Dance and Interactivity

Johannes Birringer

New Environments for Dance

> For Maya Deren film was both rupture and convergence – the screen was a place where the sense of vision was conveyed by time and its unfolding in the images of her investigation. Black bodies, white screens – a ritual played out in the form of possession and release in her projections. The rhythms of fragmentation and loss for her were a new currency, a new way to explore the optical poetry of the Americas reflected in the dances of the Caribbean. Time and cinema for her were one dance, one meshwork of physical and psychological time, the rhythms were altars of a new history written in the movements of dance.
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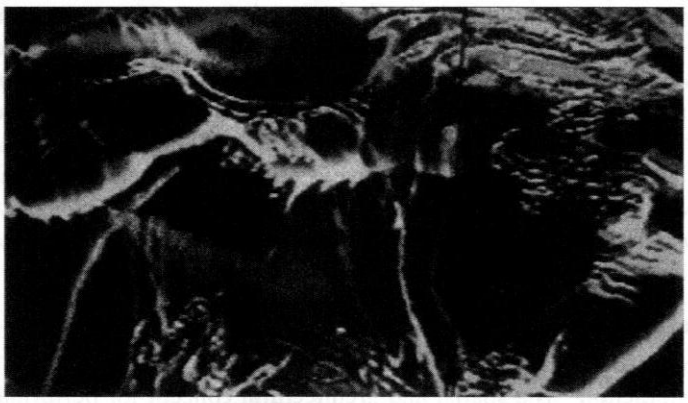
> DJ Spooky



Split
Dance with digital video projection, chor. by Lisa Naugle.
Camera choreography, Lisa Naugle, digital processing, John Crawford.
Fort Worth, 2000. Videostill: J. Birringer.

A growing number of practitioners in the international community of choreographers and performers has begun to experiment with computer-assisted work linking dance and new technologies. This hardly comes as a surprise, since dance-on-film and videodance had already attracted considerable attention at least since the 1980s. Earlier experiments, such as the astonishing films by Maya Deren, take us back to the 1940s, and today's motion capture-based animations find their historical roots in late 19th-century motion studies in chronophotography and early cinema (Muybridge, Marey, Méliès). Furthermore, dance makers, companies, researchers and teachers have used film or video as a vital means of documenting or analyzing existing choreographies. Some scholars and software programmers published tools (LabanWriter, LifeForms) that attracted attention in the field of dance notation and preservation as well as among choreographers (e.g. Merce Cunningham) who wanted to utilize the computer for the invention and visualization of new movement possibilities.[1]

At the turn of the new century, many interests in related fields—film, electronic music, digital art, science and technology, design, engineering, robotics, telecommunications—advance our understanding of the complementary thinking processes that drive new interdisciplinary research and conceptual models influenced by the computer's information processing capabilities and the internet's global reach. Performance incorporated new compositional ideas and instruments such as cameras, video-projectors, microphones, sensors, synthesizers or computer softwares. Like music before it, dance extended its reach, and choreography now encompasses space, sculpture, light, video projection, sensors, and interactive real-time digital signal processing. To a certain extent, movement has become part of the language of programming, design, animation and film editing.

At the same time, nothing would be the same again. The proscenium stage and conventional production processes seemed inadequate. New dance, involving technologies and interactive designs from the conceptual starting point, needed a different environment for its evolution. In the following, I will try to offer an overview of the terms crucial for an understanding of dance and interactivity, especially as they relate to new training environments. These terms have a wide currency in the emerging field of dance and technology, but my observations are based primarily on my own practical experience and that of my collaborators in the field.

Interactivity

I use the term "interactivity" with regard to two phenomena. First, I will address "interaction" as a spatial and architectural concept for performance, and

1. Cunningham first worked with LifeForms in 1990 for the creation of "Trackers." His interest in and use of video dates back to 1974, followed by projects with Charles Atlas, Elliot Kaplan, and other filmmakers.

secondly I will look at "interactivity" in the more narrow sense of collaborative performance with a control system in which the performer-movement or action is tracked by cameras or sensors and thus used as input to activate or control other component properties from media such a video, audio, midi, text, graphics, QuickTime movies, scanned images, etc. In the latter case we speak of an *interactive system* that allows performers to generate, synthesize and process images, sounds and text within a shared realtime environment.

But before examining the behavior of such systems, I want to apply the notion of interaction to the historically evolved understanding of multimedia performance as a multi-faceted and multi-dimensional dynamic process, either based on choreography or improvisation and more open-ended, fluxus-like constellations. Historically, interactivity as an aesthetic category would not derive from classical concepts of composition or choreography; rather, it is indebted to the early 20th-century avant-gardes and their experiments with performance as live concatenation of different, sometimes conflicting media (dadaist, futurist, surrealist performances) as well as with performance as a conceptual instrument for the activation and provocation of the audience. Art history derives its understanding of interactive media arts predominantly from the participatory events of the 1960s (happenings, Fluxus, process art, Situationism, kinetic art, concept art, "art and technology," the John Cage/Robert Rauschenberg collaborations, cybernetic art, closed-circuit video installations, etc) and the progressive "dematerialization of the art object" which implied the active, physical participation of the audience in the event. Since the 1970s, interactivity in art generally refers to multimedia installations and environments that involve electronic or computer-assisted *interfaces.* Nicholas Negroponte already suggested in 1970 (101) that such interfaces are characterized not only by the points of contact and interaction between a machine and the physical or information environment, but by the artistic strategies used to engage audiences in a dialogue.[2]

Compared to interactive installations and digital artworks, sound sculptures, immersive Virtual Reality environments, computer games, and the more recent internet-based forms of telerobotic and telematic performance interfaces, interactive dance in the strict sense of computer-assisted design cannot claim such a long and heterogeneous history. Dance makers have largely remained committed to presentational stagings of multimedia works – complete and highly structured works for the consumption and aesthetic contemplation of the audience. Dance installations and interactive online dance pieces which engage active viewer-participants are rare events that require careful attention and analysis, especially since we don't have any established aesthetic or social criteria for the evaluation of a successful interface. Regrettably, the professional and academic

2. For an excellent critical overview of the evolution of interactive art within the context of the visual and media arts see Dinkla (1997).

dance community has not found many commonalities with the vibrant club and techno rave cultures either, which to some extent has contributed to a sense of isolation among younger dance artists growing up with computers, music television, techno, hip hop, and the transnational exchanges and cross-overs in music.

The problem that I see is the overwhelming emphasis, in academic and concert dance training and its specialized professional practice in the West, on specific techniques (technical training in ballet and modern dance), vocabularies and compositional structures which have limited usefulness for an exploration of participatory processes and the integration of recipient behaviors and feedbacks. Moreover, dance practice as it is commonly understood in Western training has been largely focused on the performer's physical virtuosity and bodily intelligence, shaping and disciplining the body for the execution of choreography, and not for interaction with changing, mediated and unstable environments.

Addressing "interaction" as a spatial and architectural concept for performance, therefore, means shifting the emphasis away from the creation of steps, phrases, "combinations" or points on the body that initiate movement, away from the dancer's internal bodily awareness (widely encouraged in today's practices of yoga, somatics, experiential anatomy, body-mind centering and release techniques) unto her environment, to a not-given space but a constructed, shifting relational architecture that influences her and that she shapes or that in turn shapes her. Such a re-orientation also implies an initial awareness of how lighting sculpts space, and how lighting color, angle, temperature and intensity are constituents of the dynamic and intermediating geometry of space that creates opportunities for movement. Moving bodies and changing light are part of the collective consciousness in which we are enveloped and in which we are co-creative participants. This notion, in my own practice, is indebted to the plastic sculptural process that dancers, visual artists, media artists, programmers and architects have recently explored—a plastic process of "designing" fluid space and responding to transformative space that allows for integration of "nervous" or sensitive media presences.[3]

3. The term "nervous environment" is derived from the term sound artist David Rokeby uses for his interactive software "Very Nervous System" (VNS), first created in 1982. VNS uses video cameras, image processors, computers, synthesizers and a sound system to create a space in which the movements of one's body create sound and/or music. In his writing Rokeby has pointed out that VNS is not a "control system" but an interactive system, by which he means that neither partner in the system (installation and moving person) is in control. "Interactive" and "reactive" are not the same thing, according to Rokeby. "The changing states of the installation are a result of the collaboration of these two elements. The work only exists in this state of mutual influence. This relationship is broken when the interactor attempts to take control, and the results are unsatisfying." Quoted from "Lecture for 'Info Art,' Kwangju Bien-

In a sense, I see the sculptural process as a contemporary modification of Laban's Space Harmony, of the Bauhaus principles of synaesthetic abstract constructivism, and of Joseph Beuys's and Hélio Oiticica's enactments of "social sculptures." In philosophical terms, I am also suggesting a non-Western and non-Euclidian approach to spatial "science" and geometry:

> There is a need for a philosophical framework that enables us to engage harmoniously with the contextual living space in which we are immersed and from which we are as inseparable as a whirlpool is from a water flow. Reversing the man-induced ebb of essential harmonies may come through a philosophy of 'inclusionality' wherein, as in the wisdom of indigenous traditions, all things are understood to be dynamic contextual inclusions that both include and are included; i.e. wherein 'self' is to 'other' as whirlpool is to riverflow (Lumley 2001; quoted with permission).

In other words, a relational performance architecture is participatory, and it does not exclude virtual architectures, as Rafael Lozano-Hemmer has suggested in his writings and artistic projects, for example his highly charged public interface event "Vectorial Elevation" (1999-2000), a transformation of Mexico City's Zocalo Square with enormous light sculptures created by participants on the Internet using a virtual reality program.[4] On the contrary, dance and the changing notions of "site-specificity" in interactive installations need to be discussed with regard to virtual reality environments and such models of immersion that integrate physical and synthetic, 3-D simulated environments, in order to perceive the connections between designs based on representational space and designs generated from algorithms. Current developments in computer science, artificial life research and 3-D design programming (VRML) point to hitherto unimagined combinations and hybrid environments for performance and play which could have a considerable impact on collaborations between choreographers, composers and designers interested in complex, imaginative and dynamic "improvisation technologies," to use the term that William Forsythe applied to his rehearsal operations.

I want to give an example of such research to clarify my point. At the recent "Subtle Technologies" Conference in Toronto, Maja Kuzmanovic and David Tonnesen showed a computer simulation of the "T-Garden" project they are currently developing with their FOAM initiative at Starlab (Brussels). Tonnesen

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nale," 1996. [http./www.interlog.com/_drokeby/install.html]. For a very illuminating discussion on lighting and choreographic rehearsal process, see Senta Driver (2000): 41-78.

4. For an extensive documentation and critical discussion of his interactive art project, see Rafael Lozano-Hemmer (2000).

emphasized the interdisciplinary nature of the "T-Garden" collaboration and explained its conception:

> It is a responsive/hybrid play-space where visitors can 'converse' with sound, dance with images and socially shape media, constructing musical and visual worlds 'on the fly.' The performance aims to dissolve the traditional lines between performer and spectator by creating a computational and media architecture which allows the visitors-players to shape their overall environment through their own movements, as well as their social encounters with each other. At the same time, T-Garden constitutes part of a larger research project investigating five fundamental questions:
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> 1. How do we develop sustainable, international collaboration networks between cultural institutions, operators and policy makers?
> 2. How do we allow the project to evolve in the most open and interactive manner (a.o. looking at authorship and copyright issues).
> 3. How do people individually and collectively make sense of responsive, hybrid environments, articulating their knowledge in a non-verbal language?
> 4. Can play (in the broadest sense of the word) become an essential model for cross-cultural experience?
> 5. How can new forms of expression be sustained by a fusion of media, matter, motion and gesture (Kuzmanovic and Tonnesen 2001; quoted with permission).[5]

These questions point to the heart of current experimentations with interactivity, which for dance makers until very recently was largely a dialogue with composers and programmers who designed MIDI-activated sonic environments for non-linear choreography. "T-Garden" suggests an expanded architecture allowing the performers or "gardeners" to experience physical and tactile relationships to a virtual reality that they can actually modify and shape, moving through the projective, computer-generated world. Since the computer-generated world needs to be projected via surround-sound speakers and LCD projectors, it means that the performer moves through light waves, fields of color and pulsations, floating virtual objects, etc., and her body potentially experiences ruptures of the kinesthetic from the visual senses as all physical body-surfaces gain a multidimensional tactile extensionality.

Such "movement-through" interactive and generative environments posits a shift in perception that many dance practitioners, used to working in real time and real space, have been reluctant to engage. The engagement requires new

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5. For more information on the project, visit <http://www.fo.am/> and <http://www.subtletechnologies. com>

vocabularies informed by interactive design and VRML (Virtual Reality Modelling Language) and involves such notions as parameters, mapping, navigation, tracking systems, Musical Instrument Digital Interface (MIDI), genetic algorithms, modules and patches based on specific programming languages such a MAX/MSP, etc. It also requires at least a basic understanding of the underlying computational processes which generally remain invisible. And it prompts us reflect on contemporary science-derived concepts of "emergent" or autogenerative systems as they are now being used by diverse artists working with interactive video installations, artificial life architectures, 3D shared spaces, telerobotics, and telepresence/telematic art.[6]

Navigations and Interfaces

Technology has decisively challenged bodily boundaries and spatial realities, profoundly affecting the relations between humans and machines. The convergences between dance and technology reflect back on the question of dance and its physical-sensory relationship to space and the world, its immediate, phenomenological embodiedness to lived experience in *one place*. We are still in one place among other moving bodies when we dance, whether we are in a rehearsal studio or in the street or a discotheque. If dance indeed takes the lead, among the theatrical arts, in absorbing technology as a creative tool, it needs to revise its rehearsal methods and training facilities.

First, interactivity has implied the relocation of the compositional process into a laboratory-like environment. The directors of the ISA at Arizona State University call it the "intelligent stage," where dancing takes place with computer-assisted design and MIDI interfaces in an interactive ambience which allows a different "programming" of physical motion and motion sensing. At ISA the stage is wired for internet access and telematic transmission of streaming video and MIDI signals, while also featuring the "Very Nervous System" design developed by Rokeby. As with other tracking systems such as BigEye or Eyecon, the sensing in the VNS interface is done by cameras and motion detection devices. But the dancers also become "sensors," adapting to a new spatial awareness of a digitally enhanced space or "operating system" which triggers responses and feedback. Dancers appear to be touching invisible partners; they become ghost-catchers. Musicians have referred to them as "composed instruments."[7]

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6. For a provocative discussion of new interactive media art and virtual environments, see the new book by Martin Rieser and Andrea Zapp (2002). See also Lev Manovich (2001).
7. The Choreographic Center at Essen, Germany, convened the "Cross Fair" colloquium in November 2000, bringing together numerous media artists, designers and choreographers to debate the implications of the "Intelligent Stage." Paul Kaiser (Riverbed) showed the "Ghostcatching" installation, Steina Vasulka, Michael Saup and Louis-Philippe Demers addressed technologies as independent, intelligent systems,

Secondly, the engineering of *interface designs* moves to the foreground in such labs, and the term "sensing" gains a dimension reaching beyond the physical and organic understanding of bodily anatomy, musculature, and proprioceptive spatial awareness of moving-within-the-kinesphere that dancers trained in modern traditions (after Laban) bring to the studio. The convergence of interface design and movement analysis extends earlier Laban-derived structural explorations of the body's repertoire for movement. In more than one sense, it involves the entire sphere of movement as interaction, encompassing perceptive and receptive processes. If movement is a "continuous current" (Laban), a new understanding of "interspaces" in networked performance (telematics) is now evolving. The interactivity of sensitive environments is one crucial aspect of it. The notion of real-time flow changes, as the environment also functions as a video studio or soundstage, and cameras, sensors and appropriate lighting need to be continuously calibrated. There will be constant interruptions. If the environment is networked, there will be delays in the uplink/downlink teleoperation; such delays might affect kinesthetic perception. The most significant intervention into movement today is the dis-location, and subsequent re-distribution, of movement as captured and processed image, micro-movement, sampled ghost. Movement, as it is used in interactive and networked performance-installations, is not a continuous current with space itself but continuously crosses between real space, projective space (video/animation) or other virtual contexts

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and Jeffrey Shaw (ZKM) presented an overview of the innovative interactive installations created at the ZKM. Shaw spoke of immersive and interactive interface environments and referred to Nottingham University's Mixed Reality Lab where experiments with "MASSIVE," a multi-user distributed virtual reality system, helped the British ensemble Blast Theory to develop their new project, *Desert Rain*. The project was completed during their residency at the Zentrum für Kunst und Medientechnologie (ZKM) in Karlsruhe. Choreographers like William Forsythe went to the ZKM to create CD-ROM projects ("Improvisation Technologies") that require extensive digital video studio and computer processing facilities. With interface design by Volker Kuchelmeister and Christian Ziegler, "Improvisation Technologies" features a hypertextual content of over 60 video chapters showing lecture demonstrations in which Forsythe demonstrates the essential principles of his improvisation techniques. A solo by Forsythe, and other dance sequences performed by Frankfurt Ballet members, can be called up as further illustrations. As Ziegler pointed out at Cross Fair, the "intelligent stage" need not be understood as a physical location; it could as well refer to the specific nature of an interface design or platform on a CD-ROM or the Internet. For Ziegler, the CD-ROM is a "knowledge-reference system." For a more detailed discussion of the Cross Fair event, see my "The Intelligent Stage" (2001). The term "composed instrument" was used by Curtis Bahn, Tomie Hahn and Dan Trueman (who comprise the group Interface) at the "Dance and Interactive Systems" Think Tank I organized at the Ohio State University in January 2002. For a more detailed discussion of this term, see the report on the Think Tank:
http://www.dance.ohio-state.edu/workshops/ttreport.html.

(VR, remote sites).

Space is dematerialized, movement is captured, commuted, transferred and reconfigured/rematerialized elsewhere; we interact with sensory information such as video which projects different three-dimensional kinesthetic perceptions of movement energy, position, and velocity (cf. slow motion, close-ups, different scale, distorted color/pixilation, dis-focus, etc).[8] The programming of interfaces between dancers and the computer implies the creation of an unstable system. "Choreography" more closely resembles the "live mix" we experience in techno culture when DJs create a situation, a sound continuum, and use filter devices to modify the parameters in response to energy that is transferred between dancers and musical stream. The intensities of the event develop a kind of autopoiesis; in current dance experiments with interface designs based on feedback/triggers in real time, the composition process is like an "emergent system": symbiotic improvisation with invisible sensor lines or dynamic fields in hyperextened space.

Dance, closely associated with visual forms and rhythms, is fundamentally a multimedia system. We know from photography and motion studies that performances were staged exclusively for the camera. Choreographers discovered that videodance is a composite medium in its own right: choreography is editing of frames. Making dances for the camera has become not only a cinematographic alternative to live dance, but motivated choreographers to re-conceive the aesthetics of dance for the theatre. The impact is evident in the cinematic quality of

Memorandum
Dumb Type, multimedia dance, Tanzhaus NRW, Düsseldorf, 2000.
Videostill: J. Birringer.

8. For a fascinating discussion of the use of "dis-focus" in the complex rehearsal operations practiced in William Forsythe's Frankfurt Ballet, see Dana Casperson (2000 27ff).

many contemporary works. The Japanese companies Dumb Type (*Memorandum*) and OM2 (*The Convulsions of Mr K.*) literally used no less than six simultaneous screen projections in their recent performances, and such projective video topologies also need to be examined as moving structures in the environment. Video projection opens up a screen space for movement images that function as a virtual space; the velocity of digital video also brings concepts of nonlinear editing to the practice of composition and scenography.

The heavy use of video projection favors an installation environment rather than a traditional stage platform. Artists that I observed at the 1999 International Dance and Technology Conference (IDAT) at Arizona State University—including Troika Ranch, Company in Space, half/angel, Yacov Sharir, Ellen Bromberg, Suzan Kozel, Sarah Rubidge, Lisa Naugle, Michael Cole, Koala Yip, Robert Wechsler, Thecla Schiphorst, Isabelle Choinière, and others—focussed on performance design inside intelligent systems operated by the computer, using choreographic gesture as a control component for music and video image processing. The splitting of physical dance and digital image movement, in many instances, suggested a growing comfort with what Lisa Naugle has called "distributed choreography."[9] In a single realtime environment, this distribution can refer to choreography that is created for physical space and projected space; Naugle uses the term primarily for networked performances, where choreography is distributed between two locations in a two-way video teleconferencing environment which thus creates a live, synchronous interactive communication context.

Dancers become conscious of the deep structure of computer interfaces, learning to navigate expanded spheres of movement that require a radical reordering of the senses due to an increase in telematic or virtual interaction. We are engaged in a new form of motion studies, and in the analysis of its remote effects. To my knowledge, there are four types of environments currently evolving in dance: **(1)** *interactive environments* (based on sensors and motion tracking); **(2)** *immersive environments* (Virtual Reality based, such as the "Cave" or panoramic installations that integrate the body, with stereoscopic devices in front of the eyes, into the polysensual illusion of moving through space); **(3)** *networked environments* (telepresence, videoconferencing and telerobotics, allowing users to experience a dispersed body and to interact with traces of other remote bodies, avatars and prostheses); and **(4)** *derived environments* (motion-capture based re-animations of bodily movement or liquid architecture, which

9. Cf. Lisa Marie Naugle (2002): 56-61. See also, J. Birringer, "Dance and Media Technologies," special issue prepared and edited for *Performing Arts Journal* 70 (2002), introduction, 84-93, and Birringer et al. (in Birringer 2001: 51-77). Other important publications on dance and new technologies include Martina Leeker (2001), and Armando Menicacci and Emanuele Quinz (2001).

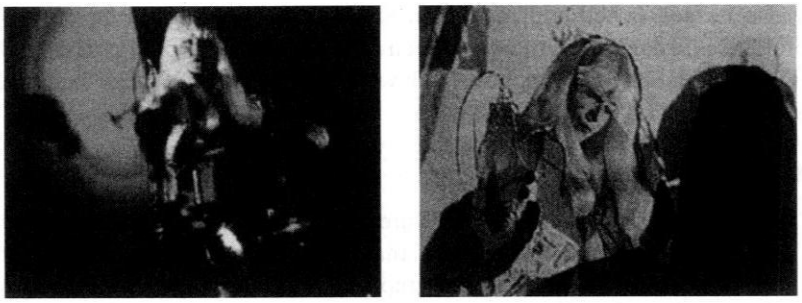
can also be networked and reintroduced into live telepresence or telerobotic operations and communications between remote sites). The parameters of all of these environment types can be mixed; we can then speak of *mixed reality environments.*

Interactive Systems

If we look at the MAX/MSP software as an example of interactive systems, we encounter specific design features that organize the relational architecture in the dance environment. MAX is a graphical programming scenario for patchbays that allow the building of controllers for realtime media performance such as sound. MSP is described by the software builders as "a set of powerful audio extensions to MAX that lets you design your own real-time synthesis and signal processing algorithms with MAX's programming interface. One can use MAX to build intricate control structures that exploit the potential of interactive audio." On the one hand, then, the MAX environment implies setting up what Richard Loveless and John Mitchell (Intelligent Stage, ISA) describe as a "global media controller" which—linked to a video/computer-controlled movement sensing system—organizes the sonic and graphic output for the sensing system (Loveless and Goodman 1999: 74-5).[10] It is an instrument that primarily controls the source materials (the sound and video files that are stored in the computer or synthesizer), sound parameters, and the dynamics of realtime synthesis; it can harbor considerable complexity since the patches can be constructed in the manner of a "nested" design—enfolded entities that are in a continuously fluctuating state of unfolding to activate the modular parts.

Given such complexity in the programmed environment, we must ask how performers and musicians regard the physical relations between performance and "controlled" parameters, and how dancers can see their movement as a form of topological "mapping" of the body's experience and proprioception within the interface. Tomi Hahn, a dancer and musicologist trained in Japanese traditional dance, collaborates with composer/bass player Curtis Bahn and violinist Dan Trueman on performances with movement sensors (designed by Bahn) which capture her arm movements and allow her to freely mix and switch between the sonic elements of the composition. Sensor data is mapped into interactive synthesis and signal processing designs within the MAX/MSP environment. The sound is realized using a spherical speaker array which creates unusual spatial effects and casts individual sound elements into particular locations forming unique, physically locatable "sound-characters" in the sonic dance design. In their performance of "Streams," there is no pre-set structure or duration. The composition intends to give the dancer improvisational freedom and control over the micro and macro elements of the sonic structure. The dance is

10. For further investigations of the intelligent stage and interactive systems, see Lovell's research reports which are collected on his website.



Streams
Interface, featuring Tomie Hahn. 2000. Photo courtesy of the artist.

an exploration of the sound-space.[11]

"Streams" is a good example of future possibilities, since until recently the use of choreographic gesture as a control component in music composition/performance for dance has been largely limited to simple musical parameters: presence or absence of sound, volume control and, more rarely, pitch control. Although much work has been done in the world of computer music by composers who write for gestural controllers, dance has remained somewhat isolated from these forays. Only through collaborative rehearsal can we expect to understand better how the dancer's physical and cognitive relationship to Real-Time interactive systems such as MAX/MSP evolve. The technical goal initially is to integrate an image-based recognition or tracking system (e.g. a computer running BigEye and another running MAX/MSP) into a unified MAX environment. But what does the "technical" integration mean to the dancers, and how do dancers integrate diverse or parallel parameters into their movement intelligence and their increasing awareness of tactile image projection spaces (as we use them in extreme close-up scenarios for telematic performance) and image movement as partners in choreographic composition?

From a choreographic point of view, the dancer within an interactive environment resembles the "player" in "T-Garden"—she will need to familiarize herself with the response behavior of the sound and video parameters, and both dancer and composer will strive to create an exponentially more sensitive, articulate and intuitive system. In a shared environment this could mean refinements in sensors, filters, and output processors, but also an attenuation of the performer's spatial-temporal consciousness. How is the performer-musician-system relationship evolving, emergent? What can we learn from jazz-improvisational structures, from video game structures, from different cultural contextualizations of virtual environments?

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11. For more information on the work on the group Interface (Bahn, Trueman, Hahn), see their websites.

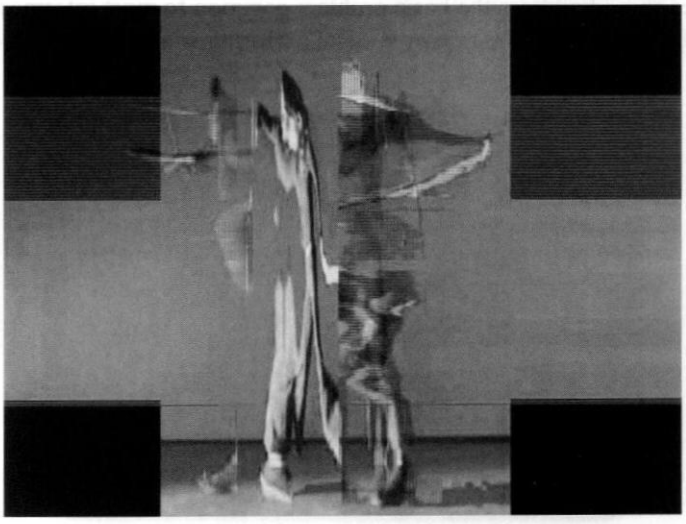
For example, dance and theatre artists in Tokyo and São Paulo have explored interactive environments as conceptual systems through very different metaphorical mappings. Dumb Type often creates dense, quivering and pulsing image projections, taken to the limits of maximum acceleration, and the computerized "image system" appears like an automatic machine moving outside of anyone's control. The dancers appear as mapping modules of the image machine: they are completely permeated by its effects, by the video-light and the intensely loud sound, and their physical presence is no longer autonomous but integrated into the machine. In Brazil, artists and performers such as Renato Cohen, Tania Fraga, Ivani Santana, Lali Krotoszynski or Diana Domingues are approaching interactive environments as transitional stages of consciousness, multidimensional and transformative poetic worlds or shamanic trance states. In her recent dance work, *Corpo Aberto*, Santana performed a one-hour solo with cameras attached to her body, continually shifting her and our awareness between her physical gestures, her movement trajectories-as-camera-eyes, and the (preprogrammed and live-circuited) projections of the contours and shadows of her body. The immediate feedback she danced with was her doppelgänger, but her projected figure gradually lost its human form and, near the end of the performance, mutated into otherworldly shapes and animated skeletons.

As these examples illustrate, dancers, composers, and media designers can interpret the relational architecture of interactive systems in many different ways, depending on a work's emphasis on dance gesture-to-music synthesis, or dance gesture-to-video synthesis. Robert Wechsler (Palindrome Intermedia Performance Group) recently suggested in an internet posting that mapping strategies should address the basic problem common to most intermedia pieces which place dancers in the role of musical performers: namely, how to create an

Corpo Aberto
Ivani Santana. São Paulo, Brazil, 2000. Photo courtesy of the artist.

interdisciplinary work that succeeds from all the choreographic, music-compositional, and filmic perspectives. What he implies, of course, is that the dancer *is* or *becomes* the "musical performer," or, in Santana's case, plays with being the eye of the camera, which is not the same as inter-acting with a dynamic multisensory sound/video environment which may respond in unexpected and uncontrollable ways. Yet the question remains whether choreographers and composers have different or conflicting goals, or whether there is an aesthetically stringent co-resonance between movement, sound, and video that can transform the entire environment kinesthetically. Let us look at two other interactive works, presented at CROSS FAIR in Germany.

Scanned, conceived and directed by Christian Ziegler, is a performance-installation that consists of video projections of a dancer's scanned movements. To create the live work, Ziegler first asks dancer Monica Gomis to perform movement phrases lasting from one to fifteen seconds, which are taped by a video camera. A program he had written for the computer allows him to let a digital video scanner unfold the movement-images over time, controlling direction and speed of the scan as well as resolution and tempo of the scanned material. In performance, the scan projections slowly emerge over a period of time, as if we were watching a painting come into life. The "choreography," according to Ziegler, "can be seen by the imagination of the viewer." One could also argue that there is no choreography, but that the interface with the computer creates temporary paintings of human gestures and movements, reorganizing the time and space of the dance-images.



Scanned
Christian Ziegler, Essen, 2000. Digital image courtesy of the artist.

Yours
Jaroslav Kapuscinski, Nik Haffner, Antony Rizzi, Essen, 2000.
Videostill: J. Birringer.

Yours, a collaboration between the young Polish composer Jaroslav Kapuscinski and Frankfurt ballet dancers Nik Haffner and Antony Rizzi, is performed as a dialogue between a pianist and a video projection of a dancer, accompanied by percussion sounds and a female voice (reciting from Beckett's "Texts for Nothing"). Kapuscinski enters the dark center of the room, with audiences seated on both sides of the Disklavier placed there, with a film screen suspended above the instrument. As he begins to play his composition, a dialogue evolves in real time: every strike of the piano keys manipulates the digital video image on the screen by intervening in the order and speed of the dancer's movements. Rizzi was filmed in the nude, his movements based on Haffner's choreography. The voice from the darkness seems to address the audience or the dancer's movements on the screen. The interface here is the piano: Kapuscinski steers the video samples of the dance, as well as additional audio samples, via a computer that "reads" the key strokes and even senses the particular articulations in the playing. The composition is newly interpreted in each live performance, and the piano interface is also open to audience exploration, as Kapuscinski suggests after his 45-minute performance. He invites the audience to "play the dancer." On opening night very few people actually tried it, being aware that Kapuscinski was working from a structured score that allowed him to develop the digital dance in a deliberate, dramatic manner. Those of us who did try the piano realized that the interactivity was based on relatively simple MIDI trigger (on/off) signals that allow the pianist to play the video image track backward and forward, freeze-frame the motion or advance it, literally, frame by frame, thus controlling the image of the dancer down to the finest atom.[12]

Conceptually, the aesthetics of interactive digital art are necessarily indebted to such "MIDI performances," exploring the potential "fastforward" connections that can be made between instruments and media, as well as directing crit-

12. For a more detailed discussion of the Cross Fair event, see my article "The Intelligent Stage" (2001): 116-22.

ical attention to our unstable relationships to sound and image environments that seem to have a life of their own. As in the case of Dumb Type's image machine in *Memorandum*, the fast-forwarding and re-winding of movement images in *Yours* plays tricks with our memory and optics, and digital artist/programmer Michael Saup went so far as to argue at CROSS FAIR that technologies are not our tools or extensions but autonomous intelligent systems: we ought to be interested in what they do to our psyche.

New collaborative work such as Paul Kaiser/Shelley Eshkar/Bill T. Jones's *Ghostcatching*, *Yours*, and *Scanned* already point in this direction. Captured movement phrases become the digital building blocks for virtual composition or for interactive performances that explore possible, emerging, and always newly manipulable relationships between live and synthetic presences, forms, images, micro-frames, sounds, and their resonances in our imagination. The promise of video tracking technology and real-time digital signal processing for choreographers and composers is the simultaneous exploration of a fluid environment in which dance can generate sound, sound can affect video images, and images inform movement or be derived from movement (motion capture).

Invisible Writing / Mapping

During his recent residency at OSU, Scott deLahunta pointed out that "the process of computation is invisible in the simplest sense that the labor of the software programmer of engineer is largely taken up in the 'writing' of an instruction that tells the computer hardware and connected peripherals how to execute (perfectly) an operation."[13] This writing and subsequent rewriting/editing is part of the creative process whereby something gets "made" in terms of digital technologies. Some programmers might decide to write code for code's sake—generally this activity is done in order to enable something else to happen or get made. It is interesting, in this respect, that choreographers have been working with software code that was by and large written by and for musicians (BigEye, Imagine, MAX/MSP, VNS).

deLahunta insists that there has been much debate about dance making and interactive systems, especially with regard to "transparency" and the receptivity of an audience to the aspects of the work that might be invisible. What is being considered "invisible" in this context is the mapping from input to various forms of output —and this mapping is essentially the consequence of someone provid-

13. This passage and some of the subsequent observations, are drawn from conversations and an unpublished manuscript, "Invisibility/Coporeality," which Scott de Lahunta presented in my Environments Lab during his residency at the Interactive Performance Series (April 2001), Ohio State University. deLahunta suggested that "writing is arguably not the best descriptive metaphor for software programming—building is preferred as often coding requires increasingly the reuse or reassemblage of previously written code." [Quoted with permission of the author.]

ing the instructions for the computer.

Input in the case of BigEye occurs through the analysis of performer-movement/action in a live video image that generates a stream of "movement tracking" data. Thus performer movement/action is used to trigger some sort of event (sonic, visual, robotic, etc) in the space around or in some proximity to the performer. The connection between the performer action that activates the stream of data and the output event (via Midi) is determined by "mapping" the input to the output in the computer in some way. "The interpreted data provides information about the speed, direction, and location of moving objects in the video image, and that information can be used to provide input control data to music-generating software." This is essentially what is referred to as an interactive system.[14]

Mapping, therefore, is at the heart of the creative process as regards these systems —which Marcelo Wanderley (IRCAM) pointed out in a detailed presentation on interactive systems at ISEA in December 2000. In a joint paper entitled "Towards a Model for Interactive Mapping in Expert Musical Interaction," Wanderley and Ross Kirk review the ways "performer instrumental action can be linked to sound synthesis parameters."[15] Their precise definition of "mapping" uses the word to refer to the "liaison or correspondence between control parameters (derived from performer actions) and sound synthesis parameters." They do not include in the concept of mapping the "actions related to data preparation, such as segmentation, scaling, limiting, etc," but point out that generally two main "mapping" directions can be derived from an analysis of past work: a) the use of generative mechanisms (e.g. neural networks) to perform mapping; and b) the use of explicit mapping strategies. For Wanderley and his fellow researchers in the field of electronic music, mapping is clearly a topic of immense creative interest and focus of artistic practice.

However, deLahunta argues, it is the manifestation of mapping that enters the field of perception of the viewer/listener, not the mapping itself. Once completed, the instructions that comprise the mapping itself are relegated to the invisibility of computation. How this invisible mapping works is of interest primarily to those who are engaged in its construction. Although deLahunta is certainly correct in observing this gap between computation and choreography, he may underestimate the curiosity with which some dance companies have approached the relations between writing operations, notation, algorithmic composition and movement creation. The Frankfurt Ballet, Jean-Christoph Maillot's Ballets de Monte-Carlo, Pablo Ventura Dance Company, Yacov Sharir, Isabelle Choinière,

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14. For a useful and straightforward breakdown, see Dobrian's website "Video motion tracking for musical input": <http://www.arts.uci.edu/dobrian/motiontracking/default.htm>
15. The Wanderley and Ross Kirk essay can be downloaded at: http://www.ircam.fr/equipes/analyse-synthese/wanderle/Gestes/Externe/Hunt_Towards.pdf

among others, have developed rehearsal systems influenced by computational thinking. What remains to be seen is whether artistic work with interactive systems allows audiences access to all facets of the systems—input, mapping, and output. It is true that dance performance using interactive systems tend to allow an audience access only to the output, while interactive installations allow access to the input and the output. deLahunta proposes to "include exposure to the mapping itself during performance." This would be comparable, in some sense, to recent experiences I have had with the new motion capture technology. In the initial stages of the capturing process performers generally cannot see the data that are recorded, nor can they experience in real time, while they perform, how the recording data might be mapped (in real time) onto a character or figure animation. This could become possible, however, with magnetic and optical capturing systems that wire the hardware/software to video projectors which could display the data processing and mapping in *real time* to the performers and, potentially, to audiences.

A real time closed circuit relationship to the mapping could afford the performer who practices with these systems a training environment for more "virtuosic" interactions with them, thus combining input measurement that responds to a higher level of detail and subtlety in performer action with more complex mappings. Wanderley/Kirk conclude their analysis by arguing that "complex mappings cannot be learned instantaneously, but then again, we have never expected this from acoustic instruments." If the reference to learning can be seen as a reference to training—it begs the question: where in the dance field do we discuss and debate notions of dance training (technique) overlapping with the development of interactive systems? Where in the dance field do we create learning environments in which dancers and/or musicians could practice in depth with interactive lighting and video projection and sound projection systems, especially if the latter (midi operated) depend on the fine tuned lighting and calibration of camera sensing systems, as well as on coresonant, aesthetic lighting design choices (in conjunction with the use of single or multiple video projection areas and surfaces) that are an integral part of a multimedia performance work?

deLahunta is most persuasive when he claims that there is a small number of practitioners whose efforts over years are accumulating richness and depth through personal determination and diversification. However, their interactive performances are focused on artistic output, not training. In addressing the concept of the invisibility of computation in relationship to physical performance and performer training in interactive systems, deLahunta cautions us about "the long-term outcome of creative activity that is proportionately shifting its center of labor from the physical spaces and composition/choreography to the virtual spaces and mapping configurations (e.g. in MAX/MSP environments). As he rightly argues, any dance artist working with interactive systems knows that the amount of work involved in "getting the technology to work" is immense and seems disproportionate to the amount of work done in the studio, perspiring

and flexing. A shift away from the physical is by consequence in aesthetic terms a shift away from formal expression to the virtual, the conceptual. deLahunta therefore wonders whether we will see audiences in the future who develop a taste for mapping and for complex yet transparent interactive architectures, coming better prepared and interested in watching or contemplating choreographic choices for dancing in interactive systems.

Once dancers begin to inhabit and play with multidimensional mapping environments, the invisibility of computation will be displaced by experiential play and the physical consciousness of new behaviors on the stage of corporeal interactivity where "interactive systems" are infiltrated increasingly by sweating/flexing bodies who spend more time in them sweating, moving, and creating new movement expressions and stories that are perhaps only possible within such interactive worlds.

Networked Interactivity

Some questions remain, for example how play and improvisation evolve across distance to create meaning, how to dance with remote partners in "real time" or how to bring the digital back into "real space," if we want to use images as live projections. The "intelligent stage" of the future may not be a theatre but the network itself. Yet in order to transmit movement-images, a dance has to "happen" at some point in real time/real space. Telematic performance thus harbors beautiful paradoxes, as transmittable data have to be produced and processed in synchrony between different locations which may involve different environments. Ralph Lemon, who recently completed his collaborative dance work *Geography* encompassing the experiences of his travels in Africa and Asia, has been working since 1996 on *Mirrors & Smoke: A Non-Linear Performance in Virtual Space*. In his online diary he writes that he's not sure yet where this work will "live" as a "product that is almost impossible to define in context to what has gone before."

Escape Velocity, Company in Space live teleperformance, IDAT99, Tempe/Melbourne, 1999. Videostill: J. Birringer.

In a teleperformance created at IDAT, the Australian Company-in-Space staged *Escape Velocity* as an interactive duet between two dancers, two cameras, and two projectors linked by a direct online connection between the Web Cafe at Arizona State University and a performance space in Melbourne. The live mix effectively merged the two dancers, layering the choreography and the bodies in a spellbinding, transparent symmetry across a vast spatial and temporal gap. It was transparent insofar as we knew that the teleconference had been set up between Arizona and Australia, we could see the audience Down Under, and when Hellen Sky started her dance in front of our eyes, we could see the projected image of her sister dancing the same choreography in Melbourne, and the two camera artists on either end of the performance began to interact with the performers and send their video signals through the line. At various points during the performance we could imagine the dancers being at-one, the sisters becoming a composite dancer floating in a third space created by the overlaid projections which included film footage of several outdoor locations (a forest, a desert). More hauntingly, the apparent symmetry of the dance of course was not precise. Tiny delays in the transmission became part of the choreography and entered into the dialogue between present physical body and technologically mediated body. Ironically, both dancers were simultaneously mediated and transprojected. At the moment when these dispersions become possible, all safe parameters of the body's relationship to space, time and place have shifted. We witnessed a dialogue between ghosts mixed onto the pixilated, filtered and manipulated surface of the filmic space created by the projectors, the dance a traveling across time, the body morphing and aging right in front of us.

In the future, we may have to become the software designers for telematic movement interaction, so that the weight of contact can be shared across distance, and emotional resonance affected. Most importantly, we discover new

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Environments III, live interactive performance installation, Haskett Hall, Columbus, 2000. Videostill: J. Birringer.

processes of composition that are cognizant of new coordinates of "placedness." Technique classes include "virtual techniques" (in telematically linked studios) and movement-with-camera and movement-with-sensors. Composition/choreography will mean, inevitably, that performance is understood, in the sensitive environments I described, as a multimedia process of design, programming, interactive architecture, capturing, editing, transposition and conversion of movement possibilities and structures, some of which may not even be anticipated by us in the rehearsal. This process will be conducted by teams with artists and engineers from different disciplines, and most likely we will see a growing number of dance works in the future not originated in dance departments or dance companies, but arising from projects that are done as collaborations in labs and alternative venues. Distance dancing may become part of the alternatives, as the Internet provides an extended studio for creative production propelling us out into the world, into new kinds of cultural conversations and exchanges.

If educational institutions want to participate in this development, certain changes are advisable: **1)** new spaces for new dance (integrated studios that combine training and performance with media and technology tools/softwares for experimentation); **2)** a complete restructuring of the existing model of dominant ballet/modern dance education, opening out to dance fusions and new techniques/new co-authoring processes that are team-based and no longer hierarchical; **3)** destructuring of existing curricula and the exploration of dynamic/interactive learning and composition environments that integrate arts and sciences; **4)** a stronger emphasis on interdisciplinary and cross-cultural research and development in telecommunications designs. Finally, one hopes that the boundaries that separate the professional dance world from club cultures, the music and art worlds, and the Net communities, will be crossed more consistently.

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