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SPECIAL ISSUE

DAC 09

after media : embodiment and context

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Making Inroads: Promoting Quality and Excellency of Contemporary Digital Cultural Practices and Interdisciplinarity

I would like to welcome you to the first special volume of the Leonardo Electronic Almanac. *DAC09: After Media: Embodiment and Context*, is a volume that generated from the conference by the same name that Prof. Penny chaired at the end of 2009.

DAC09: After Media: Embodiment and Context is the first of a series of special volumes of the Leonardo Electronic Almanac that are realized in collaboration with international academic, editors and authors.

Prof. Penny was inspired for this LEA special issue by the continuous developments in the interdisciplinary arena and in the fields of new media and digital art culture. He wanted to collate research papers that would provide the seeds for innovative thinking and new research directions. The authors featured in this volume, to whom we are most grateful for their hard work, will provide the reader with the opportunity to understand and imagine future developments in the fields of digital art culture and interdisciplinarity.

As I look at the electronic file of what we now internally refer to simply as *DAC09* the first issue of the revamped LEA, *Mish Mash*, printed and delivered by Amazon, sits on the desk next to my keyboard. The possibilities and opportunities of e-publishing, which also has physically printed outcomes, provide me with further thoughts on the importance and necessity of the work that is done by 'small publishers' in the academic field. The promising news of a new open access journal to be launched by The Wellcome Trust or the 'revolution' of researchers against Elsevier through the website http://thecostofknowledge.com/ with 9510 Researchers Taking a Stand (Thursday, April 12, 2012 at 10:57 AM) highlights the problems and issues that the industry faces and the struggles of young researchers and academics.

The contemporary academic publishing industry has come a long way from the first attempts at e-publishing and the revolution, if it can be defined as such, has benefited some and harmed others.

As the struggle continues between open access and copyrighted ownership,[1] the 'revelation' of a lucrative academic publishing industry, of economies of scales, of academics exploited by a system put in place by publishing giants (into which some universities around the globe have bought into in order to have an internationally recognized ranking system) and the publishers' system of exploitation structured to increase the share of free academic content to then be re-sold, raises some essential questions on academic activity and its outputs.

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The answers to these problems can perhaps be found in the creativity of the individuals who participate in what is, at times, an harrowing process of revisions, changes, reviews, replies and rebuttals. This is a process that is managed by academics who donate their time to generate alternatives to a system based on the exploitation of content producers. For these reasons I wish to thank Prof. Simon Penny and all the authors who have contributed to *DAC09: After Media: Embodiment and Context*.

Simon Penny in his introduction to this first LEA special volume clearly states a) the importance of the *DAC09* and b) the gravitas and professional profile of the contributors. These are two points that I can support wholeheartedly, knowing intimately the amount of work that this volume has required in order to maintain the high standards set by *Mish Mash* and the good reception it received.

For this reason in announcing and presenting this first special volume I am proud to offer readers the possibility of engaging with the work of professionals who are contributing to redefining the roles, structures and semantics of new media, digital art practices and interdisciplinarity, as well as attempting to clarify what digital creativity is today and what it may become in the future.

The field of new media (which are no longer so new and so young – I guess they could be better described as middle aged, slightly plump and balding) and digital practices (historical and contemporary) require new definitions and new engagements that move away from and explore beyond traditional structures and proven interdisciplinary partnerships.

DAC09: After Media: Embodiment and Context is a volume that, by collating papers presented at the DAC09 conference, chaired by Prof. Simon Penny, is also providing recent innovative perspectives and planting seeds of new thinking that will redefine conceptualizations and practices, both academic and artistic.

It also offers to the reader the possibility of engaging with solid interdisciplinary practices, in a moment in which I believe interdisciplinarity and creative practices are moving away from old structures and definitions, particularly in the fraught relationship between artistic and scientific disciplines. If 'cognitive sciences' is a representation of interdisciplinarity between artificial intelligence, neurobiology and psychology, it is also an example of interdisciplinary interactions of relatively closely related fields. The real problem in interdisciplinary and crossdisciplinary studies is that these fields are hampered by the methodological problems that still today contrapose in an hierarchical structure scientific methodologies versus art and humanities based approaches to knowledge.

This volume is the first of the special issues published by LEA and its appearance coincides with the newly revamped website. It will benefit from a stronger level of advocacy and publicity since LEA has continued to further strengthen its use of social platforms, in fulfillment of its mission of advocacy of projects at the

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intersection of art, science and technology. *DAC09* will be widely distributed across social networks as open access knowledge in PDF format, as well as being available on Amazon.

I extend a great thank you to all of the contributors of *DAC09: After Media: Embodiment and Context* and wish them all the very best in their future artistic and academic endeavors.

Lanfranco Aceti
Editor in Chief, Leonardo Electronic Almanac
Director, Kasa Gallery

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I would like to thank Ozden Sahin, LEA Co-Editor, for having delivered with constancy another project of which LEA could be proud. The LEA special issues are more similar to small books – 200 pages is not a small endeavor – that require special care and attentive selection.

I am very grateful to Prof. Simon Penny for the hard work that he has put into this volume and to the authors who have patiently worked with us.

To all of you my heartfelt thanks.

DAC09: After Media: Embodiment and Context is the first special volume of the Leonardo Electronic Almanac to be followed by many others that are currently in different stages of production, each of them addressing a special theme and focusing on bringing to the mainstream of the academic debate new forms of thinking, challenging traditional perspectives and methodologies not solely in the debates related to contemporary digital culture but also in the way in which these debates are disseminated and made public.

To propose a special volume please see the guidelines webpage at: http://www.leoalmanac.org/lea-special-issues-submission-instructions/

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Two decades of Digital Art and Culture

An introduction to the LEA DAC09 special edition

by

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This volume of LEA is composed of contributions drawn from participants in the 2009 Digital Art and Culture conference held at the University of California, Irvine in December 2009. DAC09 was the eighth in the Digital Art and Culture conference series, the first being in 1998. The DAC conference series is internationally recognized for its progressive interdisciplinarity, its intellectual rigor and its responsiveness to emerging practices and trends. As director of DAC09 it was these qualities that I aimed to foster at the conference.

The title of the event: After Media: Embodiment and Context, was conceived to draw attention to aspects of digital arts discourse which I believe are of central concern to contemporary Digital Cultural Practices. "After Media' queries the value of the term 'Media Arts' – a designation which in my opinion not only erroneously presents the practice as one concerned predominantly with manipulating 'media', but also leaves the question of what constitutes a medium in this context uninterrogated. 'Embodiment and Context' reconnects the realm of the digital with the larger social and physical world.

'Embodiment' asserts the phenomenological reality of the fundamentally embodied nature of our being, and its importance as the ground-reference for digital practices. 'Embodiment' is deployed not only with respect to the biological, but also with reference to material instantiations of world-views and values in technologies, a key example being the largely uninterrogated Cartesianisms and Platonisms which populate computational discourse. Such concerns are addressed in contemporary cognitive science, anthropology and other fields which attend to the realities of the physical dimensions of cognition and culture.

'Context' emphasises the realities of cultural, historical, geographical and gender-related specificities. 'Context' brings together site-specificity of cultural practices, the understandings of situated cognition and practices in locative media. The re-emergence of concerns with such locative and material specificity within the Digital Cultures community is foregrounded in such DAC09 Themes as Software and Platform Studies and Embodiment and Performativity.

The DAC09 conference included around 100 papers by an international array of contributors. In a desire to be maximally responsive to current trends, the conference was to some extent an exercise in self-organisation by the DAC09 community. The call for papers and the structure of the event was organized around nine conference themes which were themselves the result of a call to the community for conference themes. The selected themes were managed largely by those who proposed them. Much credit for the success of the event therefore goes to these hard-working 'Theme Leaders' : Nell Tenhaaf, Melanie Baljko, Kim Sawchuk, Marc Böhlen, Jeremy Douglass, Noah Wardrip-Fruin, Andrea Polli, Cynthia Beth Rubin, Nina Czegledy, Fox Harrell, Susanna Paasonen, Jordan Crandall, Ulrik Ekman, Mark Hansen, Terry Harpold, Lisbeth Klastrup, and Susana Tosca, and also to the Event Organisers: David Familian, Michael Dessen, Chris Dobrian, Mark Marino and Jessica Pressman. I am particularly grateful to Ward Smith, Information Systems Manager for DAC09, who for two years, as my sole colleague on the project, managed electronic communications, web design and the review and paper submission processes amid, as he would put it, a 'parade of indignities'. In the several months of final planning and preparation for the event, the acumen and commitment of Elizabeth Losh and Sean Voisen was invaluable.

I first published on what we now refer to as digital arts in 1987. [1] Not long after, I was lucky enough to have the opportunity to attend the first ISEA conference in 1988. Since that date I have been actively involved in supporting the development of critical discourses in the field, as a writer, an editor and an organizer of events. My role as director of the DAC09 conference gave me a perspective from which to reflect on the state of digital arts discourse and its development over two decades. As I discussed in a recent paper, [2] the first decade on media art theory was a cacophonous interdisciplinary period in which commentators from diverse fields and disciplines brought their expertise to bear on their perceived subject. This created a scenario not unlike that of various viewers looking into a house via various windows, none of them perceiving the layout of the house, nor the contents of the other rooms. In the ensuing decade, a very necessary reconciliation of various disciplinary perspectives has occurred as the field has become truly a 'field'.

While post structuralist stalwarts such as Deleuze and Derrida continue to be referenced in much of the more critical-theory oriented work in Digital Cultures, and the condition of the posthuman and posthumanist are constantly referenced, theoretical reference points for the field are usefully broadening. The emerging field of Science and Technology Studies has brought valuable new perspectives to media arts discourses, counterbalancing the excesses of techno-utopianism and the sometimes abstruse intellectualism of post-structuralist theoretical discourses. In this volume, Mark Tuters provides an exemplar of this approach in his *Forget Psychogeography: Locative Media as Cosmopolitics*, bringing Rancière and Latour to bear on a discussion of HCI, Tactical Media and Locative Media practices. Tuters provides a nuanced argument replete with examples which questions the sometimes, superficial and dogmatic re-citation of the originary role of the Situationists with respect to such practices. At DAC09, Connor McGarrigle also took a thoughtful revisionist position with respect to the Situationists. [3]

In this context, the new areas of Software Studies and Platform Studies have emerged and have been nurtured in previous DAC conferences. In this spirit, Chandler McWilliams attempt to "thread the needle between a reading of code-as-text that obfuscates the procedural nature of code, and an overly technical description of programming that reinstates the machine as the essential arbiter of authentic acts of programming" is emblematic of the emergence of Software Studies discourses which are quintessentially interdisciplinary and erudite on both sides of the science wars divide. Similarly, Mark Marino's meditations on heteronormativity of code and the Anna Kournikova worm call for what he calls Critical Code Studies, here informed by queer theory. In their proposal for an 'AI Hermenteutic Network' Zhu and Harrell address the question of intentionality, a familiar theme in AI critical discourse (i.e., John Searle 'Minds,

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Brains and Programs' 1980). Citing Latour, Agre, Hayles and others, they offer another example of the science-wars-sidestepping technical development based in interdisciplinary scholarship noted in the discussion of Chandler McWilliams' contribution.

Another trend indicative of the maturation of this field is its (re)-connection with philosophical discourse. In this context, the deep analysis of Electronic Literature in terms of Wittgensteinian Language Games by Mauro Carassia is something of a tour de force. While a tendency to extropianism is here not explicitly discouraged, this discussion places such technological practices squarely as indicators of transition to post-human subjectivity, and in the process, open the discussion to phenomenological, enactive and situated critiques as well a drawing in the relevance of pre-cognitivist cybernetic theorisation.

One of the aspects of contemporary media arts discourse which I hoped to foreground at DAC09 was questions of embodiment and engagement with contemporary post-cognitivist cognitive science. Several papers in the current collection reflect such concerns, and indeed they were foregrounded in several conference themes. One example of the value of the application of such theory is evidenced in Kenny Chow and Fox Harrells leveraging of contemporary neuroscience and cognitive linguistics in their deployment of the concept of "material-based imagination" in their discussion of Interactive Digital Artworks. In a quite different approach to embodiment and computation, Carrie Noland discusses choreography and particularly the choreography of Cunningham, with reference to Mauss and Leroi-Gourhan, and with respect to digital choreographic tools.

The DAC community did not choose to make Game Culture a focal theme in DAC09 – perhaps because the field has grown so quickly and has built up a structure of conferences and journals. Nonetheless, gaming culture was referenced throughout the event, and was the subject of numerous presentations, such as Josh and Karen Tannenbaums reconsideration of 'agency as commitment to meaning', which addressed the acknowledged problematic of the tension between authorial and user agency in terms of a critique of the humanist subject. Like wise, phraseology such as Boluk/Lemieux's: "player performance in and around games has matured to the point of beginning to express underlying serial logics through heavily mannered gameplay mechanics" (in their contribution to this volume) signals the establishment of a mature and erudite critical theory of games and gaming. On a more technical note, Sullivan/WardripFruin/Mateas make an argument for enriching computer game play by application of artificial intelligence techniques to the authoring of 'quests'.

As Digital Arts became established as a practice the question of pedagogy inevitably arose – what to teach and how to teach it. Though rhetorics of convergence pretend to the contrary, one cannot dispute the profound epistemological and ontological dilemmas involved in attempting to bring together intellectual environments of such disparate communities as engineers, artists and critical theorists, in the classroom and the lab. Interdisciplinarity was therefore the ground upon which these programs were developed, and each context inflected that idea with its own color. My own reflections on the subject are published at *Convergence.* [4] It therefore seemed timely to address pedagogy at DAC09. In the process of elaboration of digital cultural practices, such emerging practices have themselves come into consideration as pedagogical tools and systems. In this volume, Elizabeth Losh surveys and discusses various pedagogical initiatives (mostly in Southern California) deploying digital tools and environments. In a contribution which crosses between the pedagogy thematic and concerns with cognition, Harrell and Veeragoudar Harrell offer a report on a science, technology, engineering, and mathematics (STEM) educational initiative among at-risk students which considers the relationships between users and their virtual identities.

In his essay, Garnet Hertz discusses the work of three artists – Reed Ghazala, Natalie Jeremijenko, and Tom Jennings. None of them 'media artists' in the conventional sense, they, in different ways and for different purposes, re-purpose digital technologies. Rounding out this volume is presentation of two online artworks by Sharon Daniels which were presented at DAC09. *Public Secrets* and *Blood Sugar* are elegant web-based art-works, both poetic and examples of a committed activist practice.

In my opinion, this collection offers readers a survey of fields addressed at DAC09, and an indication key areas of active growth in the field. Most of them display the kind of rigorous interdisciplinarity I regard as characteristic of the best work in the field. While the science-wars rage on in certain quarters, in media arts discourse there appears to be an attitude of intelligent resolution – a result in no small measure of the fact that a great many such commentators and theorists have taken the trouble to be trained, study and practice on both sides of the great divide of the 'two cultures', and to take the next necessary step of attempting to reconciling or negotiate ontologies traditionally at odds. This professional profile was very evident at DAC09 and is represented by many of the contributors in this volume. Such interdisciplinary pursuits are in my opinion, extremely intellectually demanding. The obvious danger in such work is of superficial understandings, or worse, a simple re-citation of a new canon of interdisciplinary media studies. Dangers that, happily, none of the papers grouped here, and few of the papers presented at DAC09, fell victim of. ■

The electronic proceedings of DAC09 are available at this link: http://escholarship.org/uc/ace_dac09

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Energy Geared to an Intensity High Enough to Melt Steel

Merce Cunningham, Movement, and Motion Capture

A B S T R A C T

The paper is concerned with the relation between everyday human social conditioning and the specialized skills demanded by choreography. *Exploring the choreographic methods of Merce Cunningham, the author shows how choreography requires an entrainment of the body that mirrors modes of corporeal socialization while deviating in significant ways from the conditioning normally received. Cunningham works with constraints that have little to do with social convention, but that remain historical insofar as they reflect the technological conditions of a particular era. In the paper, his methods are traced from the inception of chance operations to the employment of* Life Forms *and the software-aided creative process.*

Photograph by Tony Doughterty, courtesy of the artist.

by

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Dance may very well be an ancient technique of the body, found everywhere and throughout human history, but it is hard to imagine choreography – and the choreographer, in particular – as equally ubiquitous and omnipresent. As anthropologists know well, dance does not need the choreographer in order to exist; in fact, many cultures do not approach dance in explicitly aesthetic terms, nor do they associate dances with specific individuals responsible for their creation. Marcel Mauss, for instance, situates dance under the general rubric "Techniques of activity, of movement," in his famous effort to catalogue the multifarious ways human beings "know how to make use of their bodies." He assumes that dance is first and foremost a collective venture, the nature of which is primarily social and socializ*ing*. [1] Mauss treats dance (as opposed to "techniques of hygiene" or "sleeping") as just another large-scale body practice, similar in its movement range to walking, running, leaping, climbing, and swimming. Like these other body practices, dance is handed down from generation to generation as one of many "efficient" vehicles for the embodiment and performance of social values. [2]

Mauss's gaze is directed toward dance as an "act," one that is experienced by its author as "mechanical" and "natural," rather than aesthetic and virtuosic. [3] It is therefore difficult to imagine him treating in a similar way – that is, as another "technique of the adult" belonging to a shared *habitus* – the specialized concert dance produced by a choreographer (at least as this function has been exercised, in the form of a ballet master, from the 17th century onwards). [4] And it is next to impossible to apply Mauss's understanding of dance (classified with walking and running) to the counter-intuitive, physically and mnemonically demanding sequences of a postmodern choreographer such as Merce Cunningham. Cunningham's work is particularly interesting for thinking through the place of dance in culture, its role in fortifying or challenging the *habitus*, as well as the implication of that *habitus* (and the moving body it mobilizes) in the technical and technological conditions of the moment. Known for working within constraints having nothing to do with social convention, constraints that are often technologically determined, Cunningham's dance is far more than a feature of collective "dressage." [5] In fact, it tests more than any other movement form both the logic of habitual, socially sanctioned motor sequences (the *habitus*) and the supposedly inescapable logistics of human anatomy. And yet *as movement* – that is, insofar as dance movements are large-scale body movements like those involved in walking or swimming – even Cunningham's choreographed sequences remain "techniques of the body." They impress us as skillful and functional, aimed at getting somewhere and accomplishing some task, even as they obey arbitrary chance operations and embody intentions intimate to no collectivity or human being. In this paper I will be concerned with the relation between social conditioning on the one hand and the skills demanded by choreography on the other. I want to understand better how choreography can require an entrainment of the body that mirrors modes of bodily socialization while deviating in dramatic – and ultimately aesthetic – ways from the social conditioning a body normally receives.

Cunningham, born in Seattle in 1919, is known for his intractable dedication to emotional neutrality, his rejection of kinetic habits (already learned movement patterns), and, most dramatically, his unceasing effort to displace elements of creative decision-making from subjective to objective (external) means. After meeting John Cage in 1938, Cunningham revolutionized twentieth-century concert dance by adapting and reinterpreting many of Cage's compositional methods for the medium of movement. Throughout the 1940s, Cunningham was experimenting with Cage-inspired innovations. Distancing himself from the practice of Martha Graham, whose company he quitted in 1946, he started to approach the bond between music and dance as one that could be attenuated and, eventually, entirely broken. Realizing that collaborators could work separately, he aimed to disentangle the movement material from the dynamics, rhythmic structure, and tonal moods of the accompaniment. The result was the liberation of the moving body from the phrasing and dynamics of musical accompaniment and thus a transformation of its traditional narrative, illustrative, or expressive role. Like Cage, Cunningham also reconceived the structure of his compositions as time-based: his choreographies consisted of so many minutes to be filled, with units of action calculated mathematically. As he stated in 1948, dance could be defined, at bottom, as nothing more than "organized movement in a specified time and space". [6] The important break with modern dance (not to mention habitual techniques of the body) had been made; "constructivist" principles would from now on guide movement sequences, "specifying" the time and space into which gestures would be "organized," or enchained. [7]

Remaining faithful to this astringent poetics, Cunningham then explored the practical effects of adapting a further Cage doctrine, to wit: that in life, continuity – what we might call history, or the existence of things in time – is produced by one thing following another. Cage always took a lively interest in the way everyday aural phenomena unfold unpredictably, and he wished to emulate this unpredictable order in his own music. To Cage, this meant that the flow of sonic events in music required no more intentional organization than the flow of natural events. By 1950, to replicate this aleatory continuity of the ambient world, Cage began developing chance operations, methods for shifting the responsibility of sequencing from composer to external device [8]. Inspired by the *I Ching*, he allowed coin tosses or the surface imperfections on a sheet of paper to determine the order of notes, meters, durations, and instruments in a work. Cunningham soon followed suit. This approach to continuity as conditioned by external constraints would prove to be the source of Cunningham's most rigorous innovations in twentieth-century aesthetics.

Much attention has been paid to chance means as a general avant-garde technique; however, little has been done to theorize Cunningham's adoption of chance methods of construction as they apply specifically to *moving bodies on stage*. A constructivist, procedure-oriented aesthetics presents a particular challenge to dance, and it is therefore important to examine how chance operations impact choreography, specifically. In dance, the medium involved is the human body; this body is an organic unit with a bipedal, cephalized, symmetrical, mobile-through-the-midline-axis skeletal structure. It is not as infinitely manipulable as, say, words on a page or notes on a staff. When constructivist methods – or methods of "nonintention" – are applied to sequences of human movement, what emerges most clearly are the limits to flexion and the constraints of gravity that necessarily inhere. [9] At the same time, constructivist poetics do allow the cho-

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reographer (and thus the audience) to discover new potentials of the human neuro-musculature while offering the opportunity to explore how human sensory systems may be extended and revised in directions not demanded by normal, everyday environmental conditions – in other words, beyond the constraints of the evolutionary process. [10] When confronted with sequences found in no previous training or any other human social context, dancers must engage their senses, muscles, and memory to master the transitions from one movement to the next. Dancers become experts at adapting their own sensorimotor instrument to the situation at hand. A constraint-based or constructivist aesthetic characterizes much of the most exciting choreography produced over the last fifty years, from Anna Halprin's "game-task approach" to movement generation (realized beautifully in Trisha Brown's 1971 "Accumulation") to William Forsythe's "if this/then that" algorithmic method and his "improvisation technologies". [11] Cunningham's "nonintentional" choreographic works arguably offer the greatest challenge to dancers – with respect to both their physiology and their socialized ways of employing it. Dancers cannot rely on inverse kinetics, the reverb effect that allows the flow of energy to connect various muscle groups in supposedly organic ways. [12]

Over the years, interviews with Cunningham's dancers have confirmed that the greatest challenge they face is to augment their ability to enchain movements never enchained before in either everyday life or the traditional technique classroom. Dancers must internalize time, embody their own cues, sense – through highly developed capacities of hearing and proprioception – the presence of other bodies in their midst. Cunningham has stated that his most fulfilling aesthetic experiences have been produced by the spectacle of a dancer learning to embody his nearly impossible choreography, that is, by the spectacle of a human body in the process of rearticulating its very motility in order to perform inorganically derived choreographic "operating chains" (to evoke the terminology employed by André Leroi-Gourhan). Cunningham has also suggested that this spectacle of virtuosity constitutes the expressive content of his dances; meaning is derived neither from narrative nor from individuated emotion, but from what he calls the "human drama on the stage". [13] Dancers forge through the adjustment of their own internalized movement expectations new continuities between movements never enchained before.

Cunningham's interest in nonintentional continuities has a long history in avant-garde practice. The nature of continuity first became a prominent issue in art during the Dada period when chance operations were formally devised. Prior to World War I, the sequence of material events in art had been largely determined – or at least thought to be determined – organically, subjectively, or according to conventional (narrative, prosodic, representational) principles. Continuity resulted from a recognizable logic attributed to nature, psychology, or artistic tradition. With the invention of continuity-producing technologies, such as Tristan Tzara's word cuttings or the *cadavre exquis*, the source of continuity was explicitly displaced onto external devices, random or objective processes. The Dadaist (and Surrealist) emphasis was theoretically not on creating artworks but on unearthing some kind of preconscious, unintentional, and collective reality that could not be accessed unless conventional methods of sequencing were jettisoned. A hint of this notion remains in Cunningham's practice (and in Cage's Buddhist explanations of it). However, Cunningham stresses that his main reason for employing chance procedures is not to locate a truer, more profound reality, but simply to generate alternative possibilities, to explore unrealized virtual potentials of the body. [14] Chance operations – and later computer motion capture programs – allow him to evade habitual ways of stringing movements together. Chance procedures are, Cunningham writes, "a present mode of freeing my imagination from its own clichés and... a marvelous adventure in attention.... [gestures are as if] jabbed by an electric current." [15]

It is important to underline once again where Cunningham's emphasis lies: on enchaining movements in new ways, not primarily on inventing new movements. Cunningham takes as his *matière brute* the already given (and this explains his affinity with Robert Rauschenberg and the aesthetics of collage). [16] Cunningham works with a fairly traditional vocabulary of balletic and modern positions and movements, with a few idiosyncratic exceptions (such as his characteristic flip of the wrist). Thus, experimenting in the domain of continuity means, to him, exploring new ways of sequencing, playing with the ways one thing can follow another. In 1954, upon receiving the Guggenheim award, Cunningham explained: "the use of chance [is] a method of finding continuity, that is, continuity thought of as being the continuum of one thing after another, rather than being related by psychological or thematic or other cause-and-effect devices." [17]

The two crucial factors contributing to the unique quality of a Cunningham work are thus, paradoxically, isolation and continuity. On the one hand, movements – even on the order of single articulations, such as the tilt of a head – are isolated from larger phrases involving other parts of the body; on the other, these isolated movements, drawn from what Cunningham frequently refers to as his "gamut," [18] are placed into sequences, thereby forging phrases that give the appearance of continuity. This method of isolating and then recombining movements has always been a constant, but a recent Los Angeles revival of *Roaratorio*, Cunningham's 1983 collaboration with Cage based on James Joyce's *Finnegans Wake*, threw his reliance on isolation into relief. Before the performance began (and under full theatre lights), members of the company executed the isolated elements that, once combined into continuous phrases, would make up the material of the performed piece. [19] Each dancer practiced in isolation, as if in front of a mirror, alone before a class, displaying the vocabulary (the "gamut" of movements) that would presently be mobilized by pairs and in other patterns. The elements of *Roaratorio*, based on jigs and reels, are the passé turn, the hop, the coupé, the rond de jambe, and various isolations of the head, upper chest, and arms. Once the lights dimmed and the music began, spectators had already been introduced to the simple isolations from which (with supplementation, of course) the piece is composed. The focus of the interest, then, was not on the individual movement elements themselves but rather on their various combinations and the rigor of their execution. Isolating the movements of the body was the first step in recombining them to surprising effect.

A similar impetus can be seen governing the procedure Cunningham applied to create *Roadrunners* in 1979. While touring with his company in Europe earlier that year, Cunningham took the opportunity to visit the Antikensammlung Berlin, the museum of antiquities that houses an impressive collection of Attic vases from 1100 to 800 B.C.E. Cunningham recounts that he was attracted to the depictions of the human figures on the vases, which struck him as "lively and active." Wondering "what they could provoke going one to the other," he then sketched the figures in his notebook in stick-figure form, trying to end up with the magical *I Ching* number, sixty-four. [20] The context for his sudden interest in depicted gestures on Greek vases is both surprising and significant: the "lively" postures drew his interest because, at the time, he was planning to make a choreography "closer to TV," as he puts it. Somewhat astonishingly, the Greek vase figures made him think of TV insofar as their seriality, their discreteness as he moved from one vase to the

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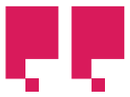
next in the display context, suggested to his eyes the "abruptness and swiftness" of television images, the way "short things... happen and disappear, and other things... come in." From the "gamut" of "shapes" jotted down in his notebook, Cunningham then produced a dance that he felt imitated TV through its pacing and dynamic: "To get from one of these shapes in its space to another in its allotted space brought about the abruptness and change of pace." Here, a modern technology (television and the choreographer's lived experience of it) proposed a style: "abrupt" and "swift." But the actual movement material came from isolated gestures found on vases from millenia earlier that he adapted to suit his particular dance vocabulary.

Cunningham was thus asking his dancers not only to imitate the depicted gestures on Attic vases but also to link these gestures together, despite the awkward ("abrupt") and often difficult routes the body had to forge between them. Cunningham's dancers were of course habituated to such assignments. Since at least 1953, when Cunningham began more dramatic experiments with chance operations in *Suite by Chance*, dancers had been required to discover continuity within the discontinuous, transitions between movements that were kinetically distinct. As one of Cunningham's dancers Remy Charlip has written, in chance-determined choreographic sequences, a dancer could very well be "standing still one moment, leaping or spinning the next. There are familiar and unfamiliar movements," he explains, "*but what is continuously unfamiliar is the continuity*, freed as it is from usual cause and effect relations." [21] Cunningham also notes: "It was physically very difficult ... [G]etting from one thing to another... was in itself part of the drama, because just to do that was so intense." [22] However intense these "unfamiliar continuities" were, however, Cunningham's dancers were fully resolved to master them. Cunningham himself would practice hours and hours to make his body fit the unfamiliar chain of motions. In doing so, he was not so much attacking the organic body as attempting to defy its habits and extend its given possibilities. For Cunningham's choreography demands that dancers develop a new type of virtuosity, a specific variety of kinesthetic flexibility that involves being able to intuit kinesthetically how to proceed from one movement to the next – a dilemma that Cunningham considers to be at the very heart of dancing. Due to the "unfamiliar" and even counter-intuitive nature of the sequencing, the dancer cannot follow a habitual kinetic impulse or reverb ("reverse kinetics"), an inscribed neuronal route. Instead, she has to forge one



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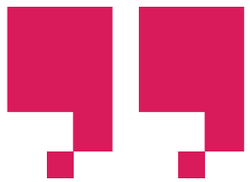

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with her own energetic flow, thereby creating the dynamics we witness on stage. "*Dynamics in movement come from the continuity*," he underscores in his rehearsal notes for the 1956 *Suite for Five in Space and Time*. [23] Extensive rehearsal time (which dancers often complete in isolation) is necessary to realign the neuromuscular connections such that one momentum can be grafted onto – and continued in – the next.

Ironically, in order to cope with the demands Cunningham's choreography makes, dancers have to rely on the very same skills required for the acquisition of the most typical, socially generated, motor chains. That is, dancers need to extend the very capacity that paleoethnographer André Leroi-Gourhan claims is responsible for distinguishing humans from other animals: the ability to increase exponentially the number of neural connections among various parts of the body and brain, an ability made possible as a result of the larger cerebral cortex gained through the long course of evolution. In *Gesture and Speech*, Leroi-Gourhan argues that over millennia, *homo sapiens* has acquired a "refined sensitivity" and "an intelligent motricity" nourished by – and recursively responsible for – the multiplicity and complexity of what he calls "operating chains." [24] Environmental conditions (and this includes natural and man-made objects as well as learned techniques) demand a gestural response; a self-correcting kinetic-kinesthetic system forges new connections in the brain, which then produces change in the environment (new technologies and techniques requiring, in turn, a new gestural response). According to this paradigm, human bodies come into existence as a result of performing sequences of movement that are functional or expressive in purpose, sequences that differ from one ethnic group to another and thus cannot be considered either necessary or inevitable.

The flexibility noted by Leroi-Gourhan is expanded and transformed into an *aesthetic program* in Cunningham's choreography. With sequencing determined by chance, Cunningham calls on his dancers to go beyond even the normal apprenticeship in a specialized dance vocabulary (and certainly beyond the demands of any social *habitus*). As his classroom exercises demonstrate, he seeks to amplify a dancer's ability to change sequencing on the spin of a dime. Cunningham dancers need to be flexible enough, adaptable enough, to perform "unfamiliar continuities" in practically every class. It is as though the choreographer were asking a toddler to walk first one way, then another way, then yet another – and in each case, the "walk" has to appear as natural, as *purposive*, as a conventional, socially-sanctioned mode of ambulation. [25] To borrow Malcolm MacIver's phrase, the "sensory ecology of the [Cunningham] animal" is one that demands a hyperdevelopment of the imitative, self-molding plasticity that humans naturally exhibit when learning new tasks. [26] Determining the outer limits of that plasticity – at once kinetic-kinesthetic and neuro-physiological – is part of the exploration that artists we call "experimental," or "avant-garde," pursue in the choreographic realm. [27]

It is instructive to listen to Cunningham dancers recount how they developed the faculties he requires. Carolyn Brown, for instance, remembers that she would learn the choreography and first practice it alone for many hours before attempting it with a partner or group. "There was only one way for me to approach [the choreography's] abruptness," she writes, "the going from one isolated movement to another without flow or intended continuity, without a rhythmic pulse dictated by the music, ... and that was with absolute concentration on each single moment." [28] Cunningham was by no means insensitive to the effort required; in fact, he discovered in that effort the very basis of his aesthetic, the "energy geared to an intensity high enough to melt steel" that he wanted his audience to view. [29] In "Two Questions and Five

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Dances," Cunningham describes his exhilaration as he observed Joan Skinner take a notoriously difficult sequence of movements and thread them together seamlessly with her own body. According to Cunningham, Skinner introduced a type of "coordination, going from one thing to another, that I had not encountered before, physically." [30] To this day, the best Cunningham dancers are able to make an "unfamiliar continuity" seem like "a new pattern," a gestural sequence possessing the same "inevitability" as an operating chain required to complete a specified task. [31] Indeed, it has been remarked that while performing, Cunningham dancers exhibit a task-like attitude, a pensive concentration; they are emoting what I call the *affect of skill*. For the dancer, the goal is not to *look* like she is revealing, through improvisation, a new possibility for the body, a new way of riding an energetic wave (as in the work of William Forsythe). Rather, her goal is to *feel* as though she were executing an operating chain, following the course of what might look unfamiliar but is actually lived on the order of the body as habitual – but habitual only because repeated a brutal number of times. The work on the body that occurs during those arduous "months of rehearsal" mirrors the process whereby a young body assumes a culture-specific body *hexis*. Cunningham's practice has a critical edge, then, for it implicitly suggests that any body *hexis* is to some extent inorganic, conventional, and arbitrary – a matter of chance.

The advantage of Leroi-Gourhan's model for studying experimental dance is that it situates the emergence of gestural sequences in the context of both the evolution of the human body and the history of its material and technological interactions. Moving beyond Mauss, Leroi-Gourhan insists that bodies become articulate not simply by assuming group behaviors, but by assuming group behaviors *developed in relation to the tools and objects the group learns to manipulate through operating chains*, tools and objects that, in a sense, come to manipulate *them*. If we follow this logic, then ostensibly a change in tool or technology would cause a change in the operating chains devised to manipulate them; the operating chains would in turn produce alterations in the body, re-shaping the very muscles, ligaments, and tendons primed to perform them. This is an important set of arguments, entirely pertinent to Cunningham's craft. For Cunningham's fascination with technologies goes well beyond wishing to imitate the rhythm of a specific technology (as in *Roadrunners*, when he sought to reproduce the swift action changes of TV). As is well known, Cunningham is one of the pioneers in the use of advanced technologies to *generate* dance sequences. For instance, in 1989, Cunningham began collaborating with Thecla Schiphorst and Catherine Lee to adapt *Life Forms Dance Software*, a three-dimensional computational tool, to the choreographic task. [32] By turning to a computer software program developed by Dr. Tom Calvert, a professor at Simon Fraser University, Cunningham was accomplishing in the most technologically advanced way available the transfer of sequencing decisions from his own will (replaced in the 1950s with coin tossing) to the programming "will" of an external device. Further, the programming technologies themselves evolved, from the more crude and approximate motion capture devices of the late 1980s to the highly refined kinematic capture devices of the next decade. In conclusion, therefore, we must ask whether the move from employing "low tech" chance operations to employing the most sophisticated version of *Life Forms* produces not only new gestural chains (new techniques of the body) but also a slightly different body (not to mention a slightly different type of dance).

In general, Cunningham's process has remained surprisingly consistent over time. No matter which software program or sequence generator he employs, Cunningham's central focus is on isolating and then reconnecting movements that the human body can make - all movements stored in the software menu were human derived, although the sequences made of them were not. He was never interested in learning how to program computers, but only in exploiting the potential of software to generate new combinations and sequences of movement. Beginning with *Trackers* in 1989 (premiered in 1991), he continued until his death in July of 2009 to choose the movements for each part of the dancer's body from his own favored vocabulary (starting with leg positions, then arm positions), subsequently entering them into a "menu" that could be accessed by a "Sequence Editor." As before, he often composed sequences of movements by coin-tossing chance methods, then tried them out on the animated figures that could be manipulated on the screen. And again, as Schiphorst recounts, "When these movement sequences appeared physically impossible, Merce would work with his dancers at discovering how they could be made to work." [33]

The salient difference, however, is that before mounting the chance-derived sequences on human bodies, Cunningham would test them out first on the virtual avatar, a generalized and abstracted version of the human body if there ever was one. That is, instead of working directly with the dancer's body, whose individuality he often praised and showed to advantage, he inserted into the process this strange intermediary, a set of animate pixels that couldn't help but influence the nature of the gestural chain produced. The dancer would then have to discover internally a continuity that was unfamiliar in part because it had been conditioned by the articulations of a *virtual* figure. For the early experiments with *Life Forms*, the motions of this figure were pre-segmented into "keyframes," Schiphorst explains, "each [one] containing a body shape." [34] These body shapes were composed either of "a single limb segment" or "a chain of limb segments" based on "inverse kinetics," or the way a movement in one part of a limb habitually affects movement in another. [35] Of course, the programmer's segmentations of the animated figure, its "shapes," and the connections between them, constitute nothing more than an approximation, an extrapolation, of the potential articulations of the human body. But such approximations have become more refined over time. In 1997, Paul Kaiser and Shelley Eshkar of Riverbed Media invited Cunningham to test out their new motion capture computer animation software program, entitled *Biped* after the name of the two-footed avatar the program uses. When projected, the Biped avatar appears more "lifelike" than the earlier hoop or concentric circle figures, based as it is on a sophisticated apparatus of motion capture capable of accounting for "detailed 'kinematic' effects, including skin and tendon behavior." [36] Apparently, even a "foot landing on the ground" and the corollary reverb, those "transformations" effected throughout the rest of the body, could be registered, entered into the program, and reproduced on the screen.

However, whether using the blunt tools of an earlier era or the sharper tools of the late 1990s, Cunningham's aim was never to make choreographies that would appear natural or physiologically motivated. The fidelity of the motion capture process, in other words, merely provided more elements to isolate, not energetic curves (kinematics) to reproduce. As always, even in his latest computer-facilitated works, Cunningham was seeking connections between movements that *jar*, "continuities" that remain "unfamiliar." The very limitations of motion capture technologies, their tendency to isolate body parts, facilitates the kind of effects Cunningham hoped to achieve. For the purposes of building sequences with the software, Biped's body was divided into fourteen sections, vertically and horizontally, and its sequential possibilities were lim-

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ited by the way these fourteen sections can be connected in virtual space. (Note that these animation-based isolations mirror the way human body parts were isolated earlier in Cunningham's lists and charts.) If in earlier times, Cunningham tossed coins to make sequences out of isolated movements, sequences that he then tested out on his dancers, here the sequences of isolations were tested out first on the screen avatar. That is, the choreographer was able to have a purely visual experience of *the default continuities* the avatar produces – continuities willed neither by the choreographer nor the struggling dancer – before that choreography would be placed on the dancer in the studio and adapted, finally, to what a human body can actually do.

The result of employing *Life Forms* is therefore markedly distinct from that obtained by tossing coins and mounting unfamiliar sequences on individual dancers. Unfamiliar continuities are visualizable before they are felt. It is likely, then, that the process of discovering flow and producing continuity is less a visceral preoccupation of the individual dancer than a conundrum to be worked out by the choreographer on the screen first, then in the studio. It isn't so much that the ingenuity of individual virtuosity disappears, but rather, a new virtuosity must be born. The dancer not only imitates a sequence of isolations generated by chance, she also embodies continuities generated by disembodied calculations. The result is radically unique to Cunningham's choreography: As David Vaughan observed in 1997, "Certain of the movements in *Trackers* – angular movements of the arms performed in a counter-rhythm to those of the legs – were of a kind that was to become instantly recognizable as having originated in the computer. (Cunningham's method was to make the movements of the legs first, then those of the arms and upper body, and finally to put them together...)" [37] Of course, Cunningham allowed his dancers to adapt the computer-generated sequences to their own bodies. How could he not? However, the effect remained: that of an otherworldly articulation, a centerless limb-generated ambulation, a sequencing, or "technique of movement," utterly divorced from that found in the *habitus* of any spectator's or dancer's common world.

The argument I have been pursuing might lead one to suspect that the sequencing by means of *Life Forms* (now known as *Dance Forms*) produces robotic movements, awkward phrasings, and incoherent couplings of dancers on the stage. But even a brief glance at Cunningham's 1997 masterpiece, *Biped,* solicits an entirely different appreciation (at least on the part of this viewer). [38] The dance was generated by means of its eponymous avatar and it does indeed contain moments both strange and unsettling. The utterly original ways for two or three dancers to occupy the same space, for instance, could suggest that the dancers are indifferent to one another's presence, as if they were imitating avatars that were originally dancing in two separate parts of a computer screen that the mere touch of a key subsequently digitally superimposed. Likewise, one might be tempted to call the sequence near the beginning of *Biped* in which dancers repeatedly arch their torsos "other-worldly." The combination in rigorous succession of an arch with a *soulevé*, a *passé*, then an *arabesque* is so physically demanding as to seem nonsensical – emotionally unjustified – given the lack of narrative motivation, the neutrality of the dancers' countenances, and the uniformity of dynamics that accompany this explosion of energy and grace. But in the first case, the indifference of one phrase-executing dancer to another – even as they occupy the same cubic meter of stage – recalls nothing more vividly than the way bodies pass, insensibly, on the subway platform or city street. And in the case of the repeatedly arching backs, one is also reminded of something poignantly human. These extensions of the spine remain perfectly uniform and fully executed despite the changes in leg position that were suggested, through chance combination, by the "Sequence Editor" that was fed the "gamut of movements" based on the segmented lower limbs of the *Life Forms* avatar. Despite their ephemeral, otherworld quality – or perhaps because of it – the dancers executing these repeated arches of the torso (above the changing lower body) strike the viewer as *litheness incarnate*. What is being exhibited here, one realizes, is quintessentially human, quintessentially bipedal: it is pure vestibular virtuosity in the form of a spine suspended and balanced precariously on an arched foot or extended toe. One senses not that Cunningham's dancers have achieved – or descended to – the order of the inhuman, that they have become imitations of an essentially cyborg motility. Instead, one feels that Cunningham's dancers have at last captured the most exquisite potential of human bipedalism: its ability to continue evolving, while remaining truly itself, in relation to the architecture and infrastructure of a postmodern world. This immanent quality of bipedalism appears "as if jabbed by an electric current," as Cunningham puts it. The heightened entrainment of the body, *the augmentation of its power to be subjected,* has revealed the arbitrary in the social and the natural in the arbitrary. Techniques of the body are shown to be (always) more than techniques of the body alone; they are techniques of a body implicated in a technological environment. And this revelation – of technological interdependence – empowers the body to be (like) a technology in turn: The body burns with "an intensity high enough to melt steel." ■

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REFERENCES AND NOTES

1. See Marcel Mauss, "Les Techniques du corps," in *Sociologie et anthropologie* (Paris: Quadrige, PUF, 1950), 365, 380–382; my translation (originally published in the Journal de Psychologie in 1936; first presented as a speech in 1934). Mauss takes his cue primarily from Curt Sachs's 1933 study, *World History of the Dance*, based on accounts of ritual and social (folk) dancing.
2. Marcel Mauss, "Les Techniques du corps," in *Sociologie et anthropologie* (Paris: Quadrige, PUF, 1950), 371.
3. Ibid., 372.
4. According to Susan Leigh Foster, the term "choreographer" did not exist until the end of the 17th century, at which point it referred to the notation, not the invention, of dances. See Foster, *Choreographing Empathy: Kinesthesia in Performance* (London and New York: Routledge, 2011), 18.
5. Ibid., 374.
6. David Vaughan, *Merce Cunningham: Fifty Years*, ed. Melissa Harris (New York: Aperture, 1997), 44.
7. By "constructivist," I am referring to a tradition of art making (identified with but not initiated by the Russian Constructivists) based on applying pre-determined (and sometimes whimsical) procedures and constraints (e.g., geometry; mathematical formulas or algorithms; patterns of repetition or fragmentation, as in the mesostic; the elimination of an alphabetic letter; a combinatory or chance operation, and so on). Constructivist works self-reflexively draw attention to their own formal properties, processes of composition, and historical context. For a sensitive treatment of constructivist aesthetics, see Barrett Watten, *The Constructivist Moment: From Material Text to Cultural Poetics* (Middletown, CT: Wesleyan University Press, 2003).
8. Cage was a student of Arnold Schoenberg, who applied a constructivist principle to the production of a-tonal sequences. Cunningham's own interest in non-subjective creative processes was both a negative reaction to Graham's hyper-subjectivity and a positive response to Cage's compositions. Cunningham wrote in 1957: "In my own work, wanting to find the utmost in freedom from my own feelings, directly, or my memory of continuities and ideas about how movement ought to follow one from another, I have used a chance procedure to obtain the continuity. That is, in the choreography, chance is used to dictate what movement followed any given movement, and correspondingly so, the time and space, that is, the duration and division of the given movement, and what place it happened in" ("Lecture-Demonstration Given at Ann Halprin's Dance Deck (13 July 1957)" quoted in Vaughan, *Merce Cunningham*, 101).
9. The term "nonintention" is often applied to describe Cage's works. The composer preceded Cunningham not only in his use of chance operations, particularly those based on the *I Ching*, but also in his turn toward the computer for the production of musical and verbal works. On Cage's use of Andrew Culver's text manipulation systems, which "emulat[e] the calculations of the *I Ching*" in 1988–89, see C. T. Funkhouser, *Prehistoric Digital Poetry: An Archaeology of Forms, 1959–1995* (Tuscaloosa: University of Alabama Press, 2007), 64.
10. José Gil writes in "The Dancer's Body" that, "once one has discarded all of the emotional, representational and expressive motivations of the body," Cunningham's choreographic practice "enables the construction of a virtual plane of movement" and "the re-organization of movements of the body" according to an "impetus from the virtual plane," or the "plane of immanence" (*A Shock to Thought: Expression After Deleuze and Guattari*, ed. Brian Massumi [New York: Routledge, 2002], 124). Gil then concludes that Cunningham reveals "a body without organs" (124). I would not go so far. Deleuze-inspired readings of dance, such as those produced by Gil, Erin Manning, and Brian Massumi, lose track of the incontrovertible anatomical and physiological limits to which any dancer, including Cunningham, could attest. For a more developed critique of the Deleuzian turn in movement theory, see my *Agency and Embodiment* (Cambridge, MA: Harvard University Press, 2009). See also Brian Massumi, *Parables for the Virtual: Movement, Affect, Sensation* (Durham and London: Duke University Press, 2002) and Erin Manning, *Relation-scapes: Movement, Art, Philosophy* (Cambridge, MA: MIT Press, 2009).
11. See Sally Banes, *Greenwich Village 1963: Avant-Garde Performance and the Effervescent Body* (Durham and London: Duke University Press, 1993), 142, and William Forsythe and Thierry De Mey, *One flat thing, reproduced*, DVD (Paris: Centre national de la cinématographie, 2007), interview with William Forsythe.
12. Cunningham's practice is significantly different from that of William Forsythe, although they share certain features. Forsythe uses improvisation exercises to provoke dancers to explore the full articulatory potential of their joints, requiring them to generate movement chains out of their kinesthetic sense. In Cunningham's style, there is no improvisation; dancers must find ways to connect one movement to another, but each movement and its sequence is determined by the choreographer. An exception to this rule is when a dancer discovers another way to perform the sequence; Cunningham was known to adopt changes his dancers inadvertently introduced.
13. See Vaughan, *Merce Cunningham*, 7. See also my "The Human Situation on Stage: Merce Cunningham, Theodor Adorno, and the Category of Expression" in *Dance Research Journal* 42 No. 1 (Summer 2010).
14. There is an odd contradiction in Cunningham's thought regarding the source of the continuities produced by chance. In "The Impermanent Art" of 1952 he writes: "Some people seem to think that it is inhuman and mechanistic to toss pennies in creating a dance instead of chewing the nails or beating the head against a wall or thumbing through old notebooks for ideas. But the feeling I have when I compose in this way is that I am in touch with a natural resource far greater than my own personal inventiveness could ever be, much more universally human than the particular habits of my own practice, and organically rising out of common pools of motor impulses" (quoted in Vaughan, *Merce Cunningham*, 86). The answer to this conundrum – How could the aleatory be "more universally human"? – may lie in the type of work required to mount the phrases once they have been generated by chance. In contrast to his dadaist predecessors, Cunningham seeks to generate aleatory sequences only as a basis for further elaboration, and this elaboration does require him to reveal and re-establish the possibilities and limits of the human body. He self-consciously wishes to make works of art; accordingly, he subjects the sequences generated through chance operations or computer software to further refinement and alteration. It would require another essay to resolve the contradiction between the aleatory and the organic, or the nonintentional and the intentional. For now, I would suggest that "common pools of motor impulses" end up revealing themselves through the re-working of chance when the variables peculiar to the immediate situation impose themselves. These variables would include the capacities of the individual dancer's body; the physical coordinates of a proscenium or in-the-round stage; the time alotted; and, finally, the aesthetic judgment of the choreographer (which is a historical as well as a personal, idiosyncratic element).
15. Quoted in Vaughan, *Merce Cunningham*, 87.
16. See Roger Copeland, "Cunningham, Collage, and the Computer," *PAJ*, 63 (1999).
17. Vaughan, *Merce Cunningham*, 84–85.
18. Sometimes when Cunningham refers to a "gamut" he means the chart of individual movements chosen as material for creating a segment of the dance; each separate movement belongs to a "movement gamut." At other times, however, a "gamut" refers to a set of movement phrases; the chance operation determines which *phrase* will follow another *phrase*, but the sequence of movements within the phrase is not determined by chance. In *Roaratorio*, Cunningham worked with phrases that were conceived as indivisible units; in other dances, he broke phrases down into individual movements and recombined them according to sequences determined by chance.
19. *Roaratorio*, choreography by Merce Cunningham; music by John Cage ("Roaratorio, An Irish Circus on Finnegans Wake"); costumes by Mark Lancaster; lighting by Mark Lancaster with Christine Shallenberg; dancers Brandon Colwes, Julie Cunningham, Dylan Crossman, Emma Des-

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jardins, Jennifer Goggans, John Hinrichs, Daniel Madoff, Rashaun Mitchell, Marci unnerlyn, Krista Nelson, Silas Riener, Jamie Scott, Robert Swinston, Melissa Toogood, Andrea Weber; restaged by Patricia Lent, assisted by Robert Swinston; Walt Disney Center, June 4, 2010. Lent explains that the exercises were performed on stage as a warm-up, a regular part of pre-performance preparation that had to be conducted before the audience because the Disney stage possesses no curtain. (Interview with Patricia Lent with the author, New York City, March 17, 2011.)

20. *Roadrunners* involved a cast of fifteen dancers; the music was by Yasunao Tone accompanied by his translation of 8th century Chinese tales; it premiered in July of 1979 at the American Dance Festival, in Durham, N.C. On the various ways technology has influenced Cunningham's work, see "Four Events That Have Led to Large Discoveries (19 September 1994)" reproduced in Vaughan, *Merce Cunningham*, 276.
21. Vaughan, *Merce Cunningham*, 70; added emphasis.
22. Quoted in Vaughan, *Merce Cunningham*, 88.
23. From rehearsal notes for *Suite for Five*, an extension of *Solo Suite in Space and Time* with and added trio, duet and quintet. See "Rehearsal Notes 1952–58" in the Merce Cunningham Archives, Westbeth, New York (original emphasis).
24. André Leroi-Gourhan, *Le Geste et la parole, I: Technique et langage* (Paris: Albin Michel 1964), 115; my translation.
25. In *The Perception of the Environment: Essays in Livelihood, Dwelling, and Skill* (New York and London: Routledge, 2000), Tim Ingold argues that learning to walk is no more underwritten by the human genome than learning to bicycle; neither is an inevitable outcome of bipedalism. All ambulatory forms (and by extension, operational chains and gestures) are potentials of a developmental system that can only unfold through the pressure of a specific set of conditions: "what people do cannot be understood as the behavioral output of an inner programme but only as the intentional activity of the whole human organism in its environment" (387). Ingold's perspective clarifies an unstated premise of Cunningham's choreography (and implicitly, of Mauss's anthopology): a certain arbitrariness inheres in the way we are performatively created as moving bodies – both within aesthetic situations and without.
26. The "sensory ecology of the animal" is the set of conditions that cause it to employ and refine sensory capacities; see Malcolm A. MacIver, "Neuroethology: From Morphological Computation to Planning," in *The Cambridge Handbook of Situated Cognition*, ed. Philip Robbins and Murat Aydede (Cambridge: Cambridge University Press, 2009).
27. On "plasticity," especially with regard to the brain and the brain-body connection, see Catherine Malabou, *What Should We Do with Our Brain?* Foreword by Marc Jeannerod, trans. Sebastian Rand (New York: Fordham University Press, 2008).
28. Carolyn Brown, *Chance and Circumstance: Twenty Years with Cage and Cunningham* (New York: Knopf, 2007), 49.
29. "The Impermanent Art," quoted in Vaughan, *Merce Cunningham*, 86.
30. "Two Questions and Five Dancers," quoted in Vaughan, *Merce Cunningham*, 59. The film version of Cunningham's 1993 *CRWDSPCR* (text-messaging language for "Crowds Pacer" or "Crowd Spacer") has some remarkable passages in which dancers recount their experiences learning Cunningham's choreography. Many speak of the "kinetic memories" they must create through repeated practice; they marvel at how, over time, the awkward and seemingly impossible sequences of movement become part of their daily movement vocabulary, as natural to them as watering a plant or riding a bicycle. See *CRWDSPCR*, directed by Eliot Caplan (New York: The Foundation, 1996).
31. Dee Reynolds notes: "It's very remarkable – and many people have commented on this – that although... the sequence is random and although it is chance, when you see it, you get a tremendous sense of inevitability, in fact more than with something that's more conventionally structured, because there it looks contrived" ("The Possibility of Variety: Dee Reynolds Phones Merce Cunningham," in *Dance Theatre Journal* 2, No: 2 (2004): 38–43.
32. For a clear account, see Thecla Schiphorst, "LifeForms: Design Tools for Choreography," *Dance and Technology I: Moving Toward the Future. Proceedings of the First Annual Conference*, ed. A. William Smith (Westerville, Ohio: Fullhouse, 1992), 46–52. Cunningham's first experiments with *Life Forms* produced *Trackers*. *Life Forms* used at this point a wireframe figure (a figure built up through concentric circles); in Steve Dixon's words, *Life Forms* "is a figure animation package that enables the choreographer both to use the computer as a drawing board to conceive movements and sequences in animated form before going into the studio with dancers; and to use the animations themselves as dance, either as a discreet 'movie' or through projection on stage as an element of live dance performance" (*Digital Performance: A History of New Media in Theater, Dance, Performance Art, and Installation* Cambridge, MA: The MIT Press, 2007), 184.
33. Thecla Schiphorst, "LifeForms: Design Tools for Choreography," *Dance and Technology I: Moving Toward the Future. Proceedings of the First Annual Conference*, ed. A. William Smith (Westerville, Ohio: Fullhouse, 1992), 49.
34. Ibid., 50.
35. Ibid., 51.
36. Dixon, *Digital Performance*, 188. In *Biped* of 1999 the "dances" of the line-drawing avatars were projected on a scrim behind which the live dancers performed Cunningham's choreography. The avatar dances were generated by capturing the motions of three Cunningham dancers by means of reflective markers adhered to their joints and body parts. Cunningham did not see the avatar dances until they were projected on the scrim at the time of the premier performance in Berkeley in April 1999; the projection intervals were determined by a chance operation.
37. Vaughan, *Merce Cunningham*, 257.
38. A DVD of *Biped*, filmed by Charles Atlas, is available from mk2 through amazon.fr. The CD is not yet distributed in the United States. See *Biped/Pond Way: Merce Cunningham Dance Company* (mk2, 2006).

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