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'Periodic Convergences: Dance and Computers'

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In October 2001, I received an invitation from Söke Dinkla and Martina Leeker to submit a chapter for a book on dance and new media they were planning as a way of publishing documentation from the CROSS FAIR dance and new media workshops they had organised in 1999 and 2000 at the Choreographic Center NRW in Essen. They invited me to submit something that would "put the experiences of the workshops in a broader cultural historic context and should present the contemporary practise. We would be happy if you could give an overview over the contemporary work in the field of dance and new media with a special focus on internet performances/net dance."[1] I used this opportunity in part to touch on a couple of developments from the 1960s not normally mentioned that connected with my research interest in dance composition and computation [see Critical Appraisal footnote 14]. Other authors in the book include: Gretchen Schiller, Paul Sermon, Nik Haffner, Hans-Christian von Hermann, Wayne McGregor and Wolfgang Hagen.

[1] Email to the author, 25 Oct 2001.

Periodic Convergences: Dance and Computers

Scott deLahunta

Since the 1960s, the arts have been increasingly impacted by developments in computer related technologies. Some, such as video, film, graphics, photographic and sound art, have largely gone the way of the digital, embracing the 0s and 1s comprising the underlying encoding of forms as a newly creative means of recording, composing, storing, transforming and transmitting materials. Historically, these art forms have integrated new technical developments as they have occurred along a path marked by increasing computer processing speeds and storage capacities, the evolution of software programming languages and greater access to knowledge and facilities within dominant media producing cultures.

Dance and computers also have a history of convergence traceable to the early 1960s, but computer related technologies have not attained the level of integration within the field of dance as with the other art forms for the obvious reason that as a material the body in motion does not lend itself to digitisation. Historically, this convergence between dance and computers is perhaps best characterised as *periodic* or *episodic*, involving particular artists at particular times. This essay locates and describes a selection of these episodes in detail combined with some critical reflection on the historical contingencies from which they emerged.

The 1960s: Cybernetics, Computation and Choreography

In America in the early 1960s, seminal developments in both computation and choreography took place. Computation was recognising the need to develop its own field of theory, and in 1962 the first Department of Computer Sciences in the United States was established at Purdue University. In the field of choreography, at the encouragement of John Cage, Robert Dunn began a series of highly influential choreography workshops in New York City, in the fall of 1960, which culminated in the first *Judson Church* performances in 1962. While these events probably occurred isolated culturally one from the other, it is possible to speculate on some conditions of contingency and possible influence of computational ideas on choreography at that time. It is fair to speculate that the focus in Robert Dunn's choreography workshops on the use of chance, indeterminacy, rules and constraints in generating choreographic structures might have been influenced by an awareness of developments in computation, but as far as I am aware there was no explicit connection. John Cage, a major influence on Dunn, did not begin to explore composition possibilities with the computer until the 1980s. A more indirect influence on the experimentation encouraged by Dunn in his workshops, attended by future luminaries of ›post

modern‹ dance such as Steve Paxton, Yvonne Rainer, Simone Forti and Trisha Brown, might have come from the significant scientific discourses of the time such as *cybernetics* as written about by Norbert Weiner in 1948, the same year information theorist Claude Shannon published his thesis laying out a new paradigm for communication. These theories emphasised process, systems and interactivity and the quantitative dimension of information. *Cybernetics* in particular was to be a powerful influence on artists; providing the intellectual underpinning for the emphasis on process in art works and the developments of *participatory art* in the 1950s and 1960s such as the happenings – which John Cage is often cited to be the first to have staged at Black Mountain College in 1952.[1]

While Robert Dunn's workshops established the conditions out of which emerged several seminal pieces of experimental choreography, the practice of *computer art* was beginning to take shape. Early computer artists, often mathematicians and computer scientists by training, were experimenting with algorithmically generated graphic images and patterns and writing programs that explored forms of computer intelligence and creativity. In 1961, A. Michael Noll began work as a researcher with Bell Labs in Murray Hill, New Jersey. While working with the Labs, Noll began to explore the possibility of using digital computers in the visual arts by studying three-dimensional computer graphics and computational aesthetics. In a crude approximation of the *Turing Test* in which human and machine intelligence are compared, Noll invented the algorithms that would instruct a computer to generate an image that would mimic in its patterns and structure Piet Mondrian's *Composition with Lines* (1917).[2]

In 1965, Noll created a work of computer animation he titled *Computer-Generated Ballet*, reported to be the »first such use of a digital computer to create an animation of stick figures on a stage«.[3] But perhaps his most significant contribution to the convergence of computers and dance was in January 1967 when he published an article in *Dance Magazine* entitled *Choreography and Computers*, in which he described a software program he was creating that would indicate stage positions of stick figures and could potentially be of use to choreographers. In the same issue, Ann Hutchinson-Guest – an authority on dance notation – penned *A Reply* to Noll's speculations, in which she writes that the computer will never replace the facility a choreographer has for composing movement with the dancer. However, she does concede that the computer might assist in the overall outlining and editing of a score for a dance.[4]

Another 1960s pioneer of the convergence between computers and choreography, who pursued a different vision of the computer and dance to A. Michael Noll, was John Lansdown, an architect by training. Based in London, Lansdown was particularly interested in the possibilities for *artificial*

creativity, in other words to use the computer to contribute to a creative process as an autonomous composer, rather than to support or augment an existing one. In his introduction to *Artificial Creativity*, a paper given at the *Digital Creativity Conference* in Brighton in 1995, Lansdown describes the computer's ability to make decisions according to rules and traces the history of the use of related *regulatory* systems in music composition, architecture and painting and distinguishes between two types: those that are *randomised* and those that are *rule-based*.[5] Contemporary choreographers have used similar systems. Merce Cunningham's and John Cage's experiments with aleatoric methods were explored further in Robert Dunn's choreography classes already mentioned, and in the 1970s Trisha Brown devised *dance making machines* – rule-based systems that generated particular performances such as *Accumulation* and *Locus*.[6] William Forsythe's use of algorithmic structures in the 1990s is well documented.[7]

In 1968, Lansdown began to experiment for the first time with *computer-generated* dances. He first attempted to use the computer to generate all the instructions a dancer would require emulating to some degree the information carrying capacity of a notation system such as *Benesh-* or *Labanotation*[8]. Soon, however, he determined that a more satisfactory method was to provide a looser framework within which there was some room for interpretation by the dancers.[9] Over time, Lansdown developed the concept of generating *peaks* of movements rather than the movements themselves and allowed the dancers to fill in the material between the *peaks*. This way the dancers functioned as *in betweeners*, to borrow a term from the practice of *key frame animation* where the major dramatic moments are sketched first and the in-between Frames filled in later.[10] These projects did not just remain on the conceptual drawing board. Lansdown's work resulted in many performances between 1968 and 1993 with various dance companies including London-based *Another Dance Group*, the *Royal Ballet School* and *The One Extra Company* of Sydney.

It is important to recall that in the 1960s and 1970s access to computers was extremely limited and programming a slow tedious process. A. Michael Noll states optimistically in his 1967 *Dance Magazine* article that »The computer and graphic output equipment might be centrally located and time-shared with many users. Anyone could apply this technology to produce this form of dance notation typewriter«.[11] Perhaps Noll thought the conditions he describes would generate more convergence between computer and dance. It did, but not surprisingly it was choreographers working in academic institutions with access to the new computing science departments who were best able to explore the possibilities, and the mainstream of contemporary dance practice tended to be unaware of, or disinterested in, the outcomes of this work. In the 1970s, software to support dance notation systems like *Benesh- and Labanotation* began to be develo-

ped, and the early 1980s saw the emergence of interactive performance systems. However, it was in the 1960s that Noll and Lansdown laid out the basic concepts of where computation and the practice of choreography could overlap.

One invention that has received little mention in accounts of the early history of convergence between dance and computers, partly because it had little to do with dance directly, is Lee Harrison III's ANIMAC (hybrid graphic animation computer) developed in the early 1960s. Appearing in the Ars Electronica-show *Pioneers of Electronic Art* curated by Steina and Woody Vasulka in 1992, the ANIMAC was designed to be able to generate an animated stick figure in real-time on a CRT (**c**athode **r**ay **t**ube) screen. From Woody Vasulka's account of his research for the show, the ANIMAC was a unique technical concept and aesthetic project that was never fully realised.[12] According to David Sturman's retrospective on the history of computer animation published for SIGGRAPH[13] in 1998, the ANIMAC was replaced by a more commercially successful product Harrison invented called SCANIMATE. Harrison's systems, largely analogue, were eventually outmoded in the 1980s when digital computer graphics *keyframe animation* was developed, e.g. *LifeForms*.[14]

Abb. 1: Ein Werbebild mit einem Tänzer, der über am Körper befestigte Sensoren die Echtzeitanimation am ANIMAC kontrolliert. Denver, 1962.

Fig. 1: A publicity image featuring a dancer with body mounted sensors controlling real time animation on the ANIMAC. Denver, 1962.

A. Michael Noll, John Lansdown and Lee Harrison to varying degrees each played a role in the weave of theory and practice out of which current relationships between computation and choreography can be traced. Some elements of these early convergences have receded, such as the discourse of cybernetics, and others have been transformed. The ANIMAC may have been superseded, but the technologies commonly referred to as *motion capture* or *performance capture* that record human movement in three-dimensions for use in computer graphics animation have managed a measure of integration into the field of dance practice through the work of a number of artists.[15] Computing aids – either generative or supporting – for choreographic compositions have not proliferated to a large degree as perhaps Noll and Lansdown were inclined to foresee. The piece of technical equipment that became ubiquitous in the rehearsal studio is clearly the video camera and television monitor, but there has been little incorporation of digital technologies, software or hardware, into this set-up. Some of the reasons for this are pragmatic having to do with costs and access. Other reasons are more fundamental, where formal disjunctions exist between properties of the *digital* and the essential components of dance practice involving human motion, corporeality and physical presence. A useful comparison is the music field where the formalisms and initial constraints

underlying musical notation, composition and execution and the physical (analysable) properties of *sound* are inherently conducive to generative investigations and artistic integration with digital technologies. These formalisms and particular physical properties are either absent to a large degree or are of a qualifiedly different nature in dance.

The 1980s: Seeing Spaces and Bodies as Interface

An American artist and computer scientist, Myron Krueger, is credited with being the first to use the video camera as a computer interface in an artistic context in the 1970s. However, in the early 1980s Canadian artist David Rokeby began to develop the *Very Nervous System* (VNS) which he would not only use in the creation of his own work, but would also eventually make available to others to use. It is this that distinguishes the VNS as significant amongst other similar developments up to that time. The VNS uses a video camera as an *eye*, the cable to the computer as an *optic nerve* and the computer as the *brain* to create an interactive *seeing space* in which the movements of one's body triggers sound and/or music.[16] While there are several other similar systems available today including the *BigEye* software at the *Studio for Electro-Instrumental Music* (STEIM) in Amsterdam and *EyeCôn* by the *Palindrome Inter-Media Performance Group* based in Nürnberg, VNS has become one of the softwares of choice for live performance artists wishing to explore interactive systems.[17]

Rokeby's own work, shown in exhibitions and art shows throughout Europe and North America, is installation based and favours the experience of the person who steps into the range of the video camera and uses their whole body as the *active element of the interface*. This space is intended to be experienced on an intuitive level, according to Rokeby, simulating the raw sensory perception of the body in a state of *pre-consciousness*. Through changing associations in familiar patterns of perception, awareness outside the system may seem heightened or altered. Rokeby describes his own experience:

> »An hour of the continuous, direct feedback in this system strongly reinforces a sense of connection with the surrounding environment. Walking down the street afterwards, I feel connected to all things. The sound of a passing car splashing through a puddle seems to be directly related to my movements. I feel implicated in every action around me. On the other hand, if I put on a CD, I quickly feel cheated that the music does not change with my actions.«[18]

Rokeby sees himself as an interactive artist, who creates experiences, but what is crucial to the aesthetic and social construction of the work is that

the audience is fully participant in it – they become the performers. Within the terms of contemporary art production, this means the system works best in the context of an installation or a situation in which the audience is free to come and go at any time. Confusing the boundaries between audience, participant and performer was a feature of the avant-garde art movements of the 1950s and 1960s, but now this could be further blurred with the notion of the *user* or *player* drawn from the rhetorics of human computer interface research.

The classes of input devices for interactive systems can be extended beyond video based systems to include haptic (touch) e.g. pressure and flex sensors, and non-haptic (distance), e.g. ultrasound, etc. But a *seeing space*, i.e. video based technology like VNS, requiring only a camera and software and relatively easy to set up, is an attractive option for choreographers and dancers who wish to experiment with an interactive system in performance.[19] However, here is where the discourse of experience employed by Rokeby and others working with interactive systems, becomes increasingly problematic. Experience in the context of live dance performance on a stage is complicated by the conditions of performer presence and its reception by the audience who in this situation are definitively non-participants. Positioned as spectators, their sense of the performance may emerge from a weave of subjective representations, semantic associations, memory, pattern recognition, etc. How close or how far the audience's experience is from the dancers' is difficult to determine, but besides the possibility that there exists in the viewer of dance a sympathetic kinaesthetic response, it is entirely reasonable to say that the viewer's experience is not the same as the dancer's. Therefore, if indeed the primary efficacy of these *seeing spaces* is in invoking a sensory experience, then to understand its implications for dance performances for the stage we should consider the question of training for performance.

Training in dance is accomplished through repeated exposure to a set of conditions with the aim of embodying the forms these conditions are intended to give rise to. Sensory experience is something that is harnessed towards this aim. The dancer or performer is able to achieve and maintain a state of heightened awareness that is normally reserved for specific spaces, the rehearsal studio and the stage. Each has feedback conventions embedded in them as cultures of performance practice. So what might emerge from dance-training conducted in an interactive space designed specifically for this practice? There has been some experimentation with repeated exposure to systems like the VNS in the therapeutic field, but despite well over a decade of access to interactive spaces, little sustained research in the possibilities for dance training has taken place. While believing such research in this area would benefit both dance and computer related fields such as *Human Computer Interface design* and *physical compu-*

ting, I also share this perspective on the VNS and related systems as a critical reflection on a tendency to simplify the complex relationships between experience, perception, presence and culture of the participant/performer in the interactive system, the *body at the interface*.

The 1990s Convergences noted: Telematics *and* Motion Capture

This essay proposes that the historical trajectories of dance and computers converge periodically, intersecting at various points in time around the work of particular artists. Sometimes this convergence is around the object of choreographic practice, exploring computation in the context of making dances. At other times, it is to explore the body as an interface, stimulating reflection on the relationship between the social and everyday body and the trained and specialised. New options, new periodic convergences arose in the 1990s. Two events that will be recalled in terms of dance are the arrival of the Internet and, post-ANIMAC, digital *motion capture*-technologies. While experiments in telecommunication and dance dates back at least to the telematic work of Kit Galloway and Sherrie Rabinowitz in the 1970s,[20] increasing access to the Internet and the web made it easier for dance artists to explore remote communication as type of performance space. *Motion capture*-technologies benefited directly from the entertainment industry's interest combined with increases in computing power, speed and ability to store and access greater amounts of memory. While *motion capture*-technologies and expertise are still relatively difficult to gain access to, some determined dance and computer artists have succeeded in setting up the necessary collaborations to explore the possibilities.[21]

Abb. 2: In der Performance *CO3* der australischen *Company in Space* aus dem Jahre 2001 sind Motion Capture und Internet kombiniert. Tänzerin: Hellen Sky; Foto: Jeff Busby.

Fig. 2: In this performance in 2001 of *CO3* by Australian based *Company in Space* motion capture and Internet are combined. Dancer: Hellen Sky; Photo: Jeff Busby.

At the same time, work and research into the possibilities for dance composition software and interactive systems are still very much ongoing. Some artists and groups are developing consistently along a specific trajectory of experimentation, some consolidating and assimilating new technology options as they become available. There have also been a number of workshops, conferences and symposia beginning in the early 1990s involving computer scientists, digital and dance artists, each event or project making contributions to developing shared practice and discourse.[22] This constellation of activity cannot help but sustain certain historical lines along which dance and computers have already overlapped. However, convergence in

the future may reflect less the episodic character of the last forty years and much more the negotiation of the integration of the computer and computation into all forms of cultural transaction. On the other hand, the *body in motion* has not become any less resistant to digitisation, and shifting conceptions of the arts as a research practice combined with the evolution of wearable and wireless computing could also suggest that the impact of dance on computers may be just at the start of more periodic convergences.

All URLs listed accessed June 4, 2002

Notes

1 One accessible and fairly comprehensive reference to the developments in computation related concepts is Howard Rheingold's *Tools for Thought* available at URL: http://www.rheingold.com/. See also Dinkla, Söke: Pioniere Interaktiver Kunst von 1970 bis heute. Ostfildern 1997, S. 25–42.
2 Noll, A. Michael: Human and Machine – A Subjective Comparison of Piet Mondrian's Composition with Lines 1917, and a Computer-Generated Image. In: The Psychological Record. Vol. 16, January 1966, pp. 1–10.
3 This quote of A. Michael Noll's is available at the URL under the heading *computer art*: http://www.citi.columbia.edu/amnoll/.
4 Noll, A. Michael: Choreography and Computers. In: Dance Magazine. January 1967, pp. 43–46 and Hutchinson, Ann: A Reply. In: Dance Magazine. January 1967, pp. 81–82.
5 Lansdown, John: Artificial Creativity. A version of this paper was given at the Digital Creativity Conference, Brighton, April 1995. Available at URL: http://www.cea.mdx.ac.uk/CEA/External/Staff96/John/artCreat.html.
6 Trisha Brown's ›dance making instructions‹ can be found published in different locations, e.g. *Locus* in: Contemporary Dance: An Anthology, ed. by Anne Livet. New York 1978, p. 54–55, and *Accumulation* in: The Postmodern Dance Issue: The Drama Review. Vol. 19: No. 1, March 1975, p. 29.
7 For example in William Forsythe interviewed by Paul Kaiser: Dance Geometry. William Forsythe in dialogue with Paul Kaiser. In: On Line. Performance Research. Vol. 4: No. 2, Summer 1999, pp. 66–69, and in Dana Caspersen interviewed by Senta Driver: It Starts from Any Point: Bill and the Frankfurt Ballet. In: Choreography and Dance. Vol. 5: Part 3, 2000, pp. 24–39.
8 Editors' Note: *Benesh- and Labanotation* are two notation systems, one developed by Rudolf Benesh and his wife Joan in 1955, the other invented by Rudolf von Laban in 1928. In contrast to the *Benesh Notation*, which uses classical dance as a basis, the *Labanotation* is a system to analyse and record every human movement, that means also the movement, which is not connected to dance-ideology. For further information see http://www.rz.uni-frankfurt.de/~greisbec/LABANE.html or http://www.ickl.org or rather http://www.benesh.org
9 Lansdown, John: Computer-Generated Choreography Revisited. In: Proceedings of 4D Dynamics Conference, ed. by A. Robertson. Leicester 1995, pp. 89–99. Available at URL: http://www.dmu.ac.uk/In/4dd/guest-jl.html.
10 Lansdown, John: The Computer in Choreography. In: Computer: IEEE Computer Society Journal 11:8. August 1978, 19–30.
11 Noll, A. Michael: Choreography and Computers. In: Dance Magazine. January 1967, p. 44.
12 The sources for this information can be found in the Vasulkas' on line archive. Available at URL: http://artscilab.org/eigenwelt/pdf/092-095.pdf . An off line version can be found in Schier, Jeff: Early Scan Processors – ANIMAC/SCANIMATE. In: Exhibition catalogue Pioneers of Electronic Art – Ars Electronica 1992, ed. by David Dunn. Linz 1992, pp. 94–95.
13 Editors' Note: For SIGGARPH see also the glossary.
14 Sturman, David: The State of Computer Animation. In: RETROSPECTIVE, Vol. 32, No. 1, February 1998 ACM SIGGRAPH. Available at URL: http://www.siggraph.org/publications/newsletter/v32n1/contributions/sturman.html.

15 For a description of *motion capture*-technologies and some work involving dance artists, please see deLahunta, Scott: Coreografie in bit e byte: motion capture, animazione e software per la danza. In: La Scena Digitale: Nuovi media per la danza, ed. by Armando Menicacci and Emanuele Quinz. Venezia 2001, pp 83–100. A version in English is available at URL: http://www.daimi.au.dk/~sdela/bolzano/.
16 David Rokeby interviewed by Douglas Cooper: Very Nervous System. In: Wired 3.03. March 1995. Available at URL: http://www.wired.com/wired/archive/3.03/rokeby.html. See also Dinkla, Söke: Pioniere Interaktiver Kunst von 1970 bis heute. Ostfildern 1997, p. 147–166. Further information on Myron Krueger cf. ibit, pp. 63–96.
17 More information available from the following URLs: Palindrome Inter-media performance group available from URL: http://www.palindrome.de/; STEIM available from URL: http://www.steim.nl/.
18 Rokeby, David: The Construction of Experience. Interface as Content. In: Dodsworth, Clark (Ed.): Digital Illusion: Entertaining the Future with High Technology. Jr. Addison-Wesley Publishing Company 1998. Available at URL: http://www.interlog.com/~drokeby/experience.html.
19 Two examples of dance and electronic composers/digital artists developing wearable sensor systems for use in interactive spaces are Troika Ranch based in New York City and DIEM based in Aarhus, Denmark. More information is available at these URLs: http://www.troikaranch.org and http://www.daimi.aau.dk/~diem/wayne.html.
20 Editors' Note: For further information on the beginning of telematic art cf. the interview with Paul Sermon in Chapter 2 of this publication. For further information on Kit Galloway's and Sherrie Rabinowitz' remarkable work cf. ibit. especially reference 3.
21 See reference 15.
22 This list represents several key projects and events, but is by no means comprehensive. For example: the *Shadow Project* in Jackson Hole, Wyoming organised by Thecla Schiporst and John Crawford in 1991 was followed by similar workshops at San Francisco University in 1992 and 1993, 1994 and 1995. A series of *Dance and Technology Conferences* were hosted by the University of Wisconsin (Madison, 1992), Simon Fraser University (British Columbia 1993), York University (Toronto, Ontario 1995), followed by a 4^{th} *International Dance and Technology Conference* hosted by Arizona State University (Tempe, 1999). In Europe, Terry Braun and *Illuminations Interactive* produced the *Digital Dancing* Workshops in London annually from 1994 through 1998 followed in 1999 by the *Shifts* symposium organised by *Barriedale Operahouse*. Two workshop/symposia events, *Connecting Bodies* at the School for New Dance Development in Amsterdam and *Future Moves* at Theatre Lantaren-Venster in Rotterdam were organised in 1996. *Future Moves* subsequently has taken place in collaboration with V2 Media Lab during the last two *DEAF – Digital Electronic Arts Festival* events in 1998 and 2000. In Germany, the *Cross Fair 1999* and *Cross Fair 2000 – The intelligent Stage* symposia initiatives took place at the Choreographisches Zentrum NRW, Essen. See Tanzdrama, No. 51, Issue 2/2000 and No. 57, Issue 2/2001.