Pikapika – the collaborative composition of an interactive sonic character

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***Pikapika* is a collaborative solo performance by Bahn and Hahn that presents a simple model of composition, choreography and collaboration in an interactive context. The piece offers the possibility of a new kind of interactive theatre/costume design – an interactive sonic character. This essay is a case study of a design process for interactive performance. While we include some details of our specific interface, these are primarily employed as examples to suggest our principles for creating personal, idiosyncratic interactive systems. Our collaboration integrates elemental sound and movement relationships with an awareness of the embodied cultural knowledge of the performer and with a specific sensing scheme to capture her particular gestural vocabulary. The combination of individual 'atoms' of movement and sound leads to a complexity that must be practised until they can be performed with ease as an embodied interaction. We find the process of collaboration and its articulation as a dynamic interactive structure fascinating and enduring beyond the specific technologies employed. The terms meta-composition, composed instrument and composed character are used to describe the interactive structure of the piece.**

1. INTRODUCTION

Pikapika is inspired by *anime* and *manga*, Japanese pop animation and comics. The word in Japanese means 'twinkling', and is also a metaphor for the bright flash of an atom bomb. In our piece, Pikapika is the name of the female persona Hahn assumes. In performance, Hahn wears a wireless MIDI control interface as well as a small wireless stereo amplifier and body-mounted speakers (figure 1). The wireless technology communicates with a remote computer system running MAX/MSP. This 'sensor-speaker performer' (SSpeaPer) interface extends the concept of a sensor-speaker array (SenSA) developed by Trueman and Cook, into the realm of performance art (Trueman, Bahn and Cook 2000).

In performance, Pikapika enters from the rear of the hall and strolls through the audience, emitting a variety of 'clanks', 'hisses' and 'whirs' directly from her body. She is able to navigate and transform numerous composed sets of sampled sounds, as well as control signal processing and the extension of her sounds into the hall's main sound system. Pikapika often performs with interactive video, but this aspect of the piece is not examined here.

1.1. Background: interactive music and movement systems

There is considerable interest in the convergent investigations of interactive systems, gestural control of music, and new dance/movement technologies. Many approaches have been introduced and are being used widely in the study and performance of interactive music and dance. These can be generally classified by the sensing technologies employed, including wearable devices, floor and stage sensors, and vision-based video analysis systems.

Wearable devices involve mounting various sensors, computers and transmitters on the body of a performer. The 'MidiDancer' system used by the dance company Troika Ranch employs flex sensors and a wireless transmission system coordinated through Coniglio's development environment, 'Isadora' (Coniglio 2000). At MIT, Joseph Paradiso has developed several different dance shoes incorporating elaborate sensing arrays for position, pressure, rotation, flex, and other parameters (Paradiso, Hsiao and Hu 1999). The Digital Dance Project at the Danish Institute of Electroacoustic Music (DIEM) has yielded both a general dance interface based on flex sensors and a software environment for the development of new works as used by Wayne Siegal in the production of his composition, *Movement Study* (Siegel and Jacobsen 1998). The SICIB system employs the 'Flock of Birds' motion capture system by Ascension Technology Corporation that follows small body-mounted magnets in three-dimensional space (Morales-Manzanares, Morales, Dannenberg and Berger 2001). Another example of a performance system using motion capture is seen in 'The Human Body Tracking Project' (Broadhurst 2001). At the University of Texas, Yacov Sharir has developed a wireless dance interface that incorporates a wearable computer that transmits data from flex sensors through standard wireless computer network protocols to coordinate sound and interactive 3D animation. Other approaches include the 'Control Suit' developed at the Norwegian Network for Technology, Acoustics and Music (NOTAM 2000) and the 'BodySynth' (Van Raalte 1999).

Floor and stage sensing strategies include the systems developed by Pinkston, Kerkhoff and McQuilken (1995), Paradiso, Abler, Hsiao and Reynolds (1997), and

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Figure 1

Griffith and Fernstrom (1998). Another approach is shown in the integration of sensors into the 'MIDI Trampoline' and stage design by Mark Ainger and Matthew Ostrowski for Elizabeth Streb's dance *Up* commissioned by the Wexner Center for the Arts as part of Streb's 'Popaction' concert tour.

Video sensing and analysis systems have been implemented by composer and programmer David Rokeby in his 'Very Nervous System' (http://www.interlog.com/~drokeby/vnsII.html) and have come to wide use with the release of the software implementation of this system, 'Soft VNS'. Other systems include 'BigEye' (Steim 2002), Eric Singer's Max object, 'Cyclops' (http://www.ericsinger.com) and generalised tools offered through 'jitter' by Cycling 74 (www.cycling74.com). In his article, 'Making motion musical: gesture mapping strategies for interactive computer music', Todd Winkler offers a complete overview of the use of these non-invasive sensing systems in music and dance performance (Winkler 1995).

Additional references, bibliography and information on a variety of systems may be found on the dance technology page of the ICMA working group for Interactive Systems and Instrument Design in Music maintained by Bahn and Birringer (http://www.notam02.no/icma/interactivesystems/dance.html). The Dance Technology Zone website (http://www.art.net/~dtz/) maintained by Scott Sutherland also has an extensive collection of resources for further investigation, as well as an active email listserve on dance technology.

This paper hopes to contribute to this expanding body of resources in the area of dance and interactive technologies and to present a process of collaboration in the creation of new works.

2. THE SSPEAPER INTERFACE

Growing out of the work of Trueman and Cook in 'sensor-speaker arrays', or 'SenSAs', we set out to create a wireless performance interface that integrated sonic display into costume design – essentially to reconnect interactive electronic sound with the musical body producing it (Trueman and Cook 1999). Our goal was to create a new sort of audio 'alias' for the character Pikapika, a 'sonic mask', that would extend Trueman's notions of *presence* and *intimacy* in interactive electronic chamber music to the realm of interactive theatrical performance (Trueman 1999). The result was the 'sensor-speaker performer' interface, or 'SspeaPer'. The SSpeaPer interface naturally locates and spatialises electronic sounds to emanate directly from the performer's body. The body-mounted speakers add a strong visual and aural theatrical element. In a sense, the speakers restore the 'voice' of the performer and supply the character with an aural identity that she can shape through her movements. The speakers also provide Hahn with direct physical feedback about the nuance of her sonic performance.

2.1. Costume design

A fundamental challenge at the inception of interactive dance pieces is the incorporation of the technology

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into the 'look' and 'feel' of the piece. If the dancer needs to wear an interface, then a design plan for how the device will be attached to the body, the dancer's ease of movement while wearing the interface, and the desired appearance of the dancer on stage needs to be considered. There have been a variety of creative solutions to these issues seen in the work of Troika Ranch, Stelarc, Yacov Sharir, and Palindrome. The topic of revealing or concealing the technology and/or its computer processes from the audience has been a common thread on the dance-technology listserve (dance-tech@dancetechnology.org).

The desired appearance for Pikapika's character factored strongly into the design of the interface, as did the desire to incorporate robust, easily replaceable elements wherever possible. Using slightly modified, readily available parts has drastically cut down the overall cost, compared to custom fabrication. It has also allowed us to avert catastrophe when a part has been damaged, particularly when we are 'on the road'. Many elements of the costume were drawn from non-standard uses of common objects, such as employing a nicely rounded, clear plastic 'foot care' boutique box as a 'project box' to house the amplifier and wireless technology. Other elements were drawn from commercially available electronics, such as the audio and data transmitters/receivers. Certain aspects of the costume were custom-made, including a blue suede backpack designed to safely carry the rounded project box and route wires, yet still allow great freedom of movement for the performer. The body-suit was sewn from four-way stretch lycra in 'space silver' and was chosen for its 'science fiction' appearance, freedom of movement, and the manner in which the silver fabric caught the light of the video projection. The blue, shoulder-length wig provided an added touch to Pikapika's gutsy persona. While this feature softened her often rigid robotic appearance, it also gave her a fun-loving yet wild character, one which further extended the extreme nature of her personality. Also, the costume, wig and makeup masked Hahn's own appearance, contributing to her portrayal of Pikapika.

2.2. Sensor design

Considered to be a significant aspect of the 'composition' of the work, Bahn's interface design was based on the particular movement vocabulary and body architecture of the performer. Hahn, whose background stems from traditional Japanese dance, has unique subtle arm motions developed as an aspect of the often mimetic gestural language of her training – where delicate motions of the hand often 'tell the story' of a piece. While desiring to capture these refined movements, it was important not to obscure or encumber the grace and beauty of her fingers with a glove or other device. A simple approach was chosen where the palm of each hand conceals a bi-axial accelerometer (Analog Devices ADXL202EB) in a small box. Mounted on the outside of each box are two small buttons. The sensors are read with a Basic Stamp II SX micro-controller where the data is converted to 14-bit MIDI messages and radioed back to a host computer through an Aquila MIDI radio device (no longer available, but other similar devices are now being marketed).

This interface was extremely easy and inexpensive to build and delivers four fast, highly resolved, robust streams of continuous data drawn from the movements and angles of the performer's hands. The buttons allow the performer to signal changes of texture discreetly while on stage. Using various combinations of buttons, or through timing events to discern long, short, or double presses, a large vocabulary of signals can be specified with a minimum of 'real-estate'. Recently, we have expanded the interface to also include an accelerometer on each foot, but in most cases the data drawn from the two hand-mounted accelerometers is sufficient to create an effective relationship between sound and movement.

2.3. Wearable speaker/amplifier design

Two channels of high-quality audio are transmitted from the host computer to the body of the performer through Sennheiser wireless 'bodypack' instrument transmitters and receivers. The receivers are mounted in the clear plastic backpack along with a powerful stereo amplifier used for car audio. The amplifier was removed from its standard housing in order to create a smaller, lighter package and add to the high-tech look of the costume. A rechargeable battery designed for emergency automobile use powers the sound.

A coaxial speaker, also for car audio use, is mounted on each arm in modified skate-boarding knee-pads; ready-made for action and stitched with heavy fabric and velcro attachments. The plastic cups on the tip of each knee-pad were cut out with a circular saw. Small speaker enclosures made from PVC tubing and filled with acoustic fibre were inserted. The makeshift enclosures extend out slightly from the knee-pad housing and allow the speakers to be mounted securely in place.

2.4. Tuning the interface

After the costume and interface were essentially built, they were fitted to Hahn's body like a tailored suit; wires and connections were cut to size and routed through attachments on the backpack to allow her a full range of movement. The data from the sensors were tuned to the range of Hahn's movement, focusing the greatest resolution on areas important to the selected movement vocabulary.

3. MOVEMENT AND SOUND VOCABULARIES

Hahn began studying Japanese traditional dance at the age of four in Toyko and in 1989 received the *natori*

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(professional stage title) Samie Tachibana from the Tachibana school. Her movement is informed by this training to a point where it has become 'second nature' or what she describes in her ethnographic work as embodied cultural knowledge. This active embodiment through practice can be observed in the bodies of dancers of all kinds, the stance of trained musicians, and in the bodies of all people encultured through their everyday activities (Hahn 1996, 1997, forthcoming).

3.1. Movement

Pikapika embodies movements from *bunraku* and *anime* (Japanese puppet theatre and contemporary popular animation, respectively). Hahn studied *bunraku* movement vocabulary while learning Japanese traditional dance (*nihon buyo*) pieces derived from the puppet theatre. The concept of the sonic punctuation of Pikapika's movements was drawn directly from the *bunraku* performance tradition, although the actual sounds were derived from machinery and technology.

In *bunraku*, the puppet's movements not only correspond with the narrative music of the *shamisen* (three-stringed lute) and *joruri* singer-narrator, but also dictate a variety of 'sound effects' made by a musician backstage. It is this sonic articulation of puppet movements that inspired the articulation of Pikapika's sounds and her movement vocabulary. Pikapika's movements and stance are always grounded and stable as in *nihon buyo* or martial arts. However, movements are not drawn from a *nihon buyo* female role portrayal, comprised of: elbows close to the body, knees bent, legs together, fingers held together with the hands in a gentle cup-shape or with hands within the sleeves, and toes pointed slightly inward (which keeps the line of the *kimono* trim and composed when walking). Instead, Pikapika wears pants and embodies the attributes of a *nihon buyo* stereotypic strong male role – her carriage is upright, feet shoulder-width or more apart, toes pointed outward and legs in an open position, shoulders broad, chest high, elbows away from the body, fisted or open hands (with fingers spread apart), an outwardly directed gaze, and a broad, erect torso. The quality of Pikapika's movements reflect the sharp, articulated appendages of a *bunraku* puppet, yet she maintains a fiery core of stability and self-sufficiency. Here the influence of *anime* blends with the *bunraku/nihon buyo* movement ideals.

We asked ourselves – if an *anime* character stepped off of the screen, what would she be like? There are a variety of poses and movement qualities that *anime* heroines enact, and each character certainly has her own vocabulary. However, we have drawn from the *anime* women who shirk stereotypically weak female portrayals (spineless, immature, squirmy, and coquette persona) and display a powerful, energetic character. To embody a larger-than-life intensity, Pikapika's movements must always illuminate her extreme energy flow. Her stable, warrior stance, extended limbs, and erect torso must convey her inner strength. Pikapika's actions, flow of energy, as well as her gaze emanate from her innermost core and radiate out, much like Japanese performers' movements derive from what is called *ki* energy in the *hara* (where the spirit resides at the core, or belly of the body).

Pikapika's particular gestural vocabulary emerged through rehearsal. Early on, general ideas for Pikapika's look and movement were mapped into the interface. After a phase where Hahn explored moving with the interface, a clear notion of the correlation between particular sounds with gestures arose. Hahn could then match the nature of certain movements with sound, while Bahn refined the mappings. One example is Pikapika's walk. When she strides into the room her arms are swinging, elbows at right angles, and her hands are in fists. Each swing of the arm past a sensing threshold emits a machine click or crunch. The audience's first vision of Pikapika necessitates identifying her character as strong. After a moment Pikapika generally draws her torso, head and arms back and launches into a pose with her arms held slightly below the sound threshold, resulting in silence. While the hands alone control the manipulation of sound, this sequence of movements to a static pose (loud machine sounds to silence) dramatically highlights the performer's control of sound, while simultaneously reveals the strength of Pikapika's identity.

3.2. Sound

The sound world for Pikapika is divided into five general categories: short punctuating sounds, longer textural recordings, physical modelling synthesis, granular synthesis, and algorithmically generated rhythmic passages. In addition to the narrative quality of machine-like noises that underscore the basic content of this piece, the different sounds were chosen to provide a wide-range of durations, registers and sonic qualities. In performance, these sounds can be combined freely to create complex textures.

To sonify Pikapika's movements, short punctuating machine noises were drawn from libraries of sound effects. These were divided into several categories that could be freely switched in performance: clicks, air, ratchets, zippers, etc. In order to reduce repetition, each category was defined by nearly a hundred sounds. Basic movement events were articulated to begin and end with a short burst paired with a slightly longer looping sample that could be altered in pitch during performance. The choice and pairing of these sounds was done through a chance selection within the textural category selected by the performer. All sound choices are exhausted before any repetition occurs. In addition to basic sample playback, the same samples can be doubled at the octave below, creating a thickened sound heard or felt best through the performance sound system and subwoofers.

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Longer looping soundfiles, again drawn from recordings of machinery, provide a constant sonic base to support and contextualise Pikapika's movements. A narrow range of transposition allows the sounds to be dynamically altered yet keep their low rumbling character. Trueman's 'Blotar' instrument, an aspect of the physically inspired synthesis models (PhISM) included in the MAX/MSP PeRColate distribution by Trueman and DuBois, created another sustained texture, higher in register and varying between a shrieking rock guitar and air-like bursts of noise. Again from PeRColate, the 'Munger' takes in all other sound events and creates complex textures through granular synthesis (Trueman and Dubois 2002).

The last basic sonic element is a furious rhythmic stream composed of small 'cuts' of all samples in the library. The cuts are played forward or backward and at extreme transpositions making a continuous kaleidoscope of sonic fragments. In addition to preparing the individual sounds, a vocabulary of spatial designs was created to route audio to the individual body mounted speakers, individual house speakers (up to eight channels) or dynamic panning between different locations.

4. COMPOSING CORPOREALITY

4.1. The sonic body

An important issue of cross-disciplinary practice is the development of a dancer's conception of her movement as deeply integrated with sound production; the 'sonic body'. Correlating sounds and gestures for Pikapika required a process of intense collaboration between Bahn and Hahn in order to arrive at a palette of complementary (music and dance) vocabulary. One initial process that was successful involved Hahn vocalising various sounds that she imagined would work well with her movement. From her field notes:

> 21 June 2000
> Early this week I moved *as* Pikapika, uttering machine sounds for every movement.
> My flexed arm swung along at shoulder height and came to a rigid stop . . . screee-e-eCH-zzKK!
> Walking with arms swinging . . . click – snap – click-vipp – Kk-chkT . . .
> How enjoyable and free it felt to vocalize movement. I recall I did this as a child when animating my truck flying off a dirt 'cliff' and landing in an imaginary marsh. Zingggg . . . crash, sputter, glub-glub.
> After trying on various movement sounds in the studio I found myself walking around my house and down the street continuing to listen to my movements. The rest of the week I've fallen into a habit of singing my daily movements.
> Click, craSHHH, boom. Tch.tch.tch. Click.

When Hahn led a creative warm-up session for dancers as part of a residency for the Interactive Performance Series (organised by Johannes Birringer at Ohio State University, 2001) she incorporated this process of vocalising movement into the group practice. After a period of silent warm-up and deep listening to sounds in the room, participants were asked to focus on one area of the body and imagine what sound corresponded with particular movements. After this silent phase of hearing the body's movements in one's imagination, participants were asked to vocally produce their sound as closely as possible. Here we had a room full of dancers – moving as sound. As the session progressed, the entire body was included although many noted that the complexity of this task was quite demanding. Many dancers described a similar response to Hahn's feeling that listening to their movements lingered beyond the studio and into their daily lives.

4.2. Mapping

Through this process of conceptualisation, the basic vocabulary of related sound and gesture was developed for Pikapika. One by one, sound processes were mapped to gesture in order to mimic and extend the vocalisation explored through movement exercises. We found it important that, initially, sounds were tuned to the body, not the other way around. Eventually, the relationship of sound production and movement was to become totally integrated and the interface would lead Hahn to explore unexpected areas of movement and sound. But at first, the primacy of the body and the simplicity of the vocalisation exercises informed the mapping process.

Individually, each mapping was designed with the greatest simplicity and obvious relationship. The short punctuating sounds were tuned to articulate Hahn's movement as she raised her wrists above a certain angle. The sounds continue looping as her hands are raised, allowing her to detune and transform the sounds until her wrists lower beneath the threshold angle. These basic sounds are cast into her body-mounted speakers; right arm mapped to right speaker, left to left, allowing her to walk throughout the performance space in sonic character. With the touch of a button, these same sounds, tuned down an octave and half as fast, are cast into the main sound system expanding her sonic impact. The octave transposition creates a darker, slower sound allowing the brightness of the original sounds played through her body speakers always to be locatable.

Since this fundamental machine-articulation of her character is based on raising her hands, a second relationship is established where longer soundfiles are cast into the main sound system as her hands are lowered. The soundfiles play as she rests, and their amplitude cross-fades with the amplitude of shorter clicks and whirrs. This contrary mapping plays against audience expectations and creates a form of interactive movement/sound counterpoint. As sounds move from her body speakers to the more immersive main sound system it also creates a form of spatial counterpoint.

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In a similar fashion, the other sonic elements are mapped to her body, each element being of a different register, texture, and spatial design, and each exploiting a different aspect of her movement. Consciously, the gestures needed to control each sonic element are in some way mapped contrary to each other. The MAX/MSP algorithms are set up in such a way that Hahn can initiate the performance of sonic elements and textures in any order and combination.

By sensing certain movements and assigning them to musical cues, or sonic control, one can create a rich performance environment. These assignments can also in effect make the body into a switch, limiting the overall expression of movement allowable at any time. Our focus on a simple combinatorial design of the interface gives agency and flexibility to the performer in the construction of the musical/dance form. The performer is free to reveal the clarity of the relationships exposing the mechanisms of the interface, or create complex textures where the relationships between movement and sound are less obvious.

4.3. Practice, growth and development

The simplicity of basic mappings gives way to complexity as numerous layers of contrary relationships overlap one another. In order to develop fluency with the interface, each texture and mapping must be isolated and practised individually, similar to the way that an instrumentalist isolates technical issues (such as breath, or the drawing of a bow) when practising an acoustic instrument. Gradually adding additional textural layers, the interface quickly reaches a point where a performer cannot consciously control each discrete element. The relationships encoded in the interface must then be explored physically, developing the 'touch' of the virtual instrument. Through practice, and mediations of touch, feel and 'ear', these relationships can become embodied in the performer. Hahn finds that after practising with the interface (in character) for a period of time, the conscious strain to recall each gesture-sound relationship dissipates and embodied knowledge assumes control.

In *The Embodied Mind*, Varela, Thompson and Rosch write, 'As one practices, the connection between intention and act become closer, until eventually the feeling of difference between them is almost entirely gone. One achieves a certain condition that phenomenologically feels neither purely mental nor purely physical; it is, rather, a specific kind of mind-body unity' (Varela, Thompson and Rosch 1991: 29).

In *Flow: The Psychology of Optimal Experience*, Mihaly Csikszentmihaly points out the human limitations of consciousness:

> Unfortunately, the nervous system has definite limits on how much information it can process at any given time. There are just so many 'events' that can appear in consciousness and be recognized and handled appropriately before they begin to crowd each other out . . . (however) Simple functions like adding a column of numbers or driving a car grow to be automated, leaving the mind free to deal with more data. (Csikszentmihaly 1991: 28–9)

Csikszentmihaly describes 'flow' as a level of optimal experience in consciousness – ' "Flow" is the way people describe their state of mind when consciousness is harmoniously ordered, and they want to pursue whatever they are doing for its own sake' (*ibid*.: 6). Hahn finds that the process of the new challenges due to the evolving interface provides her with such flow. With each new interface development, Hahn must hone and refine skills, demanding a heightened awareness during performance. Pikapika's character development similarly presents Hahn with consciousness management. Csikszentmihaly states, 'Following a flow experience, the organisation of the self is more *complex* than it had been before. It is becoming increasingly complex that the self might be said to grow' (*ibid*.: 40). We extend this notion of an individual's growth and find that both performer and performance persona (Pikapika) identities have spurts of growth.

Pikapika has matured over time. In hindsight we understand that her early phase was a pre-pubescent iteration. When watching early footage (from the first six months) we noticed qualities that displayed her immaturity. Pikapika appeared stiff, still struggling with her identity, expression, and the interface. She seemed removed and introverted, almost too cautious and self-conscious within the new environment. The interface was not her domain yet. Hahn finds that these qualities reveal not only her personal struggle to connect with the interactive structure, but also her challenge to clarify Pikapika's identity. Both arise from the essentiality of embodiment. Over time the interface became second nature. Once accustomed to it, Bahn would add another parameter, continuously augmenting it with new physical challenges. Gradually and organically Pikapika developed – in complexity and persona. Because Pikapika matured over time it is now difficult to separate the development of the movement from the sound. As we have stated in previous papers, 'Is the music "moving" the dance, or are the movements "playing" the music?' (Bahn, Hahn and Trueman 2001).

5. META-ART, META-COMPOSITION

Pikapika is not defined by a pre-determined score or choreography, but through a set of dynamic relationships between sound and movement. Each performance constitutes an instance of an exploration of the algorithmic structure. A performance cannot be wholly considered as a composition in the traditional sense, yet neither can it be called an improvisation. An appearance of Pikapika may be considered as an instance of a meta-compositional structure (Bahn 1998).

'Meta-composition' is a term that encompasses many

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musical traditions ranging from 'musical games' such as *Musikalisches Wurfelspiel* (Musical Dice Game) by W. A. Mozart; 'open form' and graphic notation pieces by Earle Brown and Christian Wolff; the history of algorithmic composition; text-based compositions such as Pauline Oliveros' *Sonic Meditations*; autonomous interactive systems such as George Lewis' 'Voyager', and contemporary musical games such as John Zorn's 'Cobra'. The stipulation of the meta-composition being that the composition articulates a process that yields a musical result that is structurally different in each instantiation.

When realised with real-time computer systems, the meta-composition becomes a dynamic interactive structure where compositional relationships are realised instantly, possibly as the result of gestural input. This presents a fundamental shift in the technology of articulating musical structure as Robert Rowe states:

> By attaining the computation speeds needed to execute compositional algorithms in real time, current computer music systems are able to modify their behavior as a function of input from other performing musicians. Such changes of behavior in response to live input are the hallmark of interactive music systems. Interactivity qualitatively changes the nature of experimentation with compositional algorithms: the effect of different control variables on the sounding output of the method can be perceived immediately, even as the variables are being manipulated. (Rowe 1993: 2)

In *Machine Musicianship*, Rowe further states that this shift opens up 'new compositional domains', creating an 'intriguing expansion of the craft of composition'. This expansion includes new paradigms for composition, performance, and other forms of participation in the act of music-making, and also implies a widening of the cultural context of music in a technological society:

> . . . interactive systems require the participation of humans making music to work. If interactive systems are sufficiently engaging as musical partners, they may encourage people to make music at whatever level they can. I believe it is crucial to the vitality and viability of music in our culture that significant numbers of people continue (or begin) to engage in active music making, rather then simply absorbing reproduced music bombarding them from loudspeakers on every side. (Rowe 2001: 4)

'Meta-composition' as a term grows out of the concepts of 'meta-art' and 'meta-mediums', the difference being the inclusion of interactive social structures for music-making, as opposed to the view of meta-art being primarily an autonomous system.

5.1. Meta-art

The concept of 'Meta-art' was perhaps first presented in writings concerning the work of visual artist Harold Cohen. Starting with his introduction to computers while a visiting professor of art at the University of California at San Diego in 1968, Cohen has been involved in the creation of a computer algorithm which makes drawings autonomously. His program, *Aaron*, draws upon concepts from the field of artificial intelligence, and embodies general rules that Cohen developed through his experience as a visual artist. In creating *Aaron*, Cohen has said, 'I believe that my behavior in programming the machine to simulate art-making behavior is, in itself, primarily art-making behavior' (McCorduck 1991: 46). This reflexive involvement, the artist building a model of art-making, became the basis for Herbert Simon to write the following in a catalogue for a 1984 exhibition at the Buhl Science Center in Pittsburgh, Pennsylvania:

> To understand and appreciate these drawings, we must understand the respective roles of the computer and Harold Cohen. Clearly the computer is the artist, it does the drawing, its activities guided and determined by the program that lies in its memory (just as human artists' knowledge and skills lie in their memories). Harold Cohen, equally clearly, is the meta-artist, the teacher. (*ibid*.: 46)

In the book, *Aaron's Code*, Pamela McCorduck develops the term and uses it as – 'a piece of art that itself makes art' (*ibid*.: 46). For McCorduck, the use of the computer is implicit in the definition of meta-art and the work of Cohen:

> So Aaron is the first of its kind, the representation of the artistic *process* as distinct from an artistic *object*: Aaron as program is process, rule based and at the same time disconcertingly aleatory; the entity called Aaron makes art objects. Here's the condition that vaults Aaron's creator, Harold Cohen, onto the plane of meta-artist. Cohen is the first to occupy that plane, and for now is there alone. (*ibid*.: 195)

5.2. Meta-mediums

In the book *Digital Mantras*, Stephan Holtzman attempts to establish an aesthetic foundation for the use of computers for creative expression. He states that the use of computers in the creative process 'mandates that we think of communicative and creative processes in terms of abstract structures and the manipulators of such structures'. He views the computer as the 'ultimate manipulator of abstract structure' (Holtzman 1996: vii) and states:

> Within the computer itself, in fact, there are only abstract structures, ultimately the computer must realize its 'constructions' in some medium to enable us to interpret the abstract structures it has created. Computers construct abstract representations – abstract structures – that can, with appropriate rules, be mapped onto any number of different media. (*ibid*.: 215)

He further describes the unique qualities of these representations:

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> The representations maintained in the computer in some abstract form can, in a sense, be thought of as a *metamedium*. The representation within the computer is not the medium for its realization. It is an abstracted form – a meta-representation – of the structures that will be realized in some other medium. Even virtual realities, which are never realized in a tangible medium and which only exist within a computer, must be mapped from the computer's abstract representation to a form experienced through the senses for human interpretation. (*ibid*.: 216)

5.3. Meta-composition

A 'meta-composition' is a compositional structure that itself composes, or facilitates composition/performance. It can be a construct of media, oral/aural transmission, and/or electronic technology. The meta-composition informs conventional musical activities, such as composition, improvisation or performance, yet it does not prescribe a specific time-based musical entity. As with composition, meta-composition is both an abstraction of a musical idea and an activity; a noun and a verb.

Two basic criteria for meta-composition that serve to differentiate it from other musical structures are:

(1) The interpretation of a meta-composition creates musical structures that will differ structurally in each instantiation, as a result of dynamic processes.
(2) As opposed to meta-art, the realisation of a meta-composition may be carried out by humans and/or technology.

Meta-art, as described by McCorduck and Holtzman, has dealt mainly with the model of the 'meta-artist/teacher', programming the 'artist/computer', in order to create an identifiable 'art-object or composition'. The concept of meta-art as applied to performance and interactive genres must be extended to include the collaboration between the meta-form and the participants, and the use of the meta-form in the structuring of new environments for human interaction. In this way, the importance of the computer as an autonomous artist in realising meta-compositions is diminished.

Pikapika can be considered a meta-composition in the sense that she embodies a structure of structures, all related to each other and clearly identifiable, yet differing greatly in every performance. Each instantiation of the performance is a completely different exploration of the possibilities of the sound/movement relationships, still, every performance is unmistakably 'Pikapika'. Numerous factors clearly contribute to the identity of the piece including: the persona of the character, the costume, the constrained vocabularies of sampled sounds, sound synthesis, signal processing, and the deep linkage between the body and enculturated movements of the performer, as well as the processes encoded within the computer.

This relates to the concept of meta-art introduced with Harold Cohen but differs in the sense that it is not a wholly autonomous system – rather agency is given to the performer in the creation of an instance of the meta-composition. The inclusion of human musical participation is an important aspect of interactive systems and the development of the term 'meta-composition'.

5.4. Composed instrument / composed character

We have argued that the notion of a 'composed instrument' in an interactive context includes: the design of the gestural controller itself, the choices of sounds, synthesis and digital signal processing methods for a particular performance, and the integration of new sonic display systems in the performance feedback loop. We find that creating 'composed instruments' is very much an act of 'composition', in the traditional sense (Bahn *et al*. 2001).

In this way, Pikapika is also a composed instrument. Yet, the conceptualisation of Pikapika's attributes as the constituents of her character development has extended the notion of a composed instrument in a narrative context. She is a 'composed character'. This idea has freed us to more fully examine the relationship between movement and sound often seen largely as incidental by-products of gestural controllers; to exploit the 'magical qualities' often observed in interactive performance. The choices of sounds and processes define the scope of Pikapika's identity; their relationship to traditional and contemporary movement vocabularies creates often unexpected meaning in her gesture. The use of body-mounted speakers endows her with a sonic mask as a marker of her identity, and the extension of her sound into the main sound system expands her sonic aura throughout the hall.

6. Conclusion

> The power of performance to create, store, and transmit identity and cultures lies in its reflexive nature. Through performance, human beings not only present behavior . . . they reflexively comment on it and the values and situations it encompasses . . . A definition of performance that helps us better appreciate its complex role in society is to conceive of it as a discovery and making of behavior. As a discovery, performance involves acute perception, intuition, judgement, and knowledge of human character and action. As a discovery, performance offers a statement of knowledge about the world; it is a way of knowing and learning. (Fine and Speer 1992: 8)

'Finding' and developing Pikapika's identity has relied on learning through reflexivity, a process that balances interactivity between technological and embodied practices. In *Where The Action Is: The Foundations of Embodied Interaction*, Paul Dourish writes, 'The relationship between action and meaning is central to the

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idea of embodiment. The core idea of an embodied interface is the ability to turn action into meaning . . . Meaning, after all, does not reside in the system itself, but in the ways in which it is used' (Dourish 2001: 183).

While we consciously avoid imposing a literal narrative on Pikapika, curiously audience members will tell us the narrative they imagined during her appearance. We consider each performance to be a compositional sighting/sounding of the character within a different context, charging Pikapika to be a vehicle for actuating the relationships constructed through the process of composition. Her appearances are not without meaning, Pikapika's 'embodied interactivity' (Dourish 2001) is at once a site and sight of situated meanings and complexities (Leppert 1995). For example, a priority in the design process was to extend Pikapika's presence in sight and sound to empower her with a super-human look and 'voice'. Pikapika can be loud. Her sonic mask broadcasts her character throughout the space. As a wired Asian American, biracial woman, Hahn can enact resistance to passivity through sound intensity, and wrap the audience in Pikapika's noisy articulations. The technology enables Pikapika's extended voice beyond human capacity and convey her embodied empowerment to an audience. In *Technology in Action*, Heath and Luff propose '. . . technologies transform the very ways in which individuals are able to communicate with each other, and how resources and assumptions on which we ordinarily rely are rendered problematic by the technology' (Heath and Luff 2000: xiii). Pikapika appropriates space with her rambunctious noise and shakes up the room visually, viscerally and sonically. We believe this mirrors Dourish when he states, 'Meaning is conveyed not simply through digital encodings, but through the way that computation enlivens those encodings with semantic and effective power' (Dourish 2001: 163).

In performance, theory fuses with practice through embodied acts, collapsing established dualities of composer/performer, musician/dancer, researcher/participant. Pikapika breaks down numerous other dualities: self/other, male/female, machine/body, culture/nature and Hahn's own East/West biracial identity. Pikapika, in transgressing these dichotomies, constructs her own sense of self, yet simultaneously embodies one of Hahn's own inner selves.

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