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# SPECIAL ISSUE

# D A C 0 9

# 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. *DACOG: 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.

*DACOG: 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 *DACOG* 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, 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.

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 *DACOG: After Media: Embodiment and Context*.

Simon Penny in his introduction to this first LEA special volume clearly states a) the importance of the *DACOG* 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.

*DACOG: After Media: Embodiment and Context* is a volume that, by collating papers presented at the *DACOG* 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

intersection of art, science and technology. *DACOG* 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 *DACOG: 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*



ACKNOWLEDGEMENTS

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.

*DACOG: 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 DACog special edition

by

Simon Penny

Director of DACog  
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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. DACog 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 inter-disciplinarity, its intellectual rigor and its responsiveness to emerging practices and trends. As director of DACog 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 DACog Themes as Software and Platform Studies and Embodiment and Performativity.

The DACog 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 DACog 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 Klasturp, 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 DACog, 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. <sup>1</sup> 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 DACog 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, <sup>2</sup> 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 DACog, Connor McGarrigle also took a thoughtful revisionist position with respect to the Situationists. <sup>3</sup>

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,

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 as drawing in the relevance of pre-cognitivist cybernetic theorisation.

One of the aspects of contemporary media arts discourse which I hoped to foreground at DACoG 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 DACoG – perhaps because the field has grown so quickly and has built up a struc-

ture 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*. It therefore seemed timely to address pedagogy at DACoG. 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 DACoG. *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 DACoG, 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 DACoG 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 DACoG, fell victim of. ■

The electronic proceedings of DACoG are available at this link: [http://escholarship.org/uc/ace\\_dacog](http://escholarship.org/uc/ace_dacog)

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Leonardo Electronic Almanac  
Volume 17 Issue 2

**4** EDITORIAL Lanfranco Aceti

**8** INTRODUCTION Simon Penny



**14** HUNDRED THOUSAND BILLION FINGERS:  
SERIALITY AND CRITICAL GAME PRACTICES  
Stephanie Boluk & Patrick LeMieux

**36** ELECTRONIC LITERATURE AS LANGUAGE  
GAME: A PHILOSOPHICAL APPROACH TO  
DIGITAL ARTIFACT SUBJECTIVITY  
Mauro Carassai



**50** UNDERSTANDING MATERIAL-BASED IMAG-  
INATION: COGNITIVE COUPLING OF ANIMA-  
TION AND USER ACTION IN INTERACTIVE  
DIGITAL ARTWORKS  
Kenny K. N. Chow & D. Fox Harrell



**66** PUBLIC RECORDS / SECRET PUBLICS:  
INFORMATION ARCHITECTURE FOR NEW  
POLITICAL SUBJECTS  
Sharon Daniel



**74** IMAGINATION, COMPUTATION, AND SELF-  
EXPRESSION: SITUATED CHARACTER AND  
AVATAR MEDIATED IDENTITY  
D. Fox Harrell & S. Veeragoudar Harrell

**92** PLAY, THINGS, RULES, AND INFORMATION:  
HYBRIDIZED LEARNING IN THE DIGITAL  
UNIVERSITY  
Elizabeth Losh

**110** LANGUAGE IN THE OTHER SOFTWARE  
Chandler B. McWilliams



**120** ENERGY GEARED TO AN INTENSITY HIGH  
ENOUGH TO MELT STEEL: MERCE  
CUNNINGHAM, MOVEMENT, AND  
MOTION CAPTURE  
Carrie Noland



**136** AN INTERVIEW WITH SIMON PENNY:  
TECHNO-UTOPIANISM, EMBODIED INTER-  
ACTION AND THE AESTHETICS OF  
BEHAVIOR  
Jihoon Felix Kim & Kristen Galvin

**146** MAKING QUESTS PLAYABLE: CHOICES,  
CRPGS, AND THE GRAIL FRAMEWORK  
Anne Sullivan, Michael Mateas, Noah Wardrip-Fruin

**160** NARRATING SYSTEM INTENTIONALITY:  
COPYCAT AND THE ARTIFICIAL INTELLI-  
GENCE HERMENEUTIC NETWORK  
Jichen Zhu & D. Fox Harrell



**172** ART AFTER NEW MEDIA: EXPLORING  
BLACK BOXES, TACTICS AND ARCHAE-  
OLOGIES  
Garnet Hertz

**184** OF SEX, CYLONS, AND WORMS:  
A CRITICAL CODE STUDY OF  
HETERONORMATIVITY  
Mark C. Marino

# Understanding Material-Based Imagination

Cognitive Coupling of Animation and User Action in Interactive Digital Artworks

## ABSTRACT

**We argue, from a perspective integrating cognitive science and the arts, that interactive animated visual graphics, as embodied images whose understanding relies on users' perceptual and motor apparatuses, connect both mental and material notions of images. Drawing upon cognitive science theories of conceptual blending and material anchors, recent neuroscience results regarding mirror neurons, and phenomenological approaches to human-computer interaction, we bridge the gap between visual perception and bodily interaction in digital environments – calling this process as “material-based imagination” (in contrast to the general notion of imagination as purely a mental activity).**

*Animated images trigger a reflective process in which material-based imaginative construction and elaboration can take place. When this process, enabled by today's real-time control and rendering technologies, becomes instantaneous and continuous, it mobilizes a motor-sensory feedback loop. This type of user experience constitutes embodiment of meaning and intention through interaction with digital media artifacts.*

*This kind of embodied understanding is pervasive in today's digitally mediated environments. Through analyses of digital artwork, we show the important role of imaginative blends of concepts in making multiple levels of meaning through embodied expressiveness with motion-based motor input. The implications of these analyses collectively form a step toward an embodied cognition approach to animation phenomena and toward recentralizing understanding of artistic and humanistic production in cognitive research.*

by

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## 1. INTRODUCTION

“Image” has many meanings. It literally refers to the pictorial images that exist in material forms, like sketches, photographs, or lithographic prints. It also refers to what we see, but do not consider to be fundamentally material, such as shadows or film projections. However, the term “image” has also been extended to mean that which occurs in our minds when we think of something, perhaps recalling something seen in the past. Sometimes, the term image can even refer to an imaginative construct shared by a group of people that may be more about emotional impressions and associations, like the general image of a corporation or a rock band. Hence, the term spans both the material and the mental.

However, in the field of semiotics many thinkers (e.g., Roland Barthes) have tended to separate the material image (e.g., a sound, a graphic symbol, or a picture) from the mental image, which refers to abstract ideas in our minds. Such theorists typically focus on how people make and share meanings of images. There is a substantial volume of literature on how to relate an internalized idea to a shared belief among a group of individuals. Most such arguments rest on articulating socially or culturally established relationships, stating that any symbol, whether verbal or visual, is just conventionally linked to its meaning. <sup>1</sup><sup>2</sup><sup>3</sup><sup>4</sup> Such ideas affirm a notion of mental images as abstractions.

Meanwhile, other thinkers question the idea that mental images are purely ephemeral abstractions. The philosopher Ludwig Wittgenstein asserted that images inside our brains (mental images) are no more abstract than images outside (material images), because we always think in terms of what we have already perceived, or what we are pointing at, regardless of whether they are verbal symbols or visual images. <sup>5</sup> We find that this view parallels insights from embodied and distributed perspectives on cognition, which are in direct opposition to mentalist perspectives

(often based in Cartesian mind-body dualism).<sup>6 7</sup> For example, the cognitive scientist Edwin Hutchins thinks that many physical tools in our everyday lives provide us with material images for mental operations.

Regarding animated images, the interplay between the material and the mental is more active. Moving images can be tools to think with, exhibiting material transformations in their own right, while viewers also feel visceral sensations and experience elaborate fantastic visions laid atop the material marks. In the tradition of Hutchins's instrumentally oriented examples, take the case of a compass in a cockpit where a pilot imagines where the needle should be in contrast to where it is. The rose is stable, but the turning needle may be seen as an animated image dynamic and contingent. In the case of artistic production, animated images may be much more creative, evocative, fanciful, and elaborative. They consist of material patterns enabling forms of imagination in which the image provides a constantly changing representation that is combined with the viewers' elaborating cognitive processes. This results in a tight connection between motor-sensory apprehension and imaginative experience. It is these more contingent cases of material-based imagery that interest us. Instead of concentrating on goal-specific computation, we explore material-based, open-ended imagination through cases of fluid and flexible representations in the form of animated visual images that could be called *elastic anchors* for imaginative elaboration.

Animators are well aware of this embodied form of imagination. In digital environments, animation becomes generative and interactive. Viewers of animated images are engaged not just through sensory perception, but also motor-based bodily interaction. A viewer makes meaning through this engagement of sensory and motor apparatuses with the system, echoing the embodied cognition idea that meaning-

making processes involve both perception and motor action. On one hand, animated visual images constitute embodied understanding of sensation, for example they convey information about the physical world such as the effects of gravity or motion. On the other hand, bodily motor action often embodies intention, (directedness and dispositions toward the world). The two sides conjoin a motor-sensory feedback loop between the system and the user. Far from merely differentiating the qualitative difference between interpreting moving images produced using the stroboscopic effect from individual frames (though this is important), we are interested in articulating the locus of the sense of liveliness accompanying the perception of animated images. This involves seeing the gestural nature of movements, and the way that moving images exist and express in time. We believe animated systems entailing this motor-sensory connection are able to give users an embodied experience of an expanded illusion of life.

This article presents multiple cases of material-based imagination in animation and articulates a case for the new construct of elastic anchors through these illustrative examples. Toward this end, we first present a theoretical framework clarifying our perspective on what animation is and how it functions, and necessary cognitive science ideas upon which our ideas are grounded. Ultimately, our paper serves a humanistic end. We believe the insights from animation studies and the arts are central to understanding and designing new and pervasive forms of computational media cultural artifacts. Furthermore, these insights can drive development of new and transformative art forms based upon the uncanny ability of humans to interpret animacy in the moving inanimate.

## 2. THEORETICAL FRAMEWORK

Our theoretical framework is strongly interdisciplinary. Its vantage point is strongly influenced by that of Paul Ward, one of the animation researchers who assert that animation should be studied as a discursive field integrating multiple areas of knowledge.<sup>8</sup> Following is an account of the areas that we integrate in our analyses.

### 2.1 Animation Studies

In this section, we present a brief survey of approaches to studying animation from film-based and computer graphics-based perspectives. We then characterize the inadequacies of these approaches by highlighting their over-reliance on considering the medium-specific image in animation as the central object in their investigations. These medium-centric approaches inevitably fail to cope with the new paradigm of digital animation enabled by emerging technologies and has failed to accommodate the material-based and imaginative cognition perspective that motivates this article.

#### 2.1.1 Film-Based Approaches

In humanities disciplines, animation is often seen as a marginal type of film. Scholars in the humanities have predominantly drawn on two approaches to animation research, namely contextual and textual analysis.<sup>9</sup> The former looks at production contexts, including the historical, industrial, technological, economic, cultural, and even national situations in which individual works can be understood. The latter approach, usually more theoretical and ahistorical than the former, investigates the meanings of many canonical texts of the specific medium by performing close readings of works and comparative studies such as semiotic, genre, narrative, and other analyses. While this cursory overview certainly does not encompass the entirety of film-based approaches to animation, it captures at least a sketch of the prevalent and historical approach within the field.

#### 2.1.2 Computer Graphics-Based Approaches

In computer science, animation usually refers to the digital synthesis of a sequence of images. Early research areas included hierarchical modeling and rendering in computer graphics, and development of efficient standards and encoding for multimedia. These concerns have been expanded by later studies to develop works including computer representation of physical objects and materials, photorealistic rendering techniques, simulation of physical phenomena, developing algorithmic approaches to generate organic behaviors such as flocking or other self-evolving patterns, implementing artificial intelligence (AI) programs to create animated behaviors, and much more. Initial application domains were primarily scientific, medical, architectural, and cinematic, yet the marvelous illusions generated by computers has spread to other communal and personal entertainment platforms, including television, digital billboards and signs, notebook computers, and hand-held devices.

#### 2.1.3 Definitions of Animation

Animation theorists, interested in marking a new territory that centralizes animation as a field of study in its own right, began to isolate their area of inquiry by attempting to define "animation." The majority of these theorists have focused on production processes and industrial practices, unanimously arriving at a definition that centralizes the frame-by-frame manipulation of images (Small, Levinson, Solomon, et al.).<sup>10</sup> Others, however, defined animation in terms of styles (Furniss, Wells).<sup>9 11</sup> In contrast, the Canadian animator Norman McLaren (1950) offered what has proved to be the most influential definition of animation. He defined it as about essence rather than process: "animation is the art of movements that are drawn." This idea, prioritizing movement over images or drawings, marks a major step toward the illusion of life. Yet, it still positions animation as sequential images in a particular medium (typically film), which is inadequate

in addressing the emerging phenomena pertaining to animation across multiple media, such as experientially how and why humans perceive and imbue artifacts with the illusion of life.

#### 2.1.4 Beyond Single Medium: Toward A Broader Perspective Based on Animacy, Interactivity, and Generativity

Hence, we call for a “movement” away from any single medium to a phenomenon-oriented approach to the study of animation. This movement brings into consideration human perception, cognition, and bodily interaction when dealing with animated artifacts, addressing the aforementioned discipline- and medium-centric problems. It shifts our focus from medium-specific images to diverse kinds of media artifacts imbued with an illusion of life, spanning a range from the nineteenth-century optical animation toys to computers in the late twentieth century. In fact, the close relationship between animation and many early experimental artifacts creating moving images has been respectively marked by some theorists (Cholodenko <sup>12</sup>, Manovich <sup>13</sup>, et al). Cholodenko’s recent insights are exceptional in that he draws attention to the apparatus in addition to the animated image. <sup>14</sup> The “animatic apparatus,” by which he refers to mechanical apparatuses that generate moving pictures, including the phenakistoscope and the zoetrope, manifests a double definition of animation: simultaneously meaning “endowing with life” and “endowing with movement.” One could interpret as animistically giving life to inanimate images through mechanical movements like spinning, flipping, and illuminating. The tension between the illusion of life created and the mechanical movement in the apparatus is a useful analogy to the tension between digital animation (including various characters in CGI, or the moving icons in GUI) and the implementation techniques used to realize the visual interface elements we find in operating systems like Microsoft Windows or Macintosh OS X today.

Following Cholodenko, we add another double definition: interactive and generative animation incorporates a tension between motor input and sensory feedback. Animation should not only refer to visual imagery, it also includes the operation of the apparatus, which performs the embodied and material realization of animation. Early animatic apparatuses seem on the surface level to involve only visual perception. Yet in practice, a certain degree of motor action on the viewer’s part is required, from the simplest action of peeping in, to more engaging physical operation to “generate” and “maintain” the moving images. Hence, it should be recognized that motor-sensory interaction is essential to the operation and reception of animation.

#### 2.2 Perception, Cognition, and Bodily Action (Cognitive Semantics)

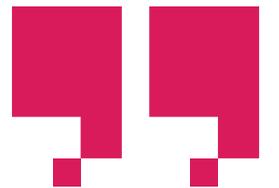
Cognitive semantics, an area of cognitive science within the field of cognitive linguistics, offers theories that propose the existence of an array of mental processes that operate pre-linguistically and often even pre-consciously in the construal of meaning from verbal text, pictures, and even films. <sup>15</sup> These processes, such as metaphorical projection and conceptual blending, highlight issues of context and situatedness rather than grammatical construction. <sup>16</sup> Cognitive semantics-based analyses of animation exploring how “meaning” is uniformly and optimally generated by mental processes, pose a challenge.

##### 2.2.1 Physicality of Images: Hutchins’s Material Anchors

Being one of the initial major proponents of the idea of distributed cognition, Hutchins meticulously describes many of our everyday practices and instruments, such as queuing and analog timepieces, in which physical structures of images represent elements for conceptual processes. He asserts that material structures and patterns, like marks or diagrams,



*The major advantage of anchors to cognitive processes is that one can reduce memory and processing loads by building the constraints of the task into the physical structure of the artifact.*



can provide us with stable images for complex mental operations, such as calculation done on paper or navigation with a compass. He calls these images material anchors, which “hold” information in place or incorporate constraints for mental manipulation. <sup>17</sup> It follows that a material image, for example, marks on paper or a compass rose and needle, can act as a direct input to the cognitive process, in which the world is used as its own representation (observers can offload cognitive processing onto objects in the world rather than holding representations in their heads). In Wittgenstein’s words, we compute by manipulating the marks or diagrams in our minds. While Hutchins’s analyses cover mostly goal-specific, instrument-oriented tasks, the material image of each artifact or instrument is equivalent to the mental image for manipulation. The major advantage of anchors to cognitive processes is that one can reduce memory and processing loads by building the constraints of the task into the physical structure of the artifact.

##### 2.2.2 Spatiality of Images: Image Schemas

While material anchors represent the distribution of concepts onto physical structures of images, image

schemas reciprocally suggest that many concepts are built upon our experiences with spatial structures of perceptual images. Based on numerous examples in our everyday use of language, George Lakoff and Mark Johnson show that metaphors not only allow us to communicate abstract concepts by projection of similarities but actually structure largely our ways of thinking through entrenchment. <sup>15</sup> Many of these metaphors are based on our bodily and perceptual experiences in space. <sup>6</sup> These metaphors are so conventional and entrenched that they often just go unnoticed, and the corresponding mental images are so embedded in our minds that exist as extremely skeletal and schematic images, what cognitive semantics calls “image schemas.” <sup>18</sup> In other words, only structural patterns are preserved in the schemas for spatial reasoning.

##### 2.2.3 Integration of Images with Concepts: Conceptual Blends

Gilles Fauconnier and Mark Turner have built upon the insights of theories of mental spaces and conceptual metaphor to result in conceptual blending theory. <sup>19</sup> The theory describes a basic mental operation that

generates new meaning by integration of concepts. The operation constructs a partial match between multiple input conceptual spaces and selectively projects from those input spaces into a novel “blended” conceptual space. Blending is a dynamic process and successive blends give rise to an emergent integration network, which is pervasive in everyday life, as well as other creative feats like rhetoric, reasoning, gameplay, and even interface design.<sup>20</sup> Fauconnier and Turner’s analyses also resonate with Hutchins’s distributed cognition analyses as they examine everyday objects like watches and money to illustrate how our minds interact with the world. Their discussion even extends to cover written, spoken, and sign languages.<sup>19</sup> To this, Hutchins contends that the arbitrary relations in most linguistic signs make them a very weak type of material anchor, because not much analogical information is held in the material form of these signs.<sup>17</sup> To Fauconnier and Turner, a material anchor can just be a structural constant or perceptual identity for a concept, like money notes. In contrast, Hutchins demands more information loaded onto material anchors.

#### 2.2.4 Matching of Images with Motor Action: Glenberg’s Meshes

Although there are nuanced differences between Fauconnier and Turner’s interpretation and Hutchins’s view, material anchors for conceptual blends mark an indispensable link by which part of human memories can be projected onto world objects. In fact, Arthur M. Glenberg has also investigated the connection between memory and the world in a way related to Lakoff and Johnson’s observations regarding the embodied mind.<sup>21</sup> His article repositions memory as a cognitive apparatus to combine, or in his words “mesh,” perceptual patterns projected from the environment with patterns of interaction from bodily experiences. The two patterns are compatible because they are both “encoded” in terms of one’s body. One can recognize a walking path as the “path home” using

a match of patterns between the perceived environment and embodied motor knowledge in one’s body memory. If material anchors suggest a “download” of structural information from memory to artifacts by perceptual processes, Glenberg’s notion of mesh recalls an “upload” of spatial and functional meaning from the environment to memory through embodied interaction. The two ideas highlight different portions of a mind-matter continuum, but they definitely do not draw any boundary. Instead, they mobilize interplay between mind and matter through the body.

### 3. MATERIAL-BASED IMAGINATION: ELASTIC ANCHORS

#### 3.1 Animated Images as Embodied Images

Hutchins’s arguments for material anchors mainly focus on human-performed instrumental and operational tasks, so his material images have to be stable and faithful representations of the elements to be manipulated in the cognitive process. However, this faithfulness does not necessarily apply to cases in which the outcome is not a priori clear and task specific, such as process-driven imagination-laden creative activities. For example in filmmaking, a storyboard is not strictly a faithful representation of the mental image inside the director’s mind, but is also a device used for contingent reflection on a creative work-in-progress, projecting evocative sensation onto the work that goes beyond the physically represented information, and allowing that work to trigger generation of subsequent imaginative images.

Animated visual images transgress the boundary between the original and the imaginative even more strongly, mobilizing viewers’ motor-sensory connections and constituting embodied understandings of sensations. Consider that the storyboard of a film in progress projects the director’s approximation of the

intended outcome. At some point, the director will need an animated visual image, technically called a “rehearsal,” an “animatic,” or a “rough cut,” especially when one wants to elicit visceral sensations such as disgust, sorrow, nervousness, and others. There are many nuances to these “gut feelings” that static images may not be able to convey. Instead, they have to be performed as actions in animated images. For example, a viewer is able to distinguish an animated character’s giggling from trembling, because the viewer perceives and understands it as exhibiting lifelike qualities previously experienced in her or his everyday life. This is quite different than the use of culturally specific symbolic conventions (such as trembling lines) without which a still image could not convey these distinctions.

While being careful not to overstate these claims, results regarding the activation of brain structures known as mirror neurons have been posited as suggesting that, when perceiving a performed action in a moving image, the viewer’s interpretation relies upon evocation of the corresponding motor-sensory knowledge from a repertoire of her or his own embodied experiences.<sup>22</sup> The coupling of perception and action enables the viewer to “recall” the associated sensation. When we see someone jumping restlessly, we understand one’s excitement, not by “reading,” but rather “sensing.” In short, animated images constitute an embodied cognitive process. Similarly, a movie director can “feel” whether an actor’s performance is matching his or her mental image, or an animator can “detect” if an animated character is moving right. This kind of visceral understanding largely takes place at the immediate, or even pre-conscious, level – requiring minimal cognitive effort.

Cognitive semantics research also provides us with accounts of understanding sensation through perception. When discussing animacy, Mark Turner states

that we cannot perceive others’ sensations, so we can only infer their sensations by comparing their actions to our own reactions in similar situations.<sup>16</sup> He refers this analogical inference to a type of parabolic projection, or metaphor, in which partial structure of a source story of the perceiver, including action and emotion in particular, is projected to a target story of the perceived. It follows that the director or animator can infer the sensation by cognitively projecting her or his own experience to the perceived action. This act of “inference” seems to be suggesting that the projection takes place at a higher cognitive level, demanding conscious mental operation. In fact, some mental projections can be cognitively effortless. This point can be illustrated in terms of conceptual blending theory. The matches between two input mental spaces, what Fauconnier and Turner call “vital relations,”<sup>19</sup> of some blends can be so tightly compressed that become automatic and unnoticed. Fauconnier has cited the computer interface phenomenon as an example of this kind of immediate blends.<sup>20</sup> In this regard, we add that for the director or animator, there is also a blend of an experience and a perceived action yielding an inferred sensation. The compression can be so tight that the animated image is immediately associated with the sensation. The image becomes an immediate and embodied input to the integration network.

As mentioned earlier, Hutchins coined the term “material anchor” to mean those material objects or images with stable patterns and structures “locking down” specific information in input concepts. We believe that animated visual images, as embodied images, not only “hold” information but also “embody” sensation or meaning, which trigger imaginative elaboration in blending.

#### 3.2 The Material-Based Reflective Process

We introduce the term “elastic anchor” to describe these imagination-provoking artifacts. In the tradition

of Hutchins's instrumentally oriented examples, material images and mental images are largely equivalent. The outputs of these blends, like the timepiece example, are fairly fixed as an entrenched cultural model.<sup>17 19</sup> For elastic anchors, the subtle difference between the visceral sensation represented by the animated image and the mental image engenders nuanced imagination. A product designer needs to sketch out different views of his or her design (a mental image) on paper in order to further develop the idea after seeing the sketches (a material image). A calligrapher practicing Chinese calligraphy has to repeat writing and looking at the words, making continuous assessments and adjustments. Practicing animators are also well aware of this kind of iterative processes. For example, an animatic sequence might suggest a visceral sensation, with which the animator can compare an intended mental image, combining partial structures from the animated image and the mental image respectively to form a new imaginative

**Figure 1.** Incidental shadow vs. intended shadow



image, and then triggering adjustment or modification to the material image. This reflective process iterates and ultimately approaches the imaginative interplay of the material image and the mental image.

Such nuanced interplay would go even more unnoticed when the reflective process becomes instantaneous. It can be illustrated by the case of shadow play. Consider the difference of natural moving images (e.g., incidental shadows) and author-intended animated images (e.g., shadow puppetry) (Figure 1). The two images can be materially the same. To Hutchins, neither representation may be valuable as a material anchor because they are not faithful representations of an object sufficient for offloading cognitive processes, they are just simple silhouettes. However, the latter can be an elastic anchor for conceptual blends in which the silhouette in action embodying a visceral sensation is blended with the viewer's mental image of an entity (whether human, animal, or even an anthropomorphic object) moving in a similar fashion, thus forming an imaginative understanding that the shadow is cast by an actual character in that mood. On the audience side, this blended image is the meaning of the puppet show. On the puppeteer's side, this might be an interim image with which the puppeteer would fine-tune for another animated shadow. In both cases, the

material image blends with the mental image to give rise to next imaginative image.

It follows that material images and mental images have a very intricate relationship. In goal-specific computational operations, they can be regarded as largely equivalent. In creative mental operations, to give an illustrative analogy, they may seem like dancing or boxing partners irregularly approaching each other, whether collaboratively or oppositionally. Moving images can be a vehicle for reconciling our understanding of this intricate relationship, because they constitute a specific type of embodied cognition process. Animated images, with their distilled visual forms, evocative movements, and the material-based reflective process, serve as an excellent elastic input for conceptual blends because the flexibility and compatibility facilitate the partial structural projection between two images that gives rise to new blends and imaginative images.

### 3.3 Elastic Coupling of Animated Images and Motor Action in Digital Media

If the animated images are instantaneously reactive, as in shadow play, the elastic anchors include not only sensory perception, but also motor action. In digital interactive media, elastic anchors are even more adaptable and elaborative, because a user might interpret his or her motor input quite variably according to the perceived generative feedback. For an interactive system, generative animated feedback often defines, or re-defines, the meaning of motor input action. For example, when a user scrolls the view of a window using two fingers on the touchpad of an Apple laptop, the scrolling effect defines the action as moving the viewpoint because the scrolling direction is the same as the finger motion. When a user touches and moves a finger on an Apple iPhone screen, the contrasting scrolling effect (just in the opposite direction) redefines the action as moving the panel instead. A few other examples follow. Turning a new page on the iPhone screen by tilting the device defines the action as flipping. Leaving marks on a touch screen defines the touch-and-move action as drawing. A swarm of particles following a pointer defines the action of moving the pointing device as choreographing. Furthermore, the magnification effect of the Dock in



**Figure 2.** Use of the jog dial of a VTR

Mac OS X defines the mouse-over action as considering, and giggling human figures in a viral interactive advertisement defines mouse-over as tickling.

As Maurice Merleau-Ponty puts it, motility reveals our consciousness as “not a matter of ‘I think that’ but of ‘I can’” move towards something.<sup>23</sup> In other words, motion-based motor action embodies our consciousness toward something, representing intention and meaning. An illustrative example related to machine operation is the jog dial of a video tape recorder (VTR). When a user spins the dial, the motion, including speed and direction, convey his various intentions of going forward or backward at variable speed (Figure 2). Likewise, in digital interactive media, motion-based motor input embodies users' consciousness “moving” toward animated feedback. Since the animated feedback is generative, programmable, and variable, the embodied meaning of motor action becomes adaptable. It follows that a coupling of animated visual images and motor input may yield adaptive and evocative meaning through imaginative blends. Consider the magnification effect of the Mac Dock. Both animation (the magnification) and action (mouse-over) may

**Figure 3.** A participant holding “letter” raindrops in *Text Rain* (1999). Image courtesy of the artists (Camille Utterback and Romy Achituv).



seem non-representational, but the coupling is meaningful when it blends with some everyday experiences (e.g., an individual asserting “pick me!” from a line of candidates).

This coupling idea echoes what we mentioned the motor-sensory feedback loop that characterizes an expanded illusion of life. Motor action triggers animation that in turn incites further bodily engagement. This loop sometimes is delayed, like in hand-drawn animation pencil test, or computer animation preview that needs rendering. Occasionally, the loop is instantaneous and continuing, like that in shadow play or real-time interactive systems. This loop, which relies on the materiality of images that one perceives and acts upon, is the core of elastic anchors. And elastic anchors are elastic in the sense that the meaning is flexibly dependent on animation and bodily interaction. In summary, elastic anchors are characterized by the following properties:

- » Material-based Imagining: They consist of material images;
- » Imagination Triggering: They “hold” dynamic information or sensation in place for perceivers, yielding imaginative blended images;
- » Action Inviting: They “invite” perceivers to take motor action, such as modification or interaction;
- » Motor-sensory Connecting: They constitute iterative motor-sensory feedback loops, such as those in sketching of architectural designs, pencil testing of hand-drawn animation, practicing at writing Chinese calligraphy, engaging in shadow play, operating a zoetrope, previewing real-time animation, and so on;
- » Spatiotemporal Patterning: When the motor-sensory feedback loop runs spontaneously and continuously, as in animated images, they provide not only spatial and structural patterns, but also temporal patterns.

We argued elsewhere that material-based imagination is pervasive in today's digitally mediated environments.<sup>24</sup> In this article, the analyses concentrate on two salient interactive digital artworks.

#### 4. ANALYSES OF INTERACTIVE DIGITAL ARTWORK

Many digital artworks rely on simple animation and motor-sensory interaction to provoke imagination. Artists such as Myron Krueger were important precursors for later practitioners such as Wolfgang Muench, Scott Snibbe, and many others. Some of the works of such artists involve full-body motion while interacting with a human-size screen animation. Relevant to our argument here, installations in this area include Wolfgang Muench's *Bubbles* (2000), Scott Snibbe's works, and Camille Utterback and Romy Achituv's *Text Rain* (1999). We choose to concentrate on *Text Rain* here because it allows us to analyze at two distinct levels of imaginative understanding, namely the immediate and the metaphorical, as shown in the following paragraphs. The work shows a projection of animated letters falling like rain. A participant standing in front of the projection can move her or his mirror image on the screen to catch, lift, and then let fall any letters (Figure 3).

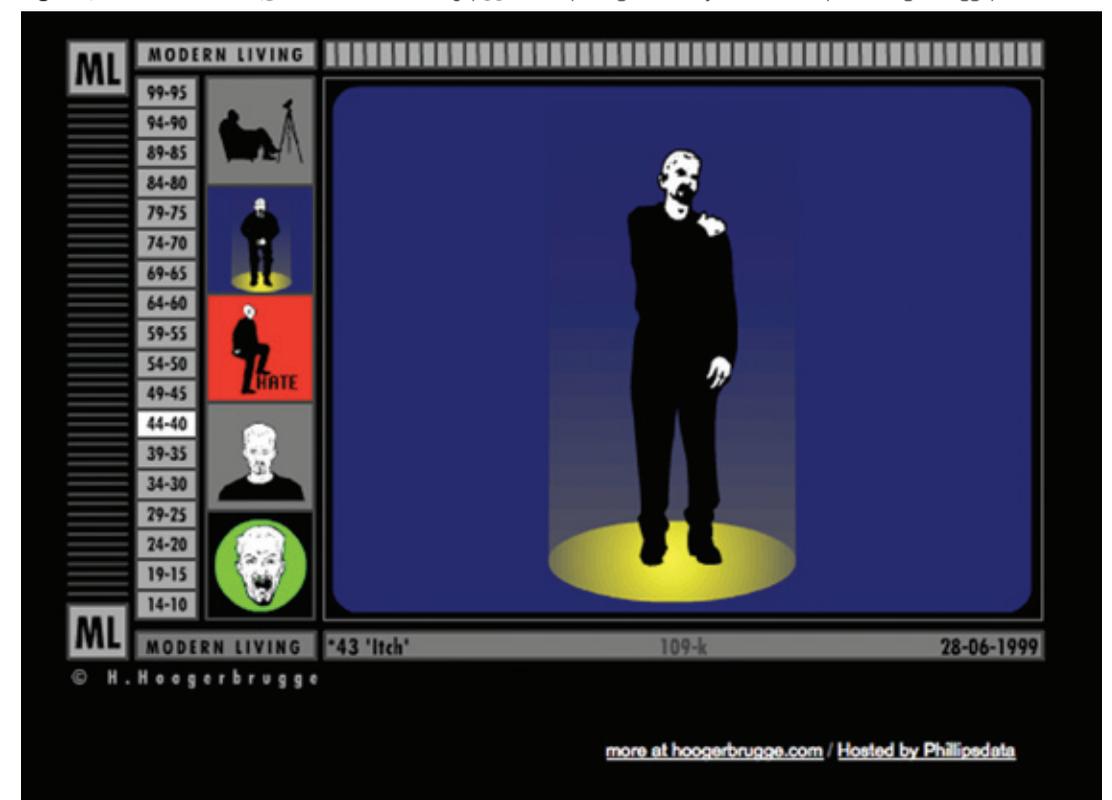
When a participant moves and sees her mirror image echoing those movements in the rain of letters, she immediately blends this elastic anchor experience with her remembered motor-sensory experience of

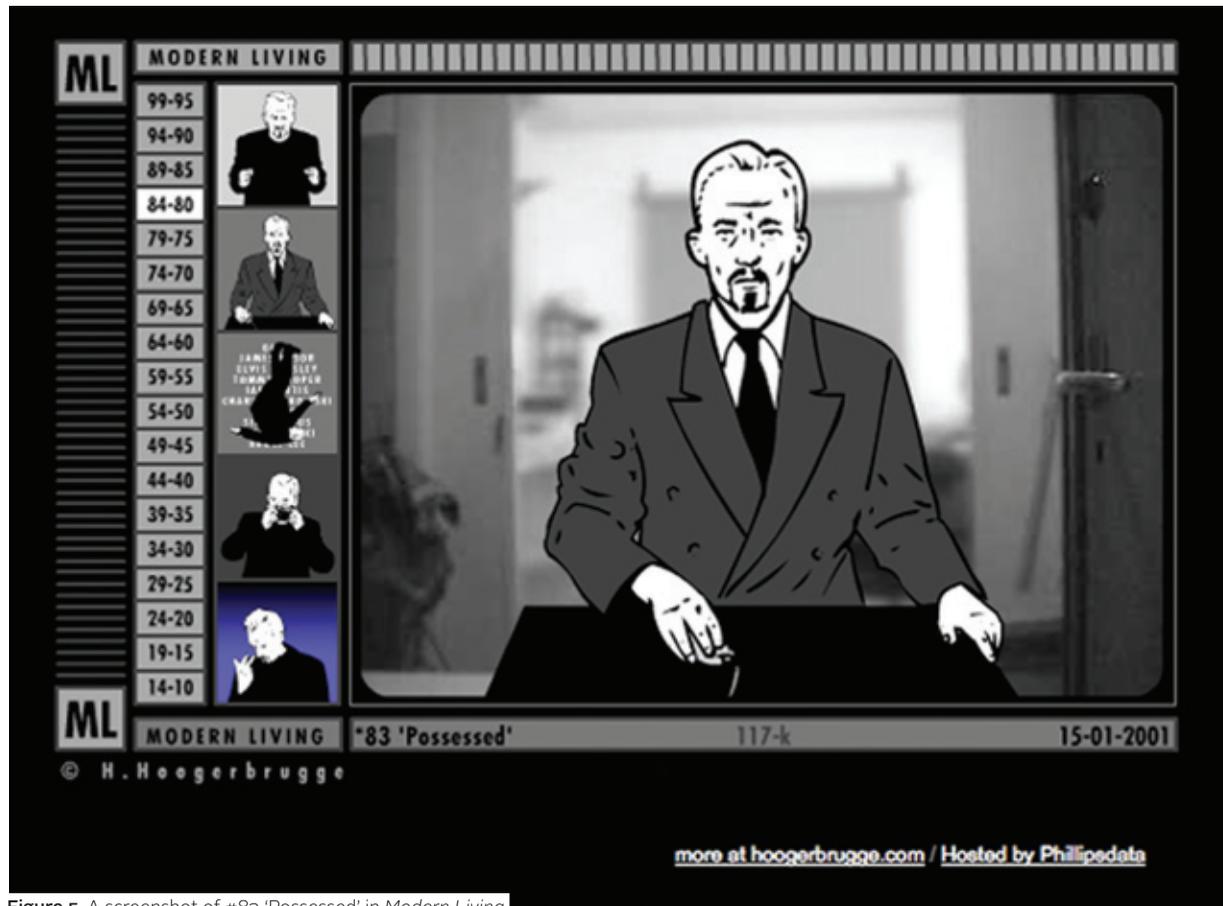
actual rain. The elaboration of this immediate blend results in an imaginary space in which the participant can move and play in the virtual rain without getting soaked.

Since each raindrop is a letter from a poem, the participant can sometimes catch a word, or even a phrase, by accumulating letters along her or his silhouette. Whenever the participant reads the line held by the body silhouette and realizes the resulting verse, the experience may be interpreted as analogical to receiving a celestial message from the sky. The action of holding virtual raindrops may analogical to the action of embracing “divine light” from the sky. Each particular elaboration of the blend is not predetermined, however many viewers find that the work provokes a metaphorical narrative of someone receiving celestial and spiritual messages via the body and the environment. The animation of falling letters, and the viewer's interaction with them, generate what the artists might describe as an imaginative integration between body and ethereal content.

Like many works of art, *Text Rain* is exhibited publicly in an art gallery or similar setting. In contrast, another work to be discussed emerged in a strikingly different platform. It was originally intended to show on the Web. Since 1997, the Dutch comic artist Han Hoogerbrugge has used the Internet to publish interactive animated comics on his website Hoogerbrugge.com. The first work, *Modern Living* (1998–2001), featuring nearly one hundred short animated films, tackles small observations in his personal life, which also resonate users' lives. The collection can be seen as a documentation of his experiments with mouse-mediated interaction in which immediate blending helps us re-map mouse action to different intentions easily. For instance, in #43 ‘Itch’, a click makes the character “itch” wherever the mouse cursor is located (Figure 4). In #54 ‘Jumpy’, a mouse-over action “drives” the character jump forward. In #60 ‘New Religion’, when the mouse moves across the characters, they stand up and then bend down forming a wave very much like the magnification effect in Mac Dock. In #61 ‘Drowning’, one can move the mouse to play hide-and-peek

**Figure 4.** A screenshot of #43 ‘Itch’ in *Modern Living* (1998–2001). Image courtesy of the artist (Han Hoogerbrugge).





**Figure 5.** A screenshot of #83 'Possessed' in *Modern Living* (1998–2001), which provokes immediate and metaphorical imagination. Image courtesy of the artist (Han Hoogerbrugge).

with the character. In #68 'Obedience', keeping the mouse over the character's head can "bend" him down to his knee. In #70 'Eternal Love', the position of the mouse determines the focusing point. Through these couplings of motor action and animated feedback, the work mobilizes motor-sensory connection and projects what we have called an expanded illusion of life.

Among numerous interactive pieces, some are more metaphorical. In #83 'Possessed' (Figure 5), the character moves his mouse in accordance with the user's mouse position. The immediate blend here lets the user easily control the character by moving to desired positions, like the mechanism of controlling shadow puppets by moving rods. The analogy between the

character and a rod puppet is compressed into a concept of virtual puppet in the animated piece. Hence, when one moves the pointer, the virtual puppet moves his hand.

What makes the piece eccentric is that bizarre images keep appearing over the character's head and making curious sounds while the user moves the pointer around. This suggests one possible metaphorical blend of the animation (at least for the authors here) with an imaginative story in which people surfing the Web, including the user, often find their attentions wandering, diverted by a multitude of hyperlinks. In the blend, the mapping between the character and the user, both are moving a mouse, is compressed into a single identity. The animation becomes like a mirror

reflecting the mental status of the user. This example shows a typical way of how *Modern Living* echoes our personal experiences through animation and motor action.

## 5. CONCLUSION AND IMPLICATIONS

This article started with a trajectory of our thoughts about images, from visual to mental representations. We believe that images not only exist materially outside our brains and mentally inside our minds, but also emerge as imaginative constructs from a reflective process between material manifestation and mental operation. In this kind of material-based imagination, animated images work as elastic anchors for sensational, visceral, and elaborative conceptual blends, because they readily engage our embodied sensations through the coupling of perceived animation and motor knowledge. Furthermore, due in part to their liveliness and relationship to embodied forms of communication such as human body language, gestures, and facial expressions, animated images easily absorb viewers in affectively rich imaginative stories and worlds. In all cases, imaginative blends of concepts are the key to understanding the artifacts, at both the immediate and the metaphorical levels.

We believe our analyses of digital artwork reflect an emerging animation phenomenon that destabilizes the border of mind and matter unprecedentedly. Accounting for this requires a new embodied cognition model of movement and fluid images, which are topics currently underexplored in the theories of image schema and conceptual blending from cognitive science. Of course, for cognitive scientists, the elastic anchor construct ultimately should be pinned experimentally, and explained in terms of cognitive processes. However, for humanistic analyses in the tradition of cognitive poetics, new theory consistent with a

convergence of results from fields including neuroscience and cognitive semantics is quite consistent with the enterprise.

This research also brings concern for humanistic interpretation back to the center of cognitive studies, in which today productivity or usability-oriented approaches are pervasive. As the digital visual culture theorist Andrew Darley put it in his keynote speech at the latest conference of animation studies,<sup>25</sup> the animation phenomenon persists in the digital age, bringing about a new meaning of "persistence of vision" by that vision is "visual imagination." Animation, the most "sophisticated and flexible" of modern media as (non-objectively) suggested by the animation theorist Paul Wells,<sup>11</sup> has become the "vehicle" of the kind of imagination that can be poetic and evocative. Currently, our work is speculative, but grounded in both humanistic interpretation and cognitive science results. In the future, we may elaborate the relationship of our constructs to the quite different, and at times apparently contradictory, epistemologies used in cognitive science and humanities-based media studies. We hope that this article sketches a potentially fruitful of reconciliation of both types of research concerns and values – and ultimately constructive and beneficial in our everyday lives. ■

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