Retro-Engineering: Wearable Sound

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Interaction and graphic phantoms

Around the turn of the millennium reviewers began to take note that the marriage of dance and technology had produced a few significant stage works which startled audiences and drew attention to *digital dance* and *interactivity* in the theatre. Projections of virtual dancers appeared on screens in Merce Cunningham's *Hand-drawn Spaces* and *BIPED*, emanations or graphic phantoms that fluttered in space while the real dancers performed the choreography on stage.[1] In *Ghostcatching*, Bill T. Jones's animated figure danced a virtual solo, at times alone and then with multiple copies of "Jones" spawned from the data extracted (motion-captured) from the performer's body. The virtual Jones was heard talking, grumbling and singing, which gave the animation an eerie sense of surreality. In Trisha Brown's *how long does the subject linger at the edge of the volume…*, the projected graphic creatures interacted with the dancers on stage as if drawn to the human bodies and their movement gestures. The jagged geometric creatures as such (irregular triangles, squares, rectangles and lines) remained indeterminate images hovering between abstraction and figuration, unaware that they were acting. Yet the graphic phantoms, sometimes referred to as digital doubles, have become supplements, algorithmic emergences allowing us to reflect upon the mediations between analogue and digital systems, between bodies and technical beings.

While the growth of computer-based art and the paradigm of interactive interfaces are accepted phenomena in today's art world and everyday technological culture, the genre of "digital performance" is still very adolescent, barely defined and thus in need of historical and conceptual underpinnings.[2] It may also have already run into limitations that concern both compositional practice (e.g. the dramaturgical placement of interfaces for trained performers in a stage work) and the participatory promise of interactive design for audiences (who have not trained with the interfaces or cannot intuitively navigate the programming protocols and compose phantom content). On the artificial intelligence front, engineers are working hard towards instilling learning capabilities into their creatures.

The question whether participatory design is actually achievable or desirable in stage-centered performances was recently addressed by the *Pixelspaces* symposium "Re-Scripting the Stage" at the 2011 ars electronica:

> Interactivity and participation have been core elements of media art since its very inception. In performances and installations produced in recent years, more or less successful attempts have been made to put this immanent interactive element in the hands of the audience attending the performance –for example, through the use of various tracking technologies. In addition to the attendant problems associated with people's inability to grasp the connection between cause and effect, the process of enabling audience members themselves to generate sounds or visuals often quickly results in the exhaustion of the performance's aesthetic, emotional or intellectual quality. In the spirit of our contemporary Age of Participation in which social media and a digital lifestyle set the tone, the panel will conduct a transdisciplinary discussion on innovative participatory scenarios for the multimedial stage-audience context, as well as approaches of how to develop and evaluate corresponding interfaces suited to such artistic works that will be produced in the future (from the *Pixelspaces* program).

If it is euphemistic to speak of the "age of participation," it is certainly pertinent to inquire about the aesthetic, emotional or intellectual quality of performances that deploy technological interfaces to generate new approaches and methodologies for bringing interaction and audience participation into stage-based performances. In this essay, I will describe a case study – the mixed reality installation *UKIYO [Moveable Worlds]* – that can illuminate some of the problems inherent in interactional design, but I am also proposing to draw historical connections to earlier moments of technoscientific and artistic research influencing a wide range of machining architectures and interfaces between the body and analogue technology that are the subject of this book.

Trackback 1: Experimentation through Visualization/Vibration

Since the performer relations to technologies are of critical importance here, my investigations will always keep performer techniques in the foreground. They are the main motivation for my artistic work, and a stronger focus on performance techniques is also important for critical reflections on how design and capture technology (e.g. audio and camera recording, editing, motion capture) have evolved over the last hundred years, if we recall early modernist experiments with sound instruments and moveable design (the *intonarumori* of the Futurists, the motion designs of Schlemmer's Bauhaus dances, or the constructivist experiments of the Russian avant-garde around the time of Malevich's collaboration with Khlebnikov, Matiushin and Kruchonykh on *Victory over*

the Sun) as well as early developments of chronophotography and film (Marey, Méliès, Muybridge, Vertov, Eisenstein).

The more sustained lineage of dance on screen and multimedia performances which incorporate projections of animations and motion pictures offers a background for understanding the compatibility between live dance and the moving image, between the polyrhythmic components of movement and the fluid digital behaviors of images and sound. Intelligent creatures, as Marc Downie programmed them for Trisha Brown's stage choreography mentioned above, are technical beings which display behaviors that are read anthropomorphically, but they are of course digital motion graphics, not bodies. In *Dancing Machines: Choreographies of the Age of Mechanical Reproduction*, Felicia McCarren's stunning historical study of the close connection between dance and the developing technology of the cinema provides ample evidence of the many convergences of movement (performance) and machines during the industrialization of images. However, her critical focus on early machine culture (and the Taylorist optimization of labor in the work place) also helps to situate "performance" and animated images within the context of work-science and studies on the economization of movement, designed to increase worker output and to distill the movements of the body to an energy-efficient productivity.[3] In her chapters on "Economy of Gesture" and "Choreocinema," she explores how the preoccupation with movement implicated dance in the field of work-science and the development of early cinematic technologies, pointing at Étienne-Jules Marey's time-motion movement studies using sequential chronophotography. She also unearths a fascinating poster from 1896 advertising the then-new technology of the cinema: a Loïe Fuller-esque dancer figure spreads her voluminous skirts providing a surface for the projected image of a train. Fuller's own innovative electric performances – with light projected onto her whirling fabrics in *Serpentine Dance* – represent an early example of "wearables" (and wearable technology) needing to be recuperated when we discuss today's smart clothing and interaction design for smart textiles.[4]

McCarren's account of how cinematic precursors made the visual analysis of the components of movement possible also made me re-think the adoption of motion capture technology for digital dance I experienced in my studio around 2001 when computational mapping of gestures allowed breaking movement down into bits of assimilable and manipulable data.[5] Both the neuroscientific context of analyzing sensorimotor activity, providing new phantoms of movement through visualization techniques such as functional magnetic resonance imaging (fMRI scans), and the newly available figure animation (LifeForms, Maya, 3D Studio Max, Character Studio, etc) and

real-time interactive software (Max/Msp, PD, Isadora), induced our ensemble to look back at earlier movement-sensitive machines and perceptual techniques scrutinized by media-archaeology studies. For early rehearsals on *UKIYO* we looked especially at Siegfried Zielinski's excavation of Aleksej Kapitanovich Gastev's engineering experiments in his Moscow Institute at the beginning of the 20th Century.[6] Gastev used early graph-writing machines that could quantify motion, and two images stood out which we used for our rehearsals, one showing the measuring of a woman worker with a prosthetic arm wielding a hammer, the other displaying a diagram of the strike force of the hammer.

The force of a movement here takes visual form (an analogue representation), plotted into dots and lines, curves and trajectories, seemingly abstracted but also visibly drawing a temporal event, curves of movement that also evoke the kinegraphic and kinesiological method that Rudolf von Laban would later use in his studies of human movement, or that Oskar Schlemmer, following Kandinsky, used for his drawings and choreography of "Figure in Space'" and "'Space Dance'" – compositions which consisted primarily of dancers moving from point to point and assuming pose after pose.

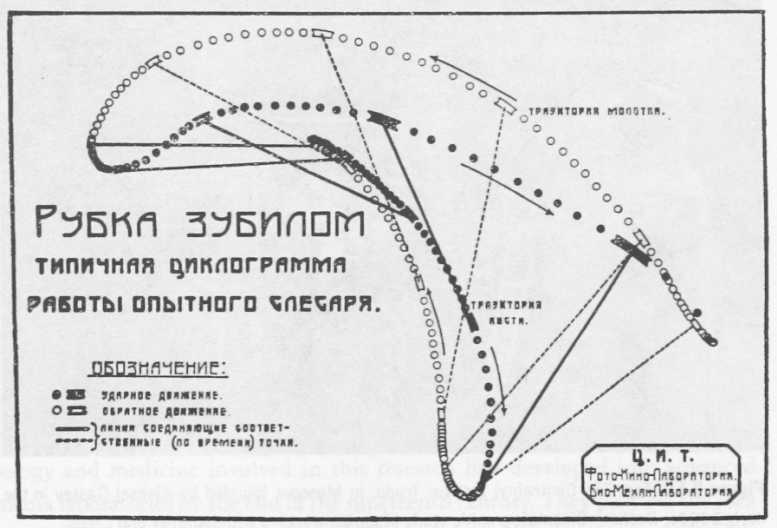


Fig. 1 Top: Strike and pressure: A demonstration of the chronocyclographic method in Gastev's Moscow Institute (C.I.T) by a female worker with an artificial arm. Two photophorescent dots are fixed on the hammer so that the movements can be recorded photographically as curves. On the right side of the picture an assistant holds a measure to provide a scale. Bottom: Diagram of the movements of a worker wielding a hammer. Photos: Reprinted courtesy of Siegfried Zielinski.

While Erin Manning argues that we always feel or perceive whole activities of undifferentiated experience, experiential duration that is not divided into actual objects, the method we see depicted in Gastev's diagrams or in Muybridge's rapid-movement stills indicates discrete "frames" of perception, measures *of* movement and not *in* movement, and thus a representation of movement in its discrete elements becomes possible, and succession of (sometimes imperceptible) movement shapes can be made visible. The diagrams trace movement analogous to drawing movement, but they also function in the sense of early analogue technologies of recording, for example when phonograph records were created to reproduce sound through the vibrations made as the needle moves along the grooves on the record: the grooves are analogous to the sound waves originally produced. Edison's first recording of the sound of his voice was made by the indentations the vibrations of his voice made on a sheet of paper passing over a rotating cylinder. Again, the indentations on the paper were analogous to the original vibrations, and when we studied Gastev's diagrams we became interested in asking how movement and gesture could be made by audiophonic instruments in dance, embedding an analogue process visibly and sensually into the environment of our current interactive technological systems, cracking the computational parameters a little, or subjecting them to the corporeal, and thus more unpredictable eventfulness and dexterity, especially as we had planned to focus on body-worn (wearable) devices, garments and accessories for kinaesonic choreography. The auditory and synaesthetic vibrations of movement, and the enhancement of the vibrational sensing body in movement, became the core of our research.

At the same time, *UKIYO* [*Moveable Worlds*] was a transcultural project – collaboratively developed with butoh dancers and artists in Japan – curving away from the digital dance and specifically orienting our movement explorations towards butoh and the deceleration of gesture, thus attempting to experience the body's floating power, morphing down, coiling and going inside (Hijikata called such apparent regression the frog's-eye view), shedding the logic of lines, shapes and directions in space, and integrating the floor/ground as a continuum of the space, *becoming* creatures (an animal, an insect) and fantastical characters rather than merely projecting their doubles. "Floating" became the conceptual metaphor for our installation, inspired by Hokusai's drawings and the Japanese *ukiyo-e* tradition of the Edo period, especially the landscape prints, the smaller drawings (*ryakuhitsu*) of working men or women showing industrious activities, and the "actor prints" depicting portraits of well-known Kabuki actors. The Japanese art historian Muto Junko has suggested that these prints were created in direct reference to the actors' appearance in particular scenes that could then be recalled and re-heard by audiences who knew the performances of characters (and the acting style used by actor families who passed down the style from generation to generation), thus making the prints "audible." Junko speaks of "hearing the prints" depicting a scene voiced and danced to *joruri* music.[7]

In order to create our audible moveable world, we worked with three primary dimensions; (1) an intricate *hanamichi* movement environment (spatial design); (2) movement of sound (from macro to micro levels) involving retro-engineering of sound devices to be worn on the body; (3) movement images (projections of digital objects and virtual spaces). Floating the audience inside the performance space implied dissolving any borders between stage and auditorium. We used this concept along with the ideas behind our wearables (intelligent garments) developed in previous design-in motion performances.

Wearing Projection / Sounding Gestures

Audible movement and sound creation through the design of wearables challenges assumptions about musical composition as well as choreography. New mobile performance technologies present significant provocations to theatrical conventions and to the dancers who are asked to generate or transduce sound as well as work in an augmented environment that responds to them. The design methods I want to sketch here also have implications for the intimacy and resonance of relationships generated in interactive environments that draw the audience inside the action, not

necessarily through an overt emphasis on any analogue or digital technologies deployed in the *mise en scène,* but through the specific aesthetics of audible dance, with its gestural and spatial communication forms and its emphasis on the costumes.

The first aesthetic choice I made in *UKIYO,* collaborating closely with fashion designer Michèle Danjoux, was to think of each performer developing a particular sound character that would have its own space (on one of the five *hanamichi*) and distinct costume. Secondly, the wearables, worn as garments or accessories on the body, offered the possibility of thinking of the dancers as instrumentalists, playing sound but also moving through it and with/along projections (our suspended screens and spheres) of silent images. Finally, our engineering of the audiophonic garments and accessories would emphasize analogue techniques and the subtle, visible hardwares that were operated in full view rather than below the visible threshold of numerical software processing and systems of "virtual instruments."

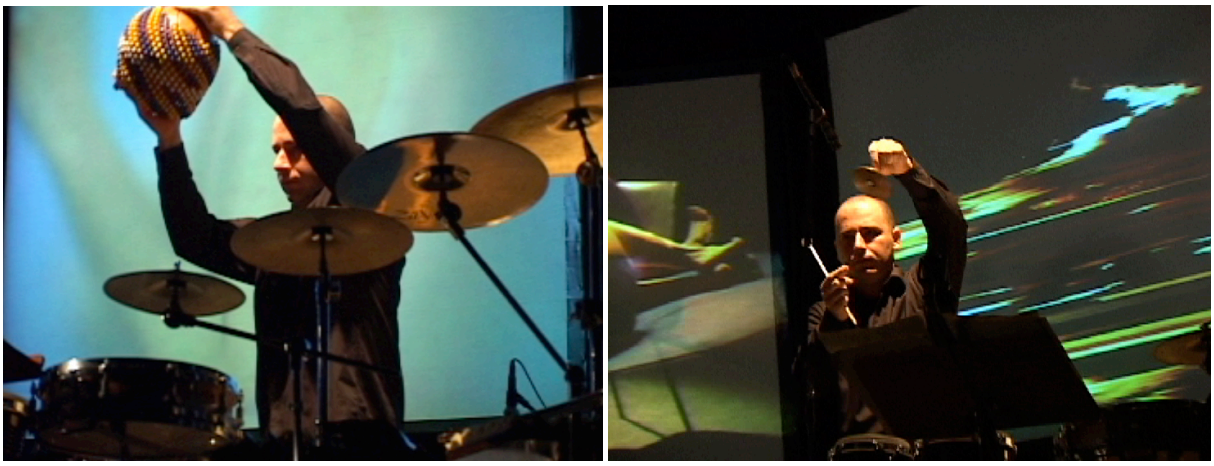
To a certain extent, *UKIYO* takes the idea of Loïe Fuller's electric dance literally, using the fabrics of costumes as projective and reflective/resonating materials but also integrating small acoustic instruments into the wearables. In a previous production, *Suna no Onna* (2007-08), our ensemble had experimented with the concept of "wearable space," transposing visual characteristics of the dancers and their wearables onto the projected environment – the landscape of dunes that framed the action. The particular physical form of the garments, existing in the real world, influenced the movement choices and actions on the material level, and the designer (Michèle Danjoux) was concerned with the cut and the fabrication, the detailing, finishes, overall silhouette statements, the structures of the garments and how the bodies behaved in them, i.e. how they were worn/performed and *choreographed into movement*. On the iconic level, the wearables were transposed to the screens where they morphed into the graphic images and animations – artificial spatialities and *anime*-like "decorative" surfaces that were clearly digital. We used suspended paper scrolls which had gaps between them, small intervals that broke the seamless landscape and allowed it to breathe as the (seated) audience was invited to perceive the dancers actuating the projected images through the slow or sudden displacements of the real.[8]

Fig. 2 Katsura Isobe with the morphic SandCoat and fish skin alone in the digital dunes landscape. Photo © 2007 Hans Staartjes

In the new work, we wanted the garments to project *sound*, and the choreography to be directed at *sounding gestures* with the audience intermingling and in close proximity, and this required a considerable re-orientation, a shift from digital processing, and reliance on sensortized garments and MIDI transmission of kinetic/physical displacements (i.e. through the accelerometers), to analogue techniques that worked through micro- and macro-sonic articulations. The audience was invited into the interior, immersive environment. In the remainder of this essay, I will address these kineaesonic performance techniques and describe some of the characters and wearable designs.

I begin with Gastev's strike and pressure diagram, depicting the movement curve of a woman's arm wielding a hammer; what is remarkable about it is the artificial/prosthetic arm (the second arm is not visible), and the woman's attire and facial expression (she is not dressed as a worker but wears a white gown, aware that she is undergoing a scientific test). Her gestures record – not phonographically but chronocyclographically– her (missing) arm now an apparatus to execute a mechanical operation over time, her sensibilities attuned to the sensorimotor degrees of freedom her prosthesis allows. Her "choreography" suggests repetition, and the diagram reflects – in Laban's terms – effort-shape. When we re-enacted the scene, we quickly came to think of her movement also as a percussive motion, the strike force creating sound on the surface where the hammer meets resistance, and creates reverberations. We coupled the tests with a percussionist

whose movements we recorded, and for a while we only worked with the hammering sounds as our "score" – the percussive rhythms oscillating and mingling with breath and the exertions of movement. I also brought film footage to the studio from a concert I had participated in, and our ensemble carefully observed the body language of the percussionist, Sérgio Aluotto, with whom I had worked in Brazil.



Figs 3&4. Sérgio Aluotto in *Corpo, Carne e Espírito,* composed by Paulo Chagas, with digital scenography by Johannes Birringer. FIT-BH Festival, Klauss Vianna Theatre, Belo Horizonte, Brazil, 2008. Photo © DAP-Lab

The virtuosity of the percussionist's work was evident, as he moved between a vast array of different, large and small instruments. Some months later we asked Olu Taiwo, who plays the role of African Kommissär (in the subtextual scenario we adapted from a recently published sci-fi novel about the long drawn-out wars of socialist revolutions in the 20th century stretching from the far East to far South-East Africa), to develop the opening prologue using a small Nigerian speaking drum.[9] We paired the real percussion and Taiwo's whispering *Sprechstimme* with an imaginary series of sounding gestures that could not be heard, this time performed choreographically by Yiorgos Bakalos in the role of Russian engineer Brashinsky. From the opening moments of *UKIYO*, then, we invite our audience inside the space of the criss-crossing *hanamichi* to listen to the dance and to move around, freely, to follow the sonorous movement and the unfolding of the aural worlds. Bakalos wields two claves (later replaced by a wooden bokken – a martial arts instrument – and, during the *Entr'acte,* by a boom microphone with which he "samples" audience breath as well as the sound of silent images projected onto the suspended screens). He uses his instruments in a suggestive metaphorical manner: they are real and not real, at the same time, but become his accessories as an engineer performing apparently operational

tasks in an environment marked by a more metaphysical butoh sensibility directed at an existential and transformative, non-dualistic awareness of body-mind manifested through dance.
All the female characters in UKIYO explicitly draw attention to microperceptual qualities

Fig. 5. Yiorgos Bakalos performing in opening scene of UKIYO © 2009 DAP-Lab

of movement, carefully situating their sensing bodies into subjective, experiential processes during which they discover the body's – and the body-costume's – potential to become sound.
Their characters build *UKIYO's* multi-dimensional textures of colour, rhythm, and musicality. The alternating solos or overlapping duets, enacted in different positions of the five *hanamichi,* require quick shifts of perspective or concentration from the visitors in the space, but the dancers often deliberately slow down the tempo to "gather" in those closest to them, drawing attention to body and instrument, to the body-as-instrument. The crowded space, at the same time, does not have a centre or particular directions into which sound and gesture are projected. The sound is constantly radiating, and hearing-seeing is complicated by the absence of a distinction between center and periphery, interior and exterior, and of course the acoustic architecture of the building is part of this ecology of sound-movements and audition.

Fig. 6. Olu Taiwo (front) and Yiorgos Bakalos (back) dancing amidst the audience in *UKIYO*, Sadler's Wells 2010 © DAP-Lab

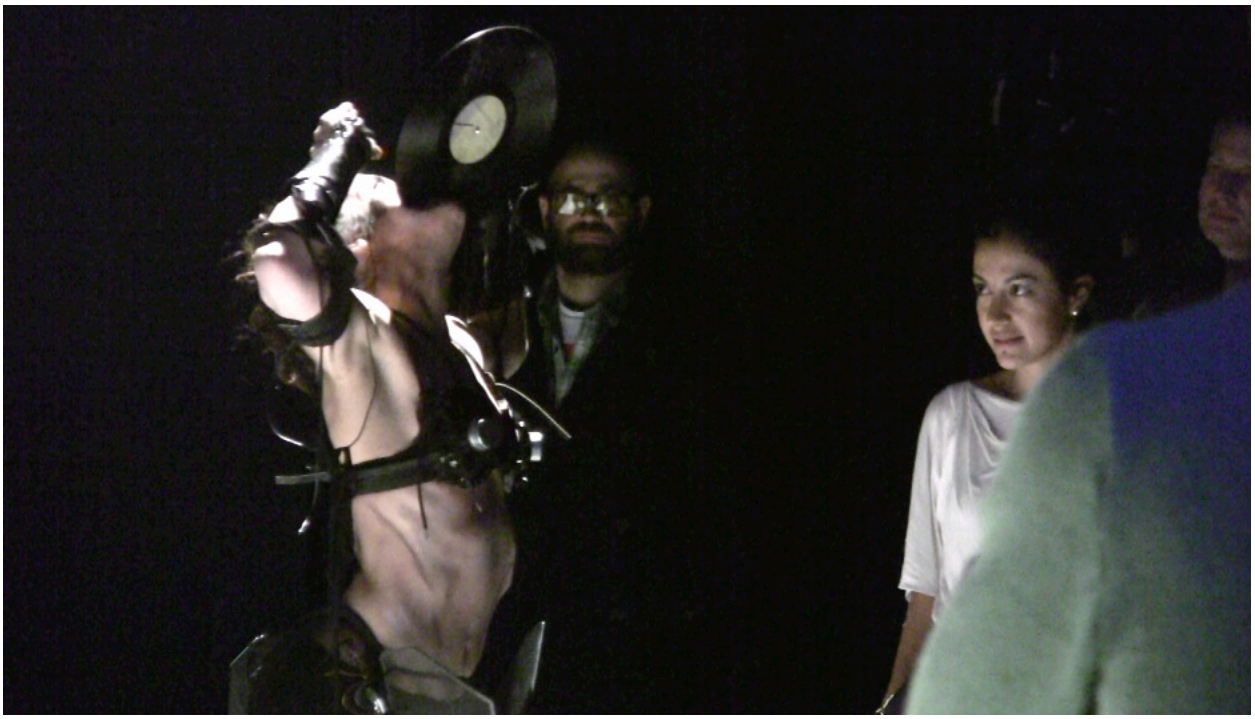


Fig. 7. Anne Laure Misme as WorkerWoman with dysfunctional speaker bra, mini metal cage crinoline with tiny speakers, ostrich leather armlettes, rag wristbands, leggings, transmitter, contact mike and old vinyl record. *UKIYO*, Sadler's Wells, 2010 © DAP-Lab

Having said this much, the choreographic installation of *UIKIYO* can now be approached more closely from the points of view of analogue performance and retro-engineering, tracking back

from the digital world in which we have lived at least since the 1980s when digital recording became mainstream (and stereo headphones, sound diffusion systems and cinematic dolby surround sound are common place). One wonders whether it is even possible to go back in history and evoke acoustical/mechanical means of recording and playback (wax cylinders and lacquers), early analogue electronics (wire recordings), optical tracks on the first talkies, the earliest uses of tape? Are the anachronisms too perplexing? Some sound artists, however, are doing precisely this; Ray Lee's extraordinary exhibition of a fictive "Ethometric Museum," first performed at the Museum of the History of Science in Oxford, and then at the 2011 BEAM Festival, Brunel University, recreates strange machines that generate tones and unusual harmonic frequencies or portray unknown purposes and hidden worlds of electro-magnetic radiation. In Japan, the noise artist Masonna has become known for performances that use analogue feedback as a central device, and the young musicians of Tokyo's Open Reel Ensemble retool old reel-to-reel tape decks to perform with exposed magnetic tape. Nam June Paik used tape and vinyl in his early performances, and Christian Marclay continued to use turntables after they had become obsolescent. Among audio engineers, interest in tape and vinyl persists, and the issue of analogue warmth or harmonic and non-harmonic distortion is often discussed with particular passion, taking us back to the phenomenal and visceral, the grainy shades of an original sound and, for example, the attendant metaphysics of the speaking body in what Roland Barthes calls "grain of the voice."[10]

But breathy, noisy materiality always enters recording and amplification through devices, and there are probably many factors that would determine individual warmth, color and character, ranging from instruments, musicians and performances, through the rooms and mics used, to the preamps, processors and effects – and the way in which they are used. When we speak about analogue sonorous qualities, we are generally referring to the character that the analogue processing/recording equipment and the recording medium add to the sound. For our performers, therefore, "playing" the wearables meant entering into the paradoxical space between acoustic sounding (the physical vehicle of music and sound) and the effects of transmission and amplification on the psychological phenomena of perception, the latter relating to discrete sound objects (*objets sonores*, as Pierre Schaeffer defined them in his *Treatise on Musical Objects* in the mid-1960s) as well as the overall sonic accretions and reverberations in the space (affected by size and shape of the building, the physical materials in it, the presence of people moving about, etc., and these are phenomena not of Schaeffer's "sound in itself," but of Alvin Lucier's play-back experiment in *I am sitting in a Room*).

When we began to rehearse with the wearables, integrated devices and hand-held instruments, we looked back at *musique concrete* and realized that we had entered into the ambivalent terrain of audio art, radio and early media theory, as Schaeffer's sound objects and acousmatics pointed toward abstracting sound from acoustic instruments and the source (the musician whom we see playing a particular instrument that generates sound), fragmenting the causal coherence of a sound event. Working with sounding gestures returns us to sources and to aurality at the same time, since gestures are both intentional (subjective) and project outward into space, away from subject or object. If we were to associate our butoh and Kabuki inflected performance styles with Artaud's spirited invocations of ecstatic intensities (which he glimpsed in the Balinese dancers he observed in 1931), of "complete, streaming naked realizations" of the poetry-in-space he envisioned, then the kinetics of movement – or the kinaesonics – point beyond musical objects to multiple levels of "animated hieroglyphics" – vibrational pulsions and transformations in space and time, gestural diagrams or ideograms that are propulsive, extending even beyond the body (without organs) into the telepathic.[11]

Fig.8 Katsura Isobe as RedMutant with partial corset and one-sided paillette sleeve, performing in *UKIYO*, KIBLA Media Arts Center, 2010 © DAP-Lab

It is not contradictory, then, to think of our corporeal music theatre as becoming animated with hieroglyphics, with colors and textures evoking timbres, softly and abstractly soaring when

Katsura Isobe (her character is called RedMutant), in fragmented red leather corset and asymmetrical sleeve, rustles the air with waves of her arm, conjuring invisible ghosts, her feet tapping the floor with tiny steps, or when Anne Laure Misme (WorkerWoman) wipes the floor with her old vinyl record, flapping it around until it warps and crackles, then sweeping her microphoned finger across the grooves and beginning to build up a cacophony of noise as if we were in a factory of heavy machines all pounding away at different rhythms like in the worker underworld of Fritz Lang's *Metropolis*.

Figs. 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

Helenna Ren's SpeakerWoman now enters quietly, she is dressed in an all white costume that is modeled after early 60s Cold War fashion (protective spacesuits) but also alludes to workers in rice fields, as she carries a wooden bo across her shoulders from which dangle two spherical speakers, the conical forms swaying gently as she walks across the *hanamichi*, dropping rice grains onto the floor. For a few moments, all we hear are the grains falling, and then high frequency sounds begin to sound from her speakers as she moves forward and backward, the wires stretching to the end of the runway and the 5.1 Channel AV amplifier. She begins to swing the speakers, and as they rotate, the sound travels in various directions, growing softer and more intimate, now resembling spectral echoes of bells and percussive music used in Kabuki performances. Her sound travels from her locational speakers outward into the direction she moves, whereas Misme's amplified and distorted noise is diffused from the surround speaker system and subwoofers. Composer Oded Ben-Tal, who worked with the dancers on these scenes, added a "postdigital" effect at the end of Misme's cacophonous noise performance by letting the volume of her amplified live recording fade to a bare minimum, at which point we hear a locked groove repeating

ticks and clippings from an eerie “drum” pattern originally taken from bandoneon tones.

Near the end of Act I, and again in the second Act, Caroline Wilkins enters as InstrumentWoman onto a *hanamichi* where her bandoneon is placed; she unfolds it like a fan, first working only with the breathing sounds it makes as the instrument contracts and exhales, her fingers tapping the wooden frame and then low frequency sounds begin to be heard, amplified by contact mics. But Wilkins also handles her instrument as a ritual object, a strange tool that becomes a crown, an adornment and an accessory to body – or a body coming alive like a fabric she wraps around herself, a bulky kimono or a mask, stretched out excessively and impetuously, composing a grotesque contour around her.

Fig 10. Caroline Wilkins as InstrumentWoman, performing with bandoneon, in *UKIYO,* KIBLA Media Arts Center 2010 © DAP-Lab

In Act II Wilkins performs away from the bandoneon, now lying on the floor, and as she re-enters with a red fan and dressed in a golden pleated costume (alluding to the sun goddess Amaterasu), she uses her voice intoning “mad” shrieks and hisses, *zaum*-like glossolalia of non-sensensical words which fuse with the larger collective sphere of kinaesonic projections (all dancers are in the space simultaneously in Act II). The sounds created by the dancers and the mad goddess travel and fluctuate across space and become intermingled with amplified and processed sound, echoes, noise, and aleatory elements (just as Cage had accepted such phenomenal multiplicities into composition, i.e. in the total sound spaces of his *Imaginary Landscapes* and *Variations*).
On a technical and aesthetic level, Wilkins’s analogue performance is exemplary for this

production; she wears the Amaterasu dress, small speakers on her spinal column, a voice microphone and contact mics on the bandoneon, and she is wired to the amplification system – the cables are visible to all. After close observations of Wilkins playing her instrument in rehearsal,

Fig.11. Caroline Wilkins in rehearsal, performing in golden ”Amaterasu” bandoneon dress with neck cape and spinal speaker and wiring. *UKIYO*, Artaud Performance Center, 2009 © DAP-Lab

noting how her body had evolved with the bandoneon, Danjoux’s design portrays the inseparable connection between Wilkins and her bandoneon. She had grown with it over time, her body and muscles knew it intimately, and her deep awareness of the instrument made its playing seem effortless (despite its weight and bulkiness of shape). The garment she wears in Act II evokes a further evolutionary state created from the material characteristics of the instrument, its structures, textures, colours and other design elements such as pleating and folding. Dress and bandoneon thus breathe together and fuse, the playing of the instrument becoming a folding and unfolding of the physical and energetic features resulting in a poetic metaphor for the unfolding of the hieratic persona of InstrumentWoman.

Her gestures and voice also have a rippling effect on the others dancers in Act II, as InstrumentWoman mediates the manga characters (avatars performing in Second Life, projected onto the screens) floating across the virtual worlds which hovered on the edges like comic strips from the childhood of 20th century character animation. Exploring the small voice of the birdcall coming from the speakers mounted on the spine of the neck accessory worn by her, Wilkins begins to call out to the other performers now crouching on their *hanamichi,* urging them to "learn" and re-enact the gestures of the anime characters. While we had initially imagined this scene as a (super)flattened animetic interaction, ironically transposing virtual *ukiyo-e* "actor prints" into analogue movement on stage, we decided to mute all computational interfaces and controllers to invert the data mapping.[12] Isobe, Misme and Ren are wearing bend and touch sensors with custom built and Eobody transmitters on their bodies, but our animetic scene remains largely

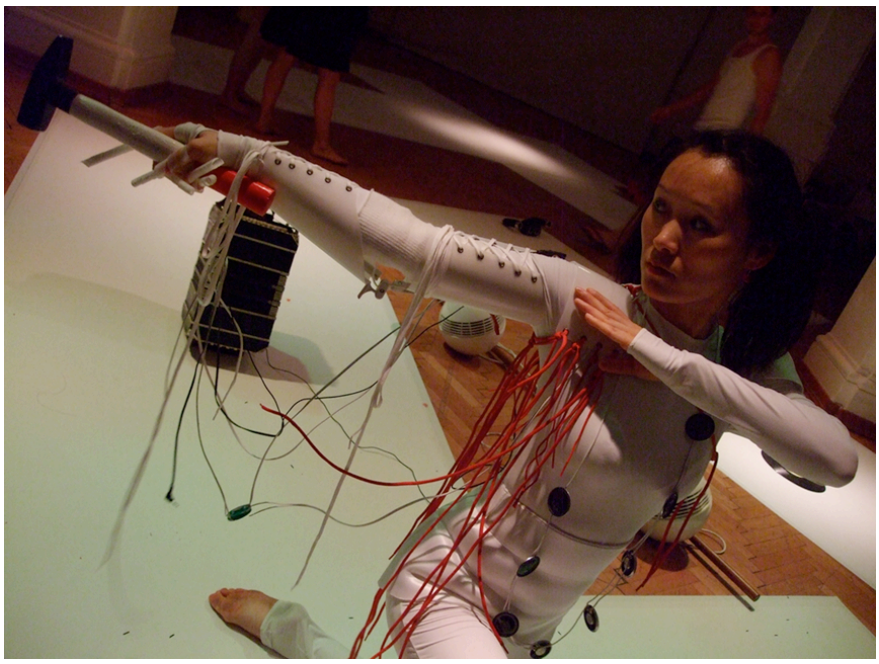


Fig. 12. Helenna Ren as HammerWoman wears lycra all-in-one body, necklace of tiny speakers and hinged polypropylene prosthetic arm with integrated bend sensor, eyelets and lacing feature, talon extended hand clutching hammer. *UKIYO*, KIBLA Media Arts Center 2010 © DAP-Lab

analogue throughout, as the sensor data were not mapped directly into sound or any visualizations. Rather, it was the projected graphics that implied an interactive affect on the dancers' gestures and behaviours, encouraging the audience to follow the rhythms and reverberations of physical actions in the space rather than identifying immediately comprehensible real-time relationships between gesture and sound. After months of technical rehearsals with sound-generating technology (MIDI, DSP, sampling, software synthesis) and mapping, the ensemble felt most comfortable with the electro-acoustic aesthetic, and the poetic complexity of the "plastic language"/oral landscape that had evolved, keeping our approach in spirit with the silent conversation between two screens

during the *Entr'acte*, when Officer Favre explains – through gestures and intertitles – the communicative system of the "smoke language" (*Rauchsprache*) to the Kommissär:

> Language is a collection of symbolic sounds, it originates in a cosmos of unrecognizable forms – which are, above all, never knowable.
>
> But please explain to me – how does the smoke language function?
>
> Well, we begin to speak what we think, we place it into the space. Then we can look at the spoken, we can walk around it, and finally we can move it. Since it exists, we can move it.[13]

This plasticity of aurality lies at the heart of our performance-installation, and we thus deliberately relinquished any overt reliance on direct interactivity dependent on software programs and matrixing of data. While the mapping of data to sound generation is common in contemporary digital intertactivity, such a system of mapping is aesthetically limiting in complex live performances where dancing with wearables and instruments – in a large-scale environment (compared to more static positions on a concert stage) – retains a kinaesthetic, visual and aural organicity which is weakened in audio computation processes (and binary code), especially if the dancer in interactive performance systems needs to pay undue attention to quantitative motion or acceleration/deceleration (i.e. learning how the bending of an arm with accelerometer attached generates a range of data values that can be mapped to control sound parameters). Again, using an example, we worked for several months with Helenna Ren (portraying her second character, HammerWoman) to explore how her gestures could be meaningfully funnelled to control pitch or timbre of audio objects (from simple wave patterns and phonographic bird sounds to fragments of her own sampled voice responding to Amaterasu's onomatopoeic words), but in the end we noted that direct mapping may bring us closer to Gastev's human factors research on strike pressure, but further away from the surreal poetic and child-like quality (*kawaii*) we sought in her character as she responds to the eccentric movements of the Japanese *anime* figures projected on the screens and intoned by Wilkins-Amaterasu. From the perspective of performer technique, Ren was much more concerned with adapting the "prosthetic arm" into the micro-movements and internal focus (listening in) we were developing together with the butoh dancers who had joined our ensemble in 2010. Dancing with wearables, thus, required the integration of the designs we engineered into the physical and perceptual processes, exploring the range of improvisatory interaction afforded by sensortized arm, microphoned finger or spinal speakers, becoming accustomed to moving with instruments and being wired to remote amplifiers, developing a heightened tactile sensibility to the

overall environment (with unpredictable audience movement behaviour) and the graphic phantoms projected onto the three suspended screens (two flat screens and one spherical weather ball floating upward from an air pump attached to the floor that could be activated by the audience members).

Fig. 13 Katsura Isobe [right] in organic Gingko leaves dress dancing the "creation scene" actuating 3D virtual landscape projected onto weather ball. *UKIYO*, Sadler's Wells © 2010 DAP-Lab

Kinaesthetically and proprioceptively, gestural interactivity with real-time environments (sonic or visual) can deflect both from the physical virtuosity or embodied expressiveness of the performer and from the unpredictable qualities and metaphoric richness of immersive aurality and moving scenographies (films, layered animations, networked video streams). Our audience was to experience "moveability" as a concrete virtuality that was not overdetermined or correlated, in the sense in which software mappings determine, for example, the principal directions and speed of images (forwards, backwards, slow, fast, freeze) or the pitch, amplitude, wave shape, and granulation of sound. Our spatial and lighting design aimed at a space both polyphonic and limitless, able to surprise the visitors through unexpected intimacies as the dancers moved with – and through – the audible microsounds they generated, while the total electro-acoustic space could also flutter with vibrational energies and low frequency sound engulfing the audience and performers, making the audible traverse the bodies' inside-outside boundaries, and counterpoint/decenter the moving images of our projected media.

José Gil has described the space of the body as "the skin extending itself into space; it is the skin becoming space."[14] The physical, we can infer, is not the digital; the computational space-time

differs from yet also repeats coordinates of human corporeal experience (by filtering data input), and it is understandable that a growing number of theorists now speak of digital embodiment and the "folding of digital code into the biological."[15] But the fold is a critical issue, a crease in perception sensibility, and in fashion design it is a common concern, not a baroque metaphor. Clothes are folded and unfolded all the time, pleating creates shapes, surfaces rub against each other, our skin is a sensor and a conductor – or in keeping with a more computational language, a "filtering actor." Textures and colours of clothes transmit signals, communicating our choice of how we feel or want to express intention and attention, exuding our vitality, emotions, preferences and idiosyncracies, our affective states and how they change, from one day to the next, from one season to another, constant in their ephemeral idealism, functional and excessive (against the logic of function), psycho-somatic. Sometimes we wear clothes that are not comfortable, but we wear them because they excite us or offer alternate possibilities/constrictions of behaviour. They can also be membranes, fluttering with soundwaves like the membranes of loudspeakers. Clothes are sounding instruments, in this concrete analogue sense, and our performers worked with the particular constraints (e.g. the wires) that their costumes contained.

At the same time, dancers rely on a very specialized physical training regime, a deep knowledge and intimacy of their bodies, their bodies' structures and relations to/in movement, space, and change in time, movement through change and through effort. Specific techniques, if you think of William Forsythe's choreographic vocabulary, require the execution of complex isolations and isometric patterns, inversions and fragmentations at lightning speed. The Suzuki method emphasizes physical ("animal") energies and a focussed relationship of the feet to the ground, the gravitational attraction for the earth which the lower half of the body feels. Other techniques, for example in contact improvisation, spark intensified perception of the movement continuum, in touch with others, sharing distributed weight, strength, lightness, a measured giving and taking, initiating and reacting, a kind of listening to others, and a sounding/breathing with combined energies, between ground and air, spacetime of uncertainty and expectation. *UKIYO* was a collaboration with artists from Japan, and we developed a mixed vocabulary based on improvisational techniques, the expressive articulations of *tanztheater* and the slowed-down attenuation, the dilation of time in butoh. Our physical preparations for working with sensortized garments also included the "Artaud Method," explored in workshops with Hironobu Oikawa (during workshops in Tokyo) whose butoh training encompasses Chinese natural philosophy of the five elements (wood, fire, earth, metal, and water) and their energy flows circulating the body. The

Qigong system we applied uses a mixture of training methods, combining dynamic, static, meditative and interactional patterns.

It is important to point out, therefore, that *UKIYO* is a cross-cultural project with a philosophical, not merely technological, interest in developing a practice capable of integrating movement composition (both physical movement narratives and visualizations/animations of images) with methods for creating particularized audiophonic, amplificatory garments to be worn by dancers, actors and musicians in a responsive environment. Our aesthetic of interactional design techniques implies that (1) the structure of the garment cannot be developed separately from the kinaesonic potential, and (2) that the responsive systems developed for the choreographic installation allow performers to create "characters" generating their own distinct sounds.

Interfaces require the "between" – the sense of connection and convergence, grasping and letting go, a facing of one another, a touch or conversation that also implies proximity, a closeness as in an embrace when I allow the body to touch another body, sensing the other through the clothes. A continuity is experienced in such moments, perhaps it is a kind of intimacy that we don't immediately know, similar to an intimacy with fetishized objects we may not acknowledge. We generally don't think of being intimate with technological devices, or being physically close to someone at a remote distance, even as our senses obviously extend into space and connect us to what we cannot see. In our design, garments and accessories become both intensive and extensive instruments of performance that are played in midst of the audience crowding the installation and moving inside the light, sound and digital projections. The crowding also amplifies the space, and connects all of us, through the particular ways of walking, hearing in, and looking, pausing, moving about.[16] Speaking of "retro-engineering" in our design, therefore, implies a touch of irony insofar as we are concerned more with social choreography than human factors design, hard-wiring or transduction. Obviously, the dancers wear functional as well as dysfunctional or obsolescent sound devices, but the aesthetic emphasis is always on the particular character of movement, not on the technology.

Conclusion: Body Weather

When Julie Bokowiec speaks about her work with extended vocal techniques and sensors, she uses the term *kinaesonics* (derived from combining the words kinaesthetic – meaning the movement principles of the body – and sonic) for real-time interactivity and, explicitly, for one-to-one

mapping of sonic effects to bodily movements. Within a single composition, Bokowiec suggests, qualities of kinaesonic expression can change from moment to moment together with the physical location of processing parameters such as pitch, which in her concert piece *The Suicided Voice* is located at the side of the left elbow or on the left wrist. Within the architecture of a single work the colour and ecology of the system can change, requiring the performer to adopt an equally flexible approach to working within the system. The ability to multitask across a range of both utilitarian and expressive functions forms a significant part of that flexibility. Shifting expressive qualities and the fluidity of system protocols has an impact on the performer's focus and perceptions from moment-to-moment in performance. An ability to work sensitively and sensually, moving through a range of perceptual and performative states, is also a required flexibility.[17] Watching her in concert, it is indeed remarkable to see how she can control sound synthesis parameters and her recording/phonographic voice through hands, fingers and upper body, but she performs in a classical concert stance, standing in one spot behind her music stand and laptop.

Rehearsing *UKIYO*, we recognized how important it was for us to develop the sonic out of the kinaesthetic, asking the performers to use their movement skills to help create the costumes and reach a good level of technical capability with the audiophonic designs – inhabiting them. Methodologically, our approach to the production of movement in/of the space concentrated on the continuous fine-tuning of the "sounding wearables," adding the microphones, speakers and sensors into the garments and accessories that allow a combination of sensing and actuation in the mixed-reality environment, giving character to the moveable world, the atmosphere of hearing. All the garment prototypes were developed through an iterative process involving exchange between dancers and designer, and rehearsals with choreographer/filmmaker, sensor programmer, 3D animator, composers, scenographer and lighting designer. Over time it became apparent that there is an entire codex of (architectural and mathematical) elements referring to the functional and expressive directional commands of gesture, while there are also basic and complex issues arising from amplification and the size or quality of loudspeakers (and their position and movement in space). This motional grammar reminds us of the importance of the role of movement in the generation of space as such (motor space, visual space, aural space), and current neurophysiological research on the complementarity of sensory information adds a dimension that is very valuable for future investigation into sensoriality. When we apply sensor technologies to the skin or the clothes, we might augment or interfere with the visual, kinaesthetic (vestibular and proprioceptive) and tactile modalities through which the nervous system senses the external world and enables bodily orientation and cognitive processing. The dancers are not asked to work with

sensory substitution, for example replacing visual with tactile information.[18] But they are asked to assimilate complex motor activity into a quasi-virtual 3-D environment – the projected image or sound spaces (media skins) which their movement stimulates and in which they move. It is in this sense that we think of multidimensional vibrations in our interactive aural space or body weather space, the atmosphere of fluxes and fluctuations that includes the graphic phantoms and distorted moving images of "Becoming Leaf" – the butoh film created with Biyo Kikuchi, Yumi Sagara, and Jun Makime, projected onto the screens while they appear as dark shadowy ghosts amongst the audience in Act II. The dancers can stretch their physical body structure to include the rhythms of light and colour, as they are in turn touched by the highs and lows of projected rhythms (if one were to think of them metereologically). The sensation of feeling sound in an area of the body, or sensing the animated projections in another area of space where kinaesthetic expression happens, generates a synaesthetic perception stimulated by material and immaterial pulses at the same time.

What I am arguing for is not an intimacy between human actor and machining architecture; rather, I am describing scenes that have emotional and narrative layers which are created/ experienced subjectively through the movement sensations that flow – in the feedback environment – between the dancers and the audio-visual world. Movement and (light) modulation here compose the ghostly erotic atmosphere; the modulations render the movement with visual characters and the movement within sound simultaneously real and virtual. *UKIYO* [*Moveable Worlds*] reconnects audio as an intimate relationship to body, and at the same time makes literal use of the atmosphere (the natural and the techno-organic), 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 performer or mediated through the performer. The visitors inhabit the same atmosphere and move with us inside the space of action, they change places and engage according to their internal rhythms and what they gravitate towards.

We like to think of this installation as having a transcendental dimension, linking the internal processes of the nervous system (somatic) and the vibrating objects (atmospheric) to the larger environment of the networked (virtual) world. The avatars in Second Life arrive in the second Act and filter down their avataric choreographies (inspired by seventeenth century haikus and created by software) to the dancers now seated on the floor, preparing to learn new vocabularies and "unnatural" body extrusions from the spirit world. Amaterasu's shrieks fill the air, and we enter the realm of an ecstatic audiophonic world, birds fallen from the sky, their intimate calls rebounding from the white landing strips, and the dance of weightless spirits mingles with the

dance of weighted bodies, producing a semblance of community. Learning to move like an avatar, we wanted our audience to enjoy the irony of seeing Second Life as a modelling of a future theatre. At the same time, when Katsura Isobe re-enters to perform the "creation" of a synthetic natural cosmos, projected onto the suspended weather balloon and slowly metamorphosing from one season to the next, her dance crystallizes some of asynchonicities in the work. She performs in an organic dress made of real Ginkgo leaves, and a sensor is attached to a leaf in her left hand; when she repeats the movement from her RedMutant character, now her dress is not sounding but her hand can make virtual leaves float off the synthetic trees of an autumnal landscape. A union is made of dancer and world, with the audience right in the middle feeling the plasticity of a creative "smoke language."

The project described here does not just propose a design practice that utilizes interactive media technologies. It is essentially an exploration of design concepts becoming audible, seeking to draw the audience into a narrative landscape inspired by the Japanese *ukiyo-e* tradition and ideas inherited from aural/oral traditions. The sensual material design of the wearables links the tactile (the instrumental musical quality) to the acoustic perceptions we gain of the characters and of a world constantly changing through an infinite and complex system of processes occurring in- and outside of the bodies. At the same time, this aesthetic direction for the design seeks integration with the different cultural performance techniques and styles the performers bring to working with the wearables. Rather than including wearables into a palette of interactive technologies, they need to be seen as having historical and cultural resonances that require careful performer training just as musical instruments would in order to create fully integrated characters.

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[1] The virtual figurations, drawn out on software from the motion capture data collected from the performers, were conceived and created by Paul Kaiser and Shelley Eshkar (Riverbed), who had invited Cunningham and Jones into the collaborative productions; Marc Downie joined Kaiser/Eshkar for the (newly named) OpenEndedGroup's project with Trisha Brown. For *How long…*, see http://www.trishabrowncompany.org/index.php?page=view&nr=102

[2] The most comprehensive study of new technological performance to date is found in Steve Dixon's *Digital Performance: A History of New Media in Theater, Dance, Performance Art and Installation* (Cambridge, MA.: MIT Press, 2007). See also: Johannes Birringer, *Performance, Technology, and Science* (New York: PAJ Publications, 2008), Alexander R. Golloway, *Protocol* (Cambridge MA.: MIT Press, 2004), and Malcolm McCullough, *Digital Ground* (Cambridge, MA.: MIT Press, 2004).

[3] Felicia McCarren, *Dancing Machines: Choreographies of the Age of Mechanical Reproduction* (Palo Alto: Stanford University Press, 2003). Inspired by McCarren's historical analysis, Jennifer McColl's PhD thesis, "Bodies and Labour: Industrialization, Dance and Digital Performance" (Brunel University, 2011), tracks the role of performance from earlier industrial eras up to its function in contemporary late capitalist digital art contexts. An extract from her thesis is included in this volume in Chapter 7: Motion Machines: Taylorism & Electric Dance.
For a closer discussion of Marc Downie's algorithmic creatures (which his collaborator Paul Kaiser describes as "thinking images"), see Johannes Birringer, "Thinking Images: Conversation with Paul Kaiser and Marc Downie," *PAJ* 89 (2008), 17-37.

[4] For the current research context of wearable fashion and performance, see Xiaoming Tao, ed., *Wearable Electronics and Photonics* (Cambridge: Woodhead Publishing Ltd., 2005), and Jane McCann and David Bryson, eds., *Smart Clothes and Wearable Technology* (Cambridge: Woodhead Publishing Ltd., 2009). Some of the ideas in this chapter are of course indebted to my design collaborator Michèle Danjoux; see our jointly written "The Sound of Movement Wearables," *Leonardo* (2013, forthcoming).

[5] For an interesting critique of mapping gestures and a defense of "unmappable" organic movement, see Erin Manning, *Relationscapes: Movement, Art, Philosophy* (Cambridge, Mass.: MIT Press, 2009), pp. 61-76.

[6] Siegfried Zielinski, *Deep Time of the Media- Toward an Archaeolgy of Hearing and Seeing by Technical Means (*Cambridge: MIT Press, 2006), pp. 227-53.

[7] Muto Junko, "Enjoying Actor Prints: Imagining the Voices of Actors and Music," in Gian Carlo Calza, ed. (2005), *Ukiyo-e* (London: Phaidon Press, 2005), pp. 10-11.

[8]See Johannes Birringer and Michèle Danjoux, "Wearable Performance," *Digital Creativity* 20:1-2 (2009), 95-113.

[9] The choreographic installation we created uses no spoken words, but references a conversation between the Kommissär and Officer Favre, filmed in silent black and white/film noir style and projected as an entr'acte with inter-titles between Act I and Act II. *UKIYO*'s template combines at least three historical and narrative research layers or reference systems, for example the physical gestures reflecting Russian engineering (Gastev's motion experiments, as they have been strikingly excavated in Siegfried Zielinski's *Deep Time of the Media- Toward an Archaeolgy of Hearing and Seeing by Technical Means* [Cambridge: MIT Press, 2006, pp. 227-53]) and some of the sound gestures refering to Khlebnikov and *zaum* as well as the Japanese ukiyo-e tradition and Hokusai's manga drawings; the black and white film noir scenes were inspired by Christian Kracht's novel *Ich werde hier sein im Sonnenschein und im*

Schatten (Cologne: Kiepenheur & Wisch 2008); and the retro-engineering was partly inspired by C. Kelly's book on phonography and sound art: *Cracked Media: the sound of malfunction* (Cambridge, MA: MIT Press, 2009).

[10] Roland Barthes, "The Grain of the Voice," in *The Responsibility of Forms*, trans. Richard Howard (New York: Hill and Wang, 1985), pp. 274. My interpretation of earlier audio technologies and sound art experiments is here inspired also by Frances Dyson's important book, *Sounding New Media: Immersion and Embodiment in the Arts and Culture (*Berkeley: Univ. of California Press, 2009). For our film scenes in *UKIYO*, our ensemble took recourse to Michel Chion's research on film sound in *Audio-Vision*: *Sound on Screen*. Trans. Claudia Gorbman (New York: Columbia University Press, 1994).
[11] See Antonin Artaud, *The Theatre and its Double*, trans. M.C. Richards (New York 1958), p. 52.

[12] See Thomas Lamarre's illuminating analysis of Japanese *anime* and "superflat" animation derived from the Edo-period woodblock prints of the *ukiyo-e* tradition (Hokusai), in *The Anime Machine: A Media Theory of Animation* (Minneapolis: University of Minnesota Press, 2009), esp. pp. 110-23
[13] Kracht, Ich werde hier sein im Sonnenschein und im Schatten, pp. 43-44 (my translation).

[14] José Gil, "The Paradoxical Body," *TDR: The Drama Review,* 50:4 (2006), 21-35.
[15] Anna Munster, *Materializing New Media: Embodiment in Information Aesthetics* (Hanover, Dartmouth College Press/University of New England, 2006), p. 56.

[16] The phrase "hearing in" is indebted to Tim Ingold's persuasive account of the experience of sound *in* movement, experienced, like breath or like the wind, as a movement of coming and going, inspiration and expiration. See his "Against Soundscape," in Angus Carlyle (ed.), *Autumn. Leaves: Sound and the Environment in Artistic Practice* (Paris: Double Entendre, 2007), pp. 10-13. See also his "The eye of the storm: visual perception and the weather," *Visual Studies* 20:2 (2005), 97-104.
[17] Julie Wilson-Bokowiec and Mark Bokowiec "Sense & Sensation: the Act of Mediation and its Effects," *Intermedialites: history and theory of the arts, literature and techniques,* 12 (2008), 129-42.
[18] Cf. Francis Lestienne, "Les sciences du mouvement: art & handicap," *Bains numériques*, vol. 2 (2008), pp. 81-87. For information on the "Choreography and Cognition" research project, see http://www.choreocog.net. For the wider context of cross-overs between neuroscience and dance, see Johannes Birringer/Josephine Fenger, eds., *Tanz im Kopf/Dance and Cognition* (Münster, LIT Verlag, 2005). The development of interactional performance in the dance and technology community can be traced back to the early and mid-1990s. An overview of software development for performance is offered by Scott deLahunta: <http://huizen.dds.nl/~sdela/transdance/report/>. He organized the path-breaking workshop "Software for Dancers" at Sadler's Wells Theatre in London (October 2001); it was followed by "Performance Tools: Dance and Interactive Systems," at Ohio State University in January 2002; cf. < http://minuet.dance.ohio-state.edu/~jbirringer/Dance_and_Technology/tt.html />. Most recently deLahunta coordinated the research project "Choreographic Objects: traces and artifacts of physical intelligence," which includes Emio Greco/PC's *Capturing Intention*, Wayne McGregor's *Autonomous Choreographic Agents*, and the *Siobhan Davies Dance Archive*, and William Forsythe's *Synchronous Objects* (http://synchronousobjects.osu.edu). My concerns about interactivity and its effects on performance aesthetics were first expressed in blogs released during my 2006 Interaktionslabor (http://interaktionslabor.de), and subsequently in "After Choreography," *Performance Research* 13:1 (2008), 118-22.