

The Sound of Movement Wearables

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Choreographic principles of composition are largely directed at the creation of movement and the temporal organization of moving bodies in space. Some choreographers think of this process as “temporary drawings” (Sidi Larbi Cherkaoui), others work with complexity theories in mind and develop spatial methodologies for bodily extensions into environments that negotiate the intervals between presence (states of being) and transmutable movement in multiple ways (William Forsythe). In tanztheater, the dancers’ presence resonates with darker undertones, emotional turmoils acted out through obsessively repeated gestures and acute physical/psychic self-revelation (Pina Bausch)[1]. In comparison, Japanese butoh dance contains its metaphysics in movement that slowly, microscopically, sometimes imperceptibly, lives and breathes an interior world, the body metamorphosing between spirit, flesh, and matter, animal and human forms, ineffable shapes.

Choreography always writes the presence of bodies in the theatre in particular ways, but in contemporary digital or mixed reality performance such writing is now considered taking place in processual biogrammatic events or assemblages articulated through performative interfaces or “transductions,” as Sher Doruff calls them [2]. The performing bodies perform with or through media, with accessories and within compositional matrices – programmed environments – that can affect multiple sensory perceptions. What we propose in this essay are questions that primarily address *sound wearability* and transformability of sound and sounding bodies in choreography, shifting attention to the design processes of creating particularized audiophonic, amplificatory and kinaesonic costumes to be worn by dancers, actors and musicians in such interactive/responsive environments. The design processes take over core dramaturgical propositions of the kind of choreographic installations we shall describe, but as movement and sound propositions they also constitute new aesthetic challenges for the perceptual experiences in interactive and immersive installations. These experiences affect the performers as well as the listeners/audiences.

The wearability of sound is an intricate matter, and an under-explored phenomenon. We must ask how the functions and aesthetics of body-worn technologies enhance the bodies’ capabilities to interface with the environment as transmitters, receivers, and enablers of sensory information, how one can develop new design processes in the context of different cultural dance vocabularies through the utilization of 20th and 21st century technology and its impact in aural perception – and thus how wearability (performed) extends to the listener’s *performance of the audible*.

The Wearability of Sound: Audible Intimacies

Intimate wearables (garments or accessories) challenge performers and audiences alike when the focus of a work’s aesthetic design is directed at the creation of particular sound characters that subtly redefine the idea of the “instrument” as well as dance’s temporal drawings – especially the latter’s gestural, narrative, and erotic characteristics. In regard to the

conventions of music-theatre and dance, the “instrument” is both an object (a musical device created or adapted for the purpose of making musical sounds) and a body. The performers engage their instrument and invite the audience to observe, listen to and experience the sonorous body. The gestures play; and in the sense of the Japanese *Mâ*, they play with the intervals of time-space, drawing attention to that which is not “spoken,” intimate, fleeting and impermanent.

When devising the wearable-as-audible in performance, attention is shifted to the costume as a medium, to wearing as a performance technique that draws the digital back “across” into the visceral, into a collective behavioral environment where we listen and follow the smallest movement, the exhaling, the whisper of rustling fabric, the pleated sigh, the whirring sound of a tiny speaker worn on a wrist. In our work, dance fashions sound, but the asymmetries of our design also affect the surreal sensations (vision contrasting with hearing, touch), intimations of the grotesque in wounded, deconstructed garments or prosthetic lumps [3]. The wearables draw attention to materials, thus to tactility and to discrepancies between body and cloth that can be felt as discordance, or that are rendered – processed electro-acoustically – as noise as if the twisted cloth rippled the whole environment. Distinct sounds require conceptual leaps – a musical instrument becoming a crown, a hammer dropping to the floor and sucking up small magnets, an air pump inflating a screen that hovers above the crowd, a vinyl record becoming a camera eye. In previous work, our ensemble paid much attention to the possibilities of linking movement interactively to scenic projections of moving images and graphics, experimenting with augmented (visual) environments. Currently we think of screens as part of a sonic environment, membranes that echo the glyphic aspects of ensounded bodies. In our mixed reality installations we combine fashion design with sound design; inspired by Miyake, Yamamoto, Kawakubo, and Kabuki theatre, we examine the multifaceted, dynamic and relational aspects of garments/accessories, technologies and sounding bodies [4]. The choreographic installation *UKIYO [Moveable Worlds]*, developed by our ensemble in 2009-10 and recently staged at London’s Sadler’s Wells, serves as an example of such sound-motion design research.

Designing Wearables through Choreography

UKIYO [Moveable Worlds] is based on the Japanese *ukiyo-e* tradition of drawings depicting the transient beauty of life, and was created collaboratively with artists from Tokyo. We developed a mixed vocabulary based on improvisational techniques, expressive articulations of European tanztheater, Nigerian percussive rhythms, and the slowed-down attenuation, the dilation of time in *butoh*. Physical preparations for working with sensortized garments also included the “Artaud Method,” explored in workshops with Hironobu Oikawa whose *butoh* training encompasses Chinese natural philosophy of the five elements (wood, fire, earth, metal, water) and their motions. The Qigong system we applied uses a mixture of training methods, combining dynamic, static, meditative and interactional patterns. *UKIYO*’s attention to sound generation arose from this cross-cultural process with a philosophical, not merely technological, interest in developing a practice capable of integrating movement composition (both physical movement and image animations) with methods for creating particularized audiophonic, amplificatory, and sensortized garments. Our aesthetics of interactional design techniques implies that (1) the structure of the garment cannot be developed separately from the interaction potential, and (2) that the responsive systems developed for the choreographic installation allow performers to create “characters” generating sounds in real-time that invite audiences into a private acoustic arena.

The Sound Characters in Kinaesonic Environment

Rehearsing the different characters in *UKIYO*, all interactive patches were developed in parallel with the performers' skills and responses to the garment design in order to reach a good level of technical and expressive capability. Methodologically, our approach to sound generation started from moving with the raw materials and partial states of the emergent costumes to feel/hear their (potential) characteristics, then fine-tuning the wearables to allow a combination of gesture/motion controllers and microphonic sensing/actuation in the mixed-reality world. We used indirect mapping to process some but not all of the data in the combined PD, Max/Msp and Isadora patch environment to affect the mix of live and recorded sound. In the "creation" scene in Act II (Fig.7), a dancer also controls the projected 3D digital animation, her gestures "drawing" a landscape born from a desert but changing into rich vegetation with bursts of color. Through our choreographic, iterative and distributed approach to design, a more enhanced and hypersensual form of wearing extends into space and into 4D and 5D dimensions, including the projected virtual realms.



Fig. 1. Interfacial design development: RedMutant prototype for Katsura Isobe's character in *UKIYO* [Moveable Worlds]. Photo © 2009 DAP-Lab

UKIYO expands such kinaesonics further by focussing on the membranes of wearable microphones and mini-speakers, the small fluttering of electrical energy pulses, attached to the garments or to the skin, amplifying sound originating from the performers or mediated through them. We also work with the scenography of five criss-crossing *hanamichi* (runways), opening the space up for audience movement across. Visitors are invited inside the space of action, so that they can be as close to the dancers and musicians as they desire to be. In the complex feedback environment we have built (which includes live networked link-up to a Second Life installation with avatars mirroring the real space action), the performer interacts with the mediated environment of acoustic, visual, light and color projections constituted in continuous feedback loops with signals generated through electro-physiological data (breath, pulse, voice and sensorimotor data interfaced with computer algorithms which process sound modulations). In neurophysiological feedback environments such real-time improvisation concentrates less on semiotic processes of sense-making but on the immediate physical and emotional experience of movements inside or on the body [5]. We think of this work as having a transcendental dimension, linking the internal processes of the nervous

system and intrinsic energies of the organism to the spatial environment and its extended virtual world, as we transmit the movement to avatars in Second Life, and reinform the dancers' movement through avataric choreographies that are multifariously poetic, unrealistic, lossy, phantomic (inspired by 17th century haikus and created by software).



Fig. 2. Katsura Isobe as RedMutant with partial corset, performing in *UKIYO*, KIBLA Media Arts Center, 2010
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While it is not possible, in this short essay, to analyze empirical evidence of how audiences “perform” the audible or process sensory impulses, observations we made in several performances indicate that scale and size of the venue affect audience behavior manifestly; for example in the smaller gallery space at KIBLA (Maribor), the visitors remained mostly on the perimeter of the action, watching and listening intently, children being the only ones crossing the *hanamichi*. In the larger theatrical venues in London, audience of between 100 and 150 people milled across the entire space, intermingling with the dancers at the closest range and following audible cues or engaging with the actors offering aural and olfactory stimuli or soliciting audience members to touch wearable objects and be recorded by them, as it happens in one scene when The Engineer (Yiorgos Bakalos) cuts his path through the throng with his boom mike.

Wearable Technologies: Vibrational Augmentation

As we seek to understand better the internal and external architectures and augmentation of the body through wearable technologies, it is not sufficient to focus merely on the notion of the visual impact and “spectacle” of the body-wearable with its memorable appearance. We attend more fully to the emotional, vibrational sensations and inter/intra-psychological dimensions of wearing, i.e. to the impact the wearables have beyond the visual on our bodies serving as extension of the senses, as “we assimilate them to our body by pouring ourselves into them” [6]. This meant that in our design process we moved from the initial morphogenetic possibilities – explored through our digital photography of the choreography – to the listening body in the interface, incorporating all bouncing, reverberating sounds into the “pouring,” conjoining material and virtual oscillations into immersive experience of

imaginary space. The crackle of leaves, the dropping of salt onto the floor, the exhale of the bandoneon, the clicking of magnets against speakers, the sweeping of a vinyl groove with a finger next to a microphone, the glitches of claves seemingly beaten, the hands on the skin of the drum, the rustle of paillette sleeves (Figs. 1 & 2). The kind of mapping necessary to locate sounds in space and to replicate the physiology of auditive processes, argues Frances Dyson, is immensely complicated [7]. Choreography of wearables here becomes transmuted, and sound waves are no longer discrete units, thus favor a “non-cochlear” [8] mode of listening, not aimed at eliminating the ear (and its fluid mechanisms as sensory organ) but extending beyond it to wider form of listening and sensory engagement where other factors such as internal sensation come into play. The dancers realign ears with the body, the bones, and the pores of the skin, the whole body becoming an “acoustic sensorium” [9] and skilful transceiver of vibrational waves and sensation. This echoes the metaphysical concerns Antonin Artaud expressed in his search for the “complete, sonorous, streaming naked realization” of the theatre of cruelty: “Snakes do not react to music because of the mental ideas it produces in them, but because they are long, they lie coiled on the ground and their bodies are in contact with the ground along almost their entire length. And the musical vibrations communicated to the ground affect them as a very subtle, very long massage. Well I propose to treat the audience just like those charmed snakes and to bring them back to the subtlest ideas through their anatomies” [10].

UKIYO deployed various models for working with “wearing sound,” sound activated by the sonically extended and amplified body-in-motion for a more expressive augmented performance where immediate haptic and abstract aural qualities of the materials are intertwined for multi-sensorial experience. Rather than building costumes, accessories and performances, sound characters were generated exploring what effect garment can have on micro-textures of sonic transformation and on how we hear images or make connections between sounds and image textures in time and space. The concluding sections introduce three sound characters from *UKIYO*: WorkerWoman, InstrumentWoman, and LeavesWoman, each exploring distinctive characteristics of sound and visual aesthetic.

WorkerWoman (Act I)



Fig. 3. Anne Laure Misme as WorkerWoman wears dysfunctional speaker bra, mini metal cage crinoline with tiny speakers, ostrich leather armlettes, rag wristbands, leggings, transmitter and contact mike and rotates wireless speaker. *UKIYO*, KIBLA Media Arts Center, 2010 © DAP-Lab

In the context of *UKIYO*, WorkerWoman is a factory worker and revolutionary figure, a provocative symbol of the past (Russian Revolution and industrial age). She strives to represent simultaneously, through her vigorous repetitive movement and resultant generated gritty sound, the mechanization of the collective body and freedom for the workers from an imposed and production orientated social order. This character is noisy, strong and kinetic, and her powerful, compulsive-obsessive movements draw the audience into a dysfunctional world that does not stand still, inviting them to feel in their own bodies, her muscular and physical sensations. Tools and technologies are appropriated in new and subversive ways, as compositional means, to affect transformational change (Fig. 3), utilizing the extended sound practices of musique concrète and “cracked media” to achieve “the sound of malfunction” [11]. The dancer (Anne-Laure Misme), kitted out with various sound generating accoutrements (metal cage/mini crinoline [incorporating curved speaker grills], speakers, contact mike and vinyl disc), actively explores the technologies that extend her body physically and sonically.

Musician Sandy Finlayson notes that for Misme, “I recorded a series of samples directly from the already damaged 12" she was using, and looped segments. This created a noisy but still inherently musical sound, which may have been too delicate on its own, so this was complemented by the use of a clip-on radio microphone attached to her finger. When she dragged this over the vinyl, the sounds were amplified to the point of distortion” [12].

Wireless portable speakers with unstable Bluetooth transmission become motivational worker tools, offering unpredictability of performance and flow, two additional inverted

dysfunctional speakers worn provocatively on the body (speaker breasts integrated into bra design) paradoxically emit no sound at all, whilst unexpected sounds are forced from the flexing vinyl in a manner unintended, as Misme's motion shifts methods of sound production from playback of recorded sound, through sonic rhymes of air displacement to detecting and amplifying hidden vibrational sounds "existing below the line of audibility" [13] by use of the small contact mike. Pushing the vinyl across the white hanamichi strip, running her microphone finger over its grooves, Misme is further stimulated by her capabilities to manipulate the sonic landscape, generating a dark booming crescendo of low frequency sound and hum, intermingled with the live electronics of Finlayson in a shared creative process of improvised performance.

In the world of handmade electronics and hardware hacking, where traditional boundaries are crossed to allow, for instance, a speaker to exchange functions with a microphone, piezo disks to become contact mikes (for the detection of tiny and hidden sounds in everyday objects), and portable radios are transformed into synthesizers by making the skin part of a circuit [14], there are no set rules per se, only a willingness to experiment. This "getting messy" philosophy and methodological approach, where distortion and subversion offer new sound characteristics and creative possibilities, are most liberating to the trans-disciplinary designer integrating data transmitting, sound generating and transducing technologies into garment design concepts for the creation of sound characters for performance. In creating the WorkerWoman character, we had a loose concept for the distorted and dysfunctional sound, involving interferences and elements of analog and digital hacker culture to pull up new sounds and compositional strategies. Like the *Barong Analog* wearable synths of Stanley Ruiz, WorkerWoman would combine live performance with experimental improv/noise [15], noise that would be generated by performer and musician in a form of shared instrument alternating between the digital and the analog.

Acoustically, this character's noise making performative role explores disturbance as a tool for audience engagement and excitement. Atonality or disintegration of harmonic structure is superimposed over the top of the soundtrack of a cracked bandoneon (played by Caroline Wilkins and processed/recomposed by musician and composer Oded Ben-Tal) producing sounds through cracked technology "filled with noise, as unintended and extra-musical sounds are pulled from the technology as it is pushed to the edge of breaking" [16]. Recorded sounds of metal-working lathe and damaged vinyl intermingle, as changing playback speeds and dramatic jump effects combine with heavy breathing and other noises of a highly physical performance (Fig. 4).



Fig. 4. Anne Laure Misme as WorkerWoman performing in *UKIYO*, KIBLA Media Arts Center, 2010 © DAP-Lab

InstrumentWoman (Act II)

Caroline Wilkins as InstrumentWoman is a Kyogen character of “mad words,” relating to instrumental sound theatre (sound as opposed to music theatre, as there is no adhesion to score) and traditions of Japanese Noh and Kabuki. Exploring the musician’s physical body in relation to her extended bodily instrument in space, InstrumentWoman enacts a series of transformations through a free flowing form of improvisation, where the various sound generating elements of her performance combine to produce sequences that make musical sense. Key sound sources are the bandoneon and the voice of the performer, combined with a wearable costume incorporating wired and wireless systems of amplification into its design. After detailed observations of Wilkins playing her instrument in rehearsal, noting how her body had evolved with the bandoneon, our design suggests an inseparable connection between Wilkins and bandoneon. The garment she wears in Act II (gold pleated silk dupion dress with neoprene and leather collar feature) evokes a further evolutionary state created from the material characteristics of the instrument, its structures, textures, colors and other design features such as concertina capabilities. The dress utilizes sunray pleating that allows a radiating out of form into a kind of distinctive trapeze shape that denotes the instrument in flux. Dress and bandoneon thus breathe together and fuse – the playing of the instrument, as folding and unfolding of the physical and energetic features, resulting in a poetic metaphor for the unfolding of the golden (Amaterasu) persona of InstrumentWoman.

As the performance progresses, attention shifts from drawing, sweeping fingers – knocking, tapping, pressing keys either side of the resonant Bandoneon case – releasing a cacophony of percussive sounds (scratching, clicking, ratchet-like sounds), to the anatomical intimacy of the sound shaping mouth, on to the structures of the golden pleated trapeze dress – its collar feature extending into spinal column adorned with two square mounted speakers (to relay the voice and live electronics). Mouths within mouths open up and for Wilkins, “The voice

becomes an extension of instrumental sound, employing a wide range of techniques including speech, pitched and non-pitched sounds, Sprechstimme, etc., with the effect of spatial difference, of far and near, macro-/microscopic, created by a ‘dialogue’ between the different loudspeaker sources” [17].



Fig. 5. Caroline Wilkins (left) as InstrumentWoman, with HammerWoman in *UKIYO*, KIBLA Media Arts Center 2010 © DAP-Lab

Exploring the small voice of birdcall coming from the speakers mounted on the spine of the neck accessory worn by her (Fig. 5), Wilkins’ character begins to transform into a state of “Becoming Bird” through the combined sound-gestures. Becoming bird, in the butoh sense of visualization, enables the performer to transform her role, alongside the silent dance of the Japanese performers who act as subconscious ghosts Act II. She reaches into the spiritual dimensions of Qigong performance of energies (mixing fire and water), combining the Western technological notions of the virtual with the metaphysical consciousness of the universe found in butoh. Once again the scene involves intrinsic fusions between performer, musician and costume design in the creation of sound character and narrative. The speakers are compact but also relatively heavy (due to magnetic base for better sound quality) and must be counterbalanced on the collar which is softly padded, the presence of these transducing technologies add a sense of weight and burden to this character, almost choked at times by the pull on her collar, restricting flow, as she spits out onomatopoeic words. The audio cable that extends from the speakers to the amplifier is cut to a set length, just sufficient to allow Wilkins to advance three quarters of the way along her *hanimichi*, and then the tethering wires begin to contain her movement creating a sense of incarceration of this mad woman of mad words and gestures who cannot advance any further unless she is to remove her asphyxiating collar that begins to restrict and confine her so. The wearing and removing of the collar and negotiation with wires are indeed a pertinent part of the performance; the wires create their

own sound and resultant choreography, as they are dropped furiously to the floor in frustration, and the amputated vestigial collar provides an eerie object presence in itself, as it remains long after the performer has gone, with tiny voices, just traces, still emitting from the transparent membranes of its two golden speakers (Fig. 6).



Fig. 6. Neoprene and leather collar feature (discarded appendage) with square speakers emitting tiny voices, final scene in *UKIYO*, Sadler's Wells 2010 © DAP-Lab

LeavesWoman & Creation Scene (Act II)

LeavesWoman explores the dance of creation and the deeper metaphorical dimensions of real and digital objects coupled with bodily experience and simultaneous existence of corpo/virtual realities. Developed in collaboration with 3D designer Doros Polydorou and dancer Katsura Isobe, this prototype explores gestural creation of a 3D world, building on navigation strategies and techniques used in computer game worlds, “investigating the technological methodology as well as the instruments and the code required to create a gesture activated and body movement controlled real time virtual 3d world” [18].

The concept for LeavesWoman first evolved in December 2009 when the DAP-Lab ensemble visited Japan to work with collaborators at Keio University. The stimulus came from the iconic ephemeral image of the Gingko leaves falling to the ground to create a carpet of yellow. Outdoors transitioned to indoors, and Isobe, now in the studio, was enveloped in a sensual world of leaves. Wearing the nature, she slowly tuned to her body, touched by the texture and smell of the fresh leaves, alert to their sounds as movement initiators, her bare hands and feet slowly moving through crackling textures. Wearing one bend and one pressure sensor, transmitter on her left arm, Isobe was equipped to explore and enjoy amplified sounds within sounds, as she manipulated in real-time the organic and rendered sounds of recorded

rustle of the leaves (worked on by Ben-Tal). She thus explored the subcutaneous levels of leafness, similar to LaBelle describing the anatomy of a recording as “scrutinized, magnified, repeated, re-recorded and played back so as to hear all of its hidden and potential details, uncovering the inner dynamic nestled inside every instant or particle of sound” [19].



Fig. 7. Katsura Isobe dancing the 3D creation scene in *UKIYO*, Sadler's Wells 2010 © DAP-Lab

In the final work, Isobe is clothed in a Ginkgo dress, a simple tunic with carefully preserved leaves delicately worked into its net of fine silk tulle, and incorporating *Eowave Eobody 2HF* sensor interface. She immerses herself in this imaginary world she creates whilst simultaneously activating a new visual and sonic dimension for the audience members to enter through the data she generates using her sensors (Fig. 7). Sound/image synchronicity and causal or semantic forms of relationships between image and sound dissipate, for Isobe no longer inhabits a world of scrutinized leaf sounds but instead a world of noise music – a pitch bending, dense sonic collage of samples, stretched and compressed multi-layered frequencies, deep and low down drones vibrating the space. Rendered sounds create an extension of the sound environment of this virtual and evolving world. Audio samples/recordings for the Creation Scene sought to reflect each evolutionary section of a world forming – the cracking earth, growing trees, inhabitation and so on. Recorded sounds of church bells ringing somewhere in the distance hinted at a population rooted on the ground, but once stretched out over many minutes, all original meaning held within these sounds was gone, replaced by high pitched and airy abstract sonic textures of the sky. Data is sent via one of the sensors to a dedicated laptop running Max/MSP for the real-time manipulation of the sonic landscape, whilst the other sensor generates data for the visual realm. Antonio Damasio, in his writings on organisms (bodies and brains), discusses internal interactions and external sensory stimuli of the organism where interactions extend into the environment, stressing the importance of the conscious body in such contexts, the body that is aware of its own emotional state for flexible response based on a particular “history of interactions with the environment” [20]. This acute sense of bodily self-awareness and alertness can be observed in Isobe, who is trained to work with systems and sensors (Fig. 8), and listens through all her

sensory channels, perceiving through her entire body, her movements often animal-like, suspended somewhere between the rhythmic and the arhythmic as she navigates real and virtual spaces.

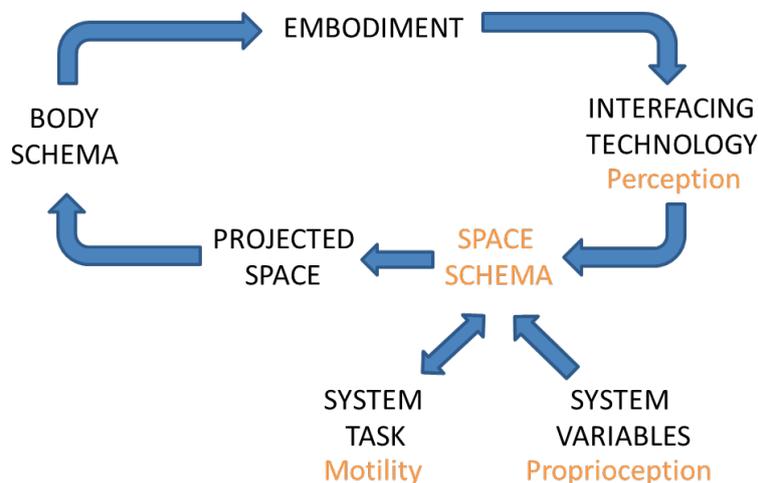


Fig. 8. The Space Schema connections for Creation Scene. Diagram provided by Doros Polydorou © 2011

Our 3D designer, Doros Polydorou, states that:

“Perception comes in the form of raw data from the performer... The embodied performer, embedded with technology capable of digitizing his or her inputs, a ‘body-in-code,’ extends his/her form with interfacing technology (e.g. wearable sensors or camera vision systems) and releases both consciously and unconsciously data signals which are being received by the system. These signals, which are then forwarded to the space schema, can tell the system sets of information such as the location of the performer in the physical space, movement patterns and movement intensity. Furthermore as the physical body and the physical space are now interconnected with the virtual realm, the performer can interact directly with objects from the virtual space. By using a variety of sensorial instruments directly on the performer’s body, acting as interface devices actuated by movement, movement quality/effort or touch, he or she can make a tree grow with a single raising of the hand” [21].

Throughout the scene, crowded by the audience which amplified the intensity Polydorou describes, Isobe’s presence seemed diminished while the affect of her gestures on the virtual world grew disproportionately with each seed that she planted. Other important characters in *UKIYO* investigating aural and visual aesthetics and how these can be shaped by drawing the audience into closer proximity and visceral experience of *sound wearability* in performance are SpeakerWoman (Fig. 9) and HammerWoman (Fig. 10) both performed in Act I by dancer Helenna Ren.



Fig. 9. Helenna Ren as SpeakerWoman wears pvc trouser suit, shin pads and foam asymmetric hat and carries martial bo with 20W suspended spherical loudspeakers. *UKIYO*, KIBLA Media Arts Center 2010 © DAP-Lab



Fig. 10. Helenna Ren as HammerWoman wears lycra all-in-one body, necklace of tiny speakers and hinged polypropylene prosthetic arm with integrated bend sensor, eyelets and lacing feature, talon extended hand clutching hammer. *UKIYO*, Sadler's Wells 2010 © DAP-Lab

Conclusion

The project described here does not just evoke a design practice that utilizes interactive media technologies. It is essentially an exploration of design concepts becoming visible and audible, where technology is manipulated to emphasize the importance of the aesthetics/metaphysics of performance. We prioritize the relationship of the aesthetic to the technical in the creation of audible wearables, seeking to involve the audience in a narrative landscape inspired by the Japanese *ukiyo-e* tradition. The sensual material design of the garments links the tactile (the

instrumental musical quality) to the acoustic perceptions we gain of the characters. At the same time, this aesthetic direction for the design is completely integrated with the different cultural performance techniques and styles the performers bring to the dance or, as Olu Taiwo, another dancer in the ensemble, would call it, to the “physical journal” of the performance artists who participated in the creation of *UKIYO*’s mixed reality.

References and Notes

Unedited references as provided by the authors

1. "Dance is always a temporary drawing, it disappears when the movement ends. So the drawing can be written over, or rewritten at any time. Each performance has to be drawn again..." Belgian-Moroccan choreographer Sidi Larbi Cherkaoui's comments have often been cited, see <www.dansfestival.com/2010/bio-sidi-larbi-cherkaoui.html>. For a video excerpt, see <www.youtube.com/watch?v=od_9QhMjJK0>. Videos of works by Forsythe, Bausch, and butoh dance are readily available online. For the expanded choreographic context, see Birringer [5].
2. S. Doruff, “The Tendency to ‘Trans-‘: The Political Aesthetics of the Biogrammatic Zone,” in M. Chatzichristodoulou, J. Jeffries and R. Zerihan (eds.), *Interfaces and Performance* (London: Ashgate, 2009), pp. 121-40.
3. The multisensory stimuli within such a dramaturgy offer rich grounds for research into synaesthetic perception/cognition in interactive environments; our ensemble initiated a new project on “Immersive Environments for Trans-sensory Interfaces” with Brazilian partners in 2011, particularly addressing empirical questions of audience’s aural perceptions and behaviors in such kinaesthetic installations.
4. In discussing movement in connection with specific choreographers and the techniques they use with dancers, one might mention that Forsythe has collaborated with Japanese fashion designers such as Miyake, Yamamoto and Kawakubo (video footage of this was featured at the Barbican exhibition “Future Beauty: 30 Years of Japanese Fashion” [2010]); the role of costume design in Japanese dance is also credited in S. Fraleigh’s recent book, *Butoh: Metamorphic Dance and Global Alchemy* (Urbana: University of Illinois Press, 2010), pp.56-61.
5. J. Birringer, *Performance, Technology, and Science* (New York: PAJ Publications, 2008), pp. 214-32.
6. M. Polanyi, *The Study of Man* (Chicago: University of Chicago Press, 1957), p. 25.
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10. A. Artaud, *The Theatre and its Double*, trans. Victor Corti (London: One World Classics, 2010), pp. 37; 58.
11. C. Kelly, *Cracked Media: the sound of malfunction* (Cambridge, MA: MIT Press, 2009). *UKIYO*’s narrative and historical reference systems are layered, and combine images and physical gestures reflecting, for example, Russian engineer A.K. Gastev’s motion and strike pressure experiments with workers wearing prostheses; sound references to Khlebnikov and *zaum*; with black and white film noir scenes inspired by C. Kracht’s novel *Ich werde hier sein im Sonnenschein und im Schatten* (e.g. we filmed scenes where an African engineer explains the plasticity of oral/aural languages to the military; other film animations reference Hokusai and Japanese sci-fi manga and anime). For a film excerpt, see: <http://people.brunel.ac.uk/dap/Ukiyo_Sadlerswells_movie.html>..
12. Sandy Finlayson (sound artist, member of DAP-Lab) in email correspondence, June 2011.
13. For an insightful discussion on the vibrational qualities and physicality of sound, see B. LaBelle, *Acoustic Territories: Sound Culture and Everyday Life* (New York: Continuum, 2009), pp. 133-137.
14. N. Collins, *Handmade Electronic Music: The Art of Hardware Hacking*, Second Edition (New York: Routledge), p. 73.

15. See S. Ruiz, "Barong Analog wearable synths and other projects involving sound and performance," <<http://www.stanleyruiz.com/index.php?/media-arts/barong-analog/>>, last accessed 21 June 2011.
16. Kelly [11], p. 34.
17. O. Ben-Tal & C. Wilkins examine their ongoing collaborations including Ukiyo, in "The embodiment of music/sound within an intermedia performance space," ARTECH 2010, 5th International Conference on Digital Arts, 22 & 23 April 2010, School of Architecture, Universidade do Minho, Guimaraes, Portugal, pp. 19-24.
18. D. Polydorou, *Immersion and Interaction: Creating Virtual 3d Worlds for Stage Performances*, (PhD thesis, Brunel University, 2011) discusses the creation scene in detail from the perspective of the 3D designer.
19. B. LaBelle, *Background Noise: Perspective on Sound* (New York. London: Continuum, 2007), p. 26.
20. A.R. Damasio, *Descartes' Error: Emotion, Reason and the Human Brain* (London: Macmillan, 1994), p. 138.
21. Polydorou [18], pp. 60-61.

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