is appropriate. It is helpful to understand and shape how the work might move forward in an ArtAbilitation context, as well as to engage with this community to consider the benefits of working in openly structured ways, making open systems for engagement.

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[1] See especially *http://www.k2.t.u-tokyo.ac.jp/members/alvaro/works/index.html*
[2] Most commonly where they have personal experience with people with the disability in question.
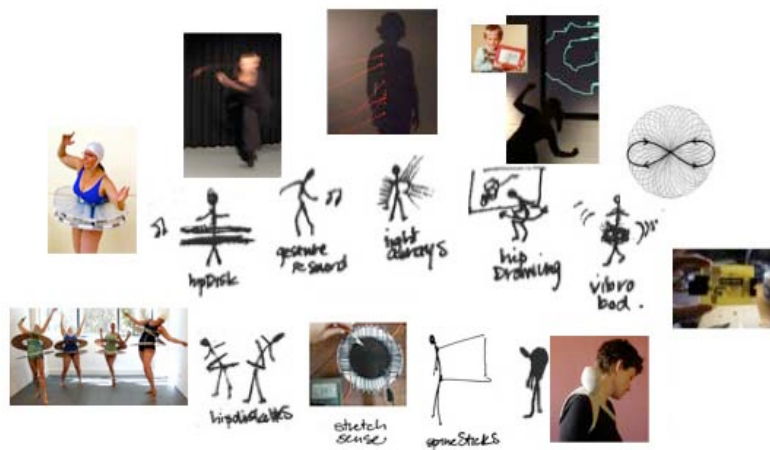
**Figure 1.** *Swing That Thing : moving to move [Wilde, 2007-2011].*

# 3. THE SUITE OF *SWING THAT THING…* DEVICES

This section provides an overview of the praxis outcomes that have emerged from the *Swing That thing…* investigation (fig.1). The suite of devices cover a range of augmenting approaches: extending the body with light; simple and complex sound; graphic output; vibrotactile feedback; and literal, physical, tangible extension of the core of the body, horizontally. Soft prosthetic extensions have also been developed, and participants have been invited to create their own exploratory devices. Each of the projects provides a different kind of feedback, and has its own affordances. It is beyond the scope of this paper to address in detail many of the technical choices. We provide sufficient information to support our discussion of how this work might be relevant to ArtAbilitation. More detailed information and publications are available at (Wilde, 2007-2011).

*3.1     Extending through technology*

The works discussed are presented in the chronological order of their conception. Development was staggered at the outset, yet each project continues to inform and be informed by the other projects, as they build towards a coherent thesis.

*3.1.1 hipDisk* (Fig.2). The *hipDisk* extends the body horizontally to exploit changing relationships between hip and torso to actuate simple tones. The interface consists of twelve soft binary switches spread evenly around the periphery of the two disks: one worn above, and one below the waist. As the wearer tilts their hip and torso in opposition, making the disks touch, different notes can be triggered. A number of tonal arrangements and scales have been tested: a chromatic scale, a major scale and a minor scale. Different participants have different preferences, so currently all three options are made available. The *hipDisk* constrains, and requires a particular kind of extension. It brings to light idiosyncrasies in posture and flexibility. It also, surprisingly, provides information about individual body-centric learning preferences, as people instinctively look for the most comfortable way to learn how the device behaves – through visual supports; physically: proprioceptively and kinaesthetically, as well as with tactile support from others; through sound; or observation. Some participants even use spatial orientation even though the interface is



**Figure 2.** *hipDisk and the hipdiskettes [Wilde, 2007]*

self-contained and centred on the body, so no matter which direction the wearer faces the behaviour of the device is consistent. (Wilde, 2008)

Because of the visual resemblance, the *hipDisk* is repeatedly compared to the hula hoop, though the physical actions required to play the devices are very different. Visually, they both form a ring around the body's core. Physically, moving the hips in extended and powerfully intentional ways is not a common activity, outside of an intimate context. It can be highly pleasurable. In the case of *hipDisk,* it also looks very strange. We do not normally view the body extended horizontally. We also do not normally undertake

activities that have a disproportionate relationship between effort and outcome. The *hipDisk* can require an inordinate amount of effort to play certain notes (this differs for each person, and is related to posture and flexibility), yet the outcome is a reedy, almost tinny, unrefined tone. There is nothing sophisticated or graceful about the *hipDisk* in any traditional sense, yet participants love wearing it and playing with it, just as most people love to play with a hula hoop, given the chance.[3]

*The hipdiskettes* (Fig. 2) iterate the different aspects of *hipDisk* through time and space to afford a deeper examination of the interconnection between choreography and composition, as well as more complex sonic output. They were formed to perform a rendition of the Bossa Nova standard, *The Girl From Ipanema*. To date they haven't succeeded. It has become apparent through presenting the failure of their attempts that the humanity of their struggle is incredibly endearing and encourages people to want to play the device themselves. It seems that, as it's seemingly impossible to succeed with the *hipDisk*, there is no threshold of success or failure, so use of the device is democratised. The interface is simply fun, and provides a challenge that is engaging, entertaining and novel, and it can be use in as complex a way as the participant desires.

When participants use the *hipDisk*, they work together or alone, they mimic other participants or do opposing experiments. They rarely remove the device in under half an hour, and when they do they seem highly energized and to date always desire to describe their experience playing it and discuss how their use compares to that of other people. *hipDisk* provides a novel opportunity for self-expression, exploration and knowledge generation through playfulness and social engagement. The therapeutic value of this seems clear for able-bodied participants – the device is fun and it connects people to their bodies and provides self-knowledge. We believe there would be similar benefits for people who are less physically-abled. While *hipDisk* may not address particular physical pathologies, it may be useful for other kinds of pathologies where self-confidence and embodied engagement are an issue. It is also attached to the body in a very firm yet comfortable way, clasping the torso above and below the waist. This may be pleasurable for people who respond positively, and are calmed by pressure.



**Figure 3.** *gesture≈sound experiments [Bencina et al., 2007]*

*3.1.2 gesture≈sound experiments* (Fig. 3). The *gesture≈sound experiments* extend the body with sound to mesh gestural/physical and sonic composition in such a way that sound production seems to be an inherent and unavoidable consequence of moving the body. The desire is to encourage people to explore through movement and sound, interdependently; and also to understand the nature of engagement when the physical interface is relatively discrete. The tested interface consists of Nintendo Wiimotes[4] bandaged to different parts of the body, sending sensor data to a computer running *Max*[5] to play sound patches developed in *Audiomulch*[6]. The sensors have been attached to forearms, shoulders, hips, upper and lower legs, spine and sternum. The different sound patches have been designed to encourage and support different kinds of movement exploration with each of the targeted body parts. (Bencina et al, 2008).

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[3] Based on personal experience, as well as anecdotal evidence provided by hoopers in Australia, North America and Japan.

[4] Trademarks registered. Further info is available at *http://www.nintendo.co.uk/NOE/en_GB/wii_54.html*

[5] A registered trademark of Cycling74. Further information is available at: *http://cycling74.com/products/*

[6] An interactive music program created by Ross Bencina. Further info is available at *http://www.audiomulch.com/*

*Gesture≈sound* is free and unconstrained, in comparison to *hipDisk*. Any movement (of the Wiimote) can be tracked, within the constraints of the different patches, and the sound is algorithmically generated, so relationships between gesture and sound can be far more complex than the binary offerings of the *hipDisk*. The unconstrained nature of *gesture≈sound* opens up a free-form expressive space that can be used to encourage exploratory movement with targeted parts of the body. If language is, indeed, generated out of movement (Gallagher, 2005), increasing a person's capacity for movement expression may support greater ease with verbal expression, as well as other forms of communication. It has been suggested that *gesture≈sound* would be useful for people with spectrum disorders, in particular Autism, where the children in question have inordinate amounts of energy and have a tendency to obsess and make patterns. In its current form the sensors are worn, rather than integrated into garments, so this may or may not be an issue – depending on whether the participant gains pleasure and comfort from physical pressure, or is hyper-sensitive to touch (or somewhere in between). Informal discussions with parents of children with Autism suggest that developing the interface for their use would be welcome and worth pursuing[7].

*3.1.3 The Light Arrays* (Fig. 4). The *Light Arrays* extrude the body with light to magnify articulations, gestures and postures. They highlight how a person's movement impacts space physically and how the different parts of their bodies interact with each other and others in shared space. The system uses either lasers or LED arrays, which, to date, have been attached to the limbs, the spine and the core of the body. By incorporating lights into garments and modular fabric supports, the *Light Arrays* prompt wearers to interact and engage, through the lights, with body position and movement as well with their dynamic position in space. Wearers report being inspired to move in new ways and to discover and explore their bodies through movement, in ways that differed from their usual methods, approaches and habits (Wilde, 2007). Though the wearer cannot see the lights in their entirety, this has been reported to be inspiring, rather than frustrating. The *Light Arrays* are currently undergoing extended development. A discussion of the aims and objectives, as well as its relevance to the ArtAbilitation community is provided at (Wilde et al, 2010).
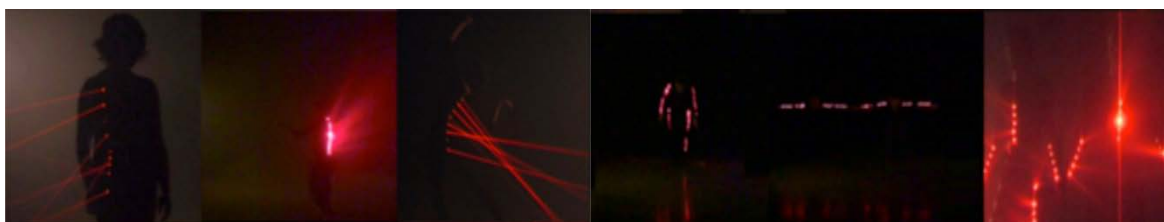

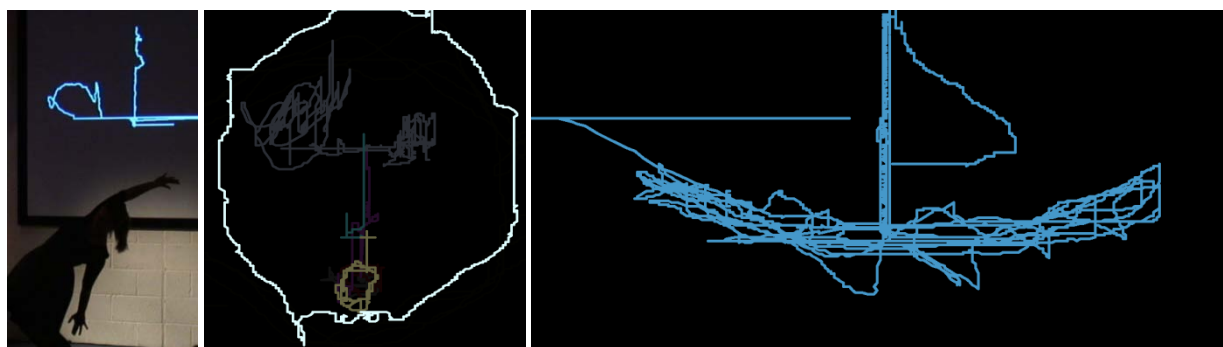
**Figure 4.** *Light Arrays [Wilde, 2008].*



**Figure 5.** *hipDrawing and some hipDrawn images (2009) [Wilde, 2007-2011]*

*3.1.4  hipDrawing* (Fig. 5). The *hipDrawing* interface turns the wearer into a human, hip-controlled Etch-A-Sketch[8] by transforming hip-movement data into 2D graphics, which are projected onto a wall or screen. The interface uses custom textile sensing technology (Helmer et al, 2008) to measure change in relative tilt between the hip and torso. The data is sent wirelessly to a computer running Processing[9]. A version will also be made that sends the graphic output to a smart phone or PDA, eliminating the need for a projector, laptop

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[7] The open nature of all of the systems has been remarked upon in informal conversations with parents of children with Autism. In each case they are eager for their child to have access. They suggest that the openness presents an opportunity for their child to engage in an exploratory manner, in a system that operates outside of language, and has room for their idiosyncrasies.

[8] A registered trademark of Ohio Art: *http://www.etch-a-sketch.com*

[9] An open source programming language and environment. Further information is available at: http://processing.org/

computer, and architecture to support the projection. The *hipDrawing* garment also incorporates an accelerometer, so that shaking the body can be used to erase the drawing (just as shaking the Etch-A-Sketch screen erases the Etch-A-Sketch drawing). It is currently made for one participant, but a multi-user version is planned to examine social navigation and engagement. In the multi-user version, participants draw on a shared screen. If one person shakes their body (or is shaken), the entire drawing is erased and their 'line' goes to the bottom of the hierarchical structure, allowing the other participants to draw over the top of their new drawings.

*hipDrawing* has a very clumsy mapping: the relatively unconstrained three dimensional movement of the body at the waist, is mapped onto an *xy* axis. As a result, its use is sometimes anti-intuitive – moving the body can result in unexpected graphic output. To draw something specific requires an ongoing shift in attention between the actions and gestures of the body, and the resulting graphic output on the screen. This causes a quality of attention that is inhabitual, an intensity of focus that people would not normally turn to the body in movement. This intense scrutiny of hip gesture opens up knew ways of seeing, thinking, and generating knowledge about this part of the body. More intensely than any of the other devices in the *Swing That Thing...* suite of works, *hipDrawing* prompts a process of creating and reflecting on new modes and patterns of bodily experience, as facilitated by the interaction between body movement and the effects of the technology. The clumsiness of the mapping also serves to democratize the technology in a similar way to the clumsy, gracelessness of the *hipDisk*. It thereby results in a system that is highly accessible to people with varying abilities, as there is no 'right' way to succeed. Tasks can be designed for personal idiosyncrasies and desired challenge levels, and outcomes provide access to the inherent aesthetics of movements of all kinds. This may provide desirable experiences for people with a range of physical and communicative challenges, for self-knowledge, as well as for creative expression and playful physical engagement. See Gallagher (2005: 144-146) for an extended discussion of the interrelation of body schema and physical activity, and the benefits of engaging in different kinds of movement that affect motility and postural schemas, as well as the role of vision in proprioception.

### 3.2    Soft Prosthetic Extension

*The OWL project* (Fig. 6, 7) is also part of the *Swing That Thing...* suite of works, but it operates quite differently than the works described above. Rather than providing an open system for physically engaged creative expression that can assist in self knowledge and learning in, through and about the body, *the OWL project* engages participants in co-creation and collaborative imagining of that which does not yet exist. There are two parts to the OWL project: interviews and workshops.



**Figure 6.** *OWL devices [Wilde and Andersen, 2009].*

In the interviews, a series of soft prosthetics that do not contain technology are used to bring the wearer's attention to the body in inhabitual ways. The devices are open and speculative, designed without a pre-defined function and tested as design 'probes' to ascertain their functionality. As the interview progresses, each new device is incrementally stranger – the first two give and receive pressure, the next two destabilize by shifting the body off axis, and the third two are like mutations that extend out from the body in subtle, but unusual ways. Interviewees are asked simple questions like: How does it feel? What is it? What does it do? And if it gave you magical powers, what kind of powers would they be? The aim is to create an emergent, imaginative space in which people might be able to conceptualise technologies that don't yet exist. The desire is to plumb people's willingness to imagine through the body in movement; discover what might happen if we let people use their embodied experience and imagination to assist in the creation of unknown technologies; and to bring the wearers' attention to their embodied-ness to see if this brings them present to their inner state and encourages magical thinking. To date, interviews have been conducted in Europe (7), Australia (8), North America (6) and Japan (4 at the time of writing). The interviews are formalised, yet open. The objects are evocative, and the interview format is designed to slow down the moment of perception, 'making strange' that moment of considering an object as a worn presence within each personal space.

The workshops are a little different. Rather than beginning with devices, participants are asked to choose a desire (Reiss, 2000), to decide where in their body it might live, then to build an exploratory object from recycled materials that somehow will embody their dreams, in relation to this desire, and give them magical powers. The workshops (3 so far) have taken place in Tokyo. Further workshops are planned for later this year, in Yamaguchi, Japan, and Sydney, Australia. The desire is to engage with as many people, from as many different cultural and socio-economic backgrounds as possible, as well as people with a range of relationships to movement and communication.

*3.2.1 Creative Thinking Across Cultures and Communities.* The geographical, cultural and socio-economic reach of the OWL project is giving us the opportunity to explore cultural differences and similarities expressed as creative thinking. Many of the outcomes are surprising, for example in one instance two people from radically different cultures, and political and socio-economic backgrounds used identical words to describe what one of the devices does. They were the only people to describe the device in this way. In another example, a participant who was interviewed in July 2009, reported in June 2010 that he has had lasting changes as a result of the things that were brought to mind during the interview process. His relationship to reading shifted, and he found himself examining why he did many things the way he did, and subsequently transformed many aspects of his life. He claims to be much happier as a direct result of the insights he gained during the interview. With regard to device #6, the quality of response has differed wildly, yet the valence has been the same. While it's difficult to draw clear conclusions from these outcomes, without exception, the experience of *the OWL project* has been reported as being unusual and bringing the attention to the body in new, different and deeply thoughtful ways. (Wilde and Andersen, 2009) We would like to see if this process might contribute in positive ways to how disabled people view and imagine through their bodies, as well as the kind of agency they imagine they might have with regard to the conceptualization and development of technologies that are relevant to them and are yet to be imagined.



**Figure 7.** *OWL devices and workshop inventions [Wilde and Andersen, 2009].*

# 4. MEASURING THE MOVING BODY

Measuring the body in movement is a major challenge for physically engaging interactive systems. *hipDrawing* and the *Extended Light Arrays* (Wilde et al, 2010) both make use of a custom textile sensor that has been developed at the CSIRO to measure elbow and wrist flexion, allowing for the relatively unconstrained movement and degrees of freedom in these parts of the body (Helmer et al, 2008). The sensor has been tested and compares favorably to the Vicon motion tracking system[10] – considered an industry "gold standard" for motion tracking. The advantage of using body-based sensors as opposed to a camera vision system such as Vicon is that body-based sensing is not restricted to the point of view of a camera (or cameras), the data can be followed in real time and, most importantly, testing can take place in any environment, including outdoors, as no installation of hardware or support systems are required. The CSIRO textile sensor connects to a body-worn microcontroller that sends data wirelessly to a laptop which has been set up to receive serial input via usb. In the *Swing That Thing…* investigation, the sensor has been adapted to measure flexion at the waist.

*3.2.1 Mixing Music, Movement and Learning.* The CSIRO textile sensor has been tested not just for accuracy of positioning data, but also for efficacy when using music to assist in learning. Researchers have worked with elite athletes at the Australian Institute of Sport[11], improving netball players' goal shooting skills by calibrating drum beats to wrist and elbow flexion. They have then examined how this information might be used to assist learning for novices, working with high school basketball players. They have also examined how adolescents learn, and teach each other about learning by embedding the sensors into a Wearable Instrument Shirt. The shirt allows elbow flexion to trigger controls on a virtual air guitar. In each case results have been notable. The netball and basketball players increased their skill levels significantly. The air guitar players were engaged, not just in the game, but also in sharing knowledge about how to play

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[10] Vicon Motion Systems are a registered trademark of Vicon: *http://www.vicon.com/*
[11] The AIS, or Australian Insitute of Sport: *http://www.ausport.gov.au/ais*

the game. The device has since been used as part of secondary education music classes to teach musical form and structure.[12]

The *Swing That Thing...* research extends this work to allow a participant to develop self-knowledge through creative expression. The intent is to examine how open systems and a variety of modalities might help people with different skills, interests and/or physical challenges, explore aesthetic possibilities through movement. The approach encourages creative engagement and allows for personal idiosyncrasies. The systems' embodiments and constraints mean that less abled participants can explore these systems alongside more able participants with equally rewarding experiences.

# 5. REFLECTION

*5.1    Foregrounding Physicality*

The body is central to this enquiry, in particular the torso. We have a much lower resolution of control in the centre of our body than in our digits and limbs. Core body interaction is experienced in a very different way than more traditional forms of interaction achieved through mouse, joystick or other peripheral. It is often experienced as clumsy in comparison, which brings our attention to the body in unusual or unexpected ways. The focus of a person trying to control a clumsy body-worn interface shifts between actions and the results of actions, so the interactions between body movement, the effects of technology and the impact of each of the different types of extension become apparent.

Body-worn devices are very different to environment-based systems as they are normally tightly coupled with the body – they cannot usually be repositioned, picked up or put down. They thus support a very different kind of engagement than systems that are not body-worn, and provide opportunities for different kinds of physical experiences and knowing. Yet they provide a number of challenges for a less able-bodied participant because of this tight coupling. Putting a garment on may be challenging for some people, and different kinds of movement and form factors, if not allowed for in the design of a garment, may compromise sensor precision. For this reason it is essential to include otherly-abled participants in the development processes of body-worn technologies. Doing so will allow us to understand how to develop for the broad range of bodies in the community, rather than restricting use of the devices, and research responses to body-typical users.

The garments and devices described in this article are architecture independent, except *hipDrawing* in its current form. This also brings focus to the body – on the actions being undertaken, as well as on the results of those actions. It supports the aforementioned process of creating and reflecting on new modes and patterns of bodily experience, and allows for the research to be undertaken in almost any environment – wherever the participant feels most comfortable. We believe this is important when trying to gain data about how things feel through the body, as people's comfort levels and behaviours may shift in different environments. This may be particularly beneficial when working with people with physical and communicative challenges.

# 6. CONCLUSION

The praxis outcomes described here encourage people to explore and move in playful ways. They open up a free-form expressive space that affords insight into how our bodies can move and what this feels like; individual body-centric learning preferences; and the idiosyncratic nature of personal, corporeal expressiveness. They engage the mind, emotions and feelings with the body, in all its dynamic capacity that may have been hitherto ignored.

The open-ness of the systems, coupled with the, at times, clumsy nature of the interaction they afford, brings people to new ways of seeing and experiencing the body. There is no "right" way of performing tasks with these systems, there is simply an open environment in which to explore, and in which to find each individual's preferred approach. This is supportive of different levels of ability and prowess. It also supports the design of activities to achieve particular outcomes that acknowledge and support the individual's strengths and preferences. For all of these reasons, as well as the playfully engaging nature of the devices, we believe them to be ideally suited to disabled or physically and communicatively challenged individuals.

By engaging with the ArtAbilitation community, we hope to discover opportunities to explore these ideas, and to extend the research in deep and seriously playful ways with people with disabilities.

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[12] such as blues chord progressions with one, four and five chords

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