

Bare Nothingness: Situated subjects in embodied artists' systems

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ABSTRACT

This chapter examines the current state of digital artworks, arguing that they have not yet made a groundbreaking impact on the cultural landscape of the early 21st century and suggesting that a reason for this lack of notoriety is the obsolete model of agency deployed by many digital artists.

As an alternative to what is framed as out-of-date forms of interactivity, the chapter highlights evolving research into interactive systems, artists' tools, applications, and techniques that will provide readers with an insightful and up-to-date examination of emerging multimedia technology trends. In particular, the chapter looks at situated computing and embodied systems, in which context-aware models of human subjects can be combined with sensor technology to expand the agencies at play in interactive works. The chapter connects these technologies to Big Data, Crowdsourcing and other techniques from artificial intelligence that expand our understanding of interaction and participation.

Keywords: Interaction, Enactivism, Digital Art, Dourish, Suchman, Noë, Typology, New Media Curation, Graham and Cook.

INTRODUCTION

The philosopher Alfred Whitehead wrote that “apart from the experiences of subjects there is, nothing, nothing, nothing, bare nothingness” (Whitehead, 1929, pp. 252-254). The present chapter will look at innovative interactive multimedia systems that integrate new conceptions of the subject into creative digital practice. Drawing on specific case studies and art historical framing the chapter will argue that digital artworks have not yet made a ground-breaking impact on the cultural landscape of the early twenty-first century, one main reason for this being the obsolete model of agency deployed by many artists who use computation as an artistic medium.

This chapter presents the argument that a great number of the most current and high profile digital art works have not yet made a significant use of the core technological innovations that have occurred in the last 10 years, and that they are largely out of sync with advances in Computer Science and Web application development, in particular with the framing of subjects and agency.

As an alternative to what is contextualised here as out-of-date forms of interactivity, it will highlight evolving research in interactive systems, artists' tools, applications, and techniques that will provide readers with an insightful and up-to-date examination of emerging multimedia technology trends. More

precisely, it will look at situated computing and embodied systems, in which context-aware models of human subjects can be combined with sensor technology to expand the agencies at play in interactive works. The chapter will connect these technologies to Big Data, Crowdsourcing and other techniques from artificial intelligence that expand our understanding of interaction and participation.

The case studies presented here will elucidate the specific technical and design strategies used in real world projects, clearly explaining the mathematical and conceptual processes and procedures at play. Basic code examples are provided, in order to allow readers to hack into and play with the concepts outlined.

The first half of the chapter will look at the emergence of new media art and put it in historical and theoretical context. The second part of the chapter will present a typology of interaction modes and propose a radical vision for digital art, one that deploys a far more sophisticated notion of agency within the participant/creator dyad than the one currently used; it will look at the formation of temporally specific contextualised relationships between subjects and digital works. The final part of the chapter will suggest solutions by examining case studies, describing how a range of more recent artworks (including two by the co-author, Eleanor Dare) present multi-linear, situated and embodied forms of *intra-activity* as an alternative to more linear forms of interaction deployed by most contemporary, high profile, digital art works.

SETTING THE STAGE

The late 1960s and early 1970s signalled the arrival of a new era for exhibition practices as well as the birth of what was later to be called ‘media art’. It is appropriate to briefly examine the events of this period, since it laid the foundations for the inclusion of digital works as an acceptable art practice and various issues around display strategies (in relation to new media and technological innovation) that occupied curators, historians and critics at the time and which still prevail todayⁱ.

At the beginning of the decade (1960)ⁱ, the art critic Clement Greenberg wrote “Modernist Painting”. The essay came to typify the Modernist critical position on the visual arts and acted as an inspiration for the ‘white cube’ as the ideal exhibition space. According to Greenberg, the “advanced” or “ambitious” Art was an art that could “test society's capacity for high art”; those called “purists”, who defended abstract art as the only defence against kitsch and the decline in culture, were also those who valued art the most. Modernism had to establish itself in the social arena, by demonstrating that the kind of experience it provided was valuable “in its own right and not to be obtained by any other kind of activity” (Greenberg, 1992, p. 775)ⁱⁱ. The area of competence of each art would lie in the uniqueness of the nature of its medium. Thus, the shared elements between the artistic disciplines should be eliminated in order for each art to reach a culmination with the absolute purity of its particular form. Greenberg’s account of artistic standards - and particularly of the ways in which art’s separateness as a social practice is secured - called into question his hope that art could become a provider of value in its own right. The form of Modernism was that of an art “whose object is nothing but itself”, constantly discovering that “the self is pure as only pure negativity can be” and offering its audience the assertion that nothing tirelessly and “adequately made over into form” (Clark, 1985, p. 60). Greenberg believed that in High Modernism, the aesthetic experience of a painting can only be understood by other kind of experience in relation to other paintings; there was no point in looking to political or historical meanings because opticality alone guaranteed art. At the time, the formulation of ‘art for art’s sake’ found its ultimate champion in MoMA and its display tactics. Visitors were to engage in exercises in aesthetic contemplation by following a set path through gallery spaces with white walls and a sparse hang that transcended the pervasiveness of the outside world; nothing distracted from the encounter with the artwork. Numerous artists based their creations - and still

do - on this very premise: the whiteness of the walls, the vast space where their work could be shown. The above premise was, however, challenged by the arrival of screen-based works, where time was disrupted and the visitor no longer viewed but 'watched' art. The moving image functioned in the same way that the 19th century heavy frame did: it isolated the surrounding scenery. A new dynamic of exhibits' juxtaposition was created that gave birth to new challenges in curatorial choices of display.

Around the same time, notably through the publication of Jack Burnham's *Beyond Modern Sculpture* (1968) and Gene Youngblood's *Expanded Cinema* (1970), the convergence of art, technology and cybernetics began to be critically evaluated. Youngblood's account praised pioneering video, cinema and computer art practices, whereas Burnham's analysis of modern and contemporary sculpture introduced the crucial distinction between sculpture as 'object' and sculpture as 'system'. According to Burnham, an object "occupies a specific space: it has *place*, remaining inert and stationary" (Burnham, 1968, p. 12). A system, however, is

[...] an aggregate of components; first, its parts are mutually dependent; and second, it may manifest some of the fundamental characteristics natural to life: self-organisation, growth, internal or external mobility, irritability or sensitivity, input and output, kinetically sustained equilibrium and eventual death.

(Burnham, 1968, p. 12)

In this context, sculpture could prolong its survival through a "transition from the object to the system" (Burnham, 1968, p. 13).

The distinction between Modernist art and the 'theatricality' of other forms of art practice was integrated intensely by Michael Fried's "Art and Objecthood" (1967). Fried distinguished the opticality of a work of art from the experience of viewing it (which he called 'theatricality') in a text that attacked Minimalism. He was against art appreciation being conditioned by cultural, historical or sociological factors, which, as he claimed, prevented the work from being seen as an independent entity. Minimalist art, he stated, is a "largely ideological [...] enterprise" (Fried, 1967, p. 1). As a "new genre of theatre", it became the negation of art (Fried, 1967, p. 3). Objecthood, in this light, is precisely this context of the "condition of non-art" (ibid.). Drawing on Greenberg, he traced a clear difference between "modernist painting's self-imposed imperative that it defeat or suspend its own objecthood through the medium of shape" and the literalist "espousal" of objecthood as "an art in its own right" (Fried, 1967, p. 6). In "Art and Objecthood", Fried defined clearly the differentiation between Modernist art and the arts that dealt mostly with space or time. In the case of screen-based works, both of the latter notions usually form a central part in their essence and presentation. If one opens up the argument even further, it could be suggested that contemporary art production "is a proposal to live in a shared world, giving rise to other relations, and so on and so forth, ad infinitum" (Bourriaud, 2002, p. 22). The aesthetic experience here is closer to the notion of social exchanges than artistic appreciation. He found that this new genre, "inasmuch as it compelled a durational viewing experience akin to theatre, undermined both the medium specificity and the presumed instantaneousness of modernism" (Mondloch, 2010, p. 1). Cinema, on the other hand, was never in danger of theatricality, as the screen was not experienced as an object functioning in a specific physical relation to us (Fried, 1967).

Kate Mondloch, in her extensive analysis on viewing media installation art, suggests that the divide suggested by Fried between Minimalism and the cinema gradually shrank with the expanded field of art and media practices in the 1960s and 1970s and the consequent overlapping of boundaries between the sculptural and the cinematic (Mondloch, 2010, p. 1). In 1965, with the release of the first portable video recorder, Portapak, by Sony, the video apparatus became an easy-to-use device for recording the moving image, one that started being used by artists as a means of artistic expression. In the same year, Andy Warhol showed his first recordings with a Norelco slant-track video recorder at a party in New York, and Nam June Paik presented his work *Electronic Video Recorder* in the New York Café *Au Go Go*, created using a Portapak. "Just as collage technic [sic] replaced oil paint, so the cathode ray tube will replace the canvas", he wrote on the flyer that was distributed on the first public showing of the video, a sentence that

has come to be referenced innumerable times ever since (Marin & Grosevic, 2006, p. 10, see also Rush, 1999, p. 82) ⁱⁱⁱ. His footage of the Papal visit (allegedly shot from a cab whilst the Pope and his entourage made their way down 5th Avenue) is considered to be the birth of video art (Rush, 1999, Knight, 1996). In the same period, and contrary to the Modernist tradition and the praise of optical form alone, the Fluxus movement attempted to break down the barriers separating different forms of art and merge music, theatre, visuals arts and most importantly, the artists and their audience; art and life was seen as one inseparable mode of existence. In 1967, a video installation by Bruce Nauman entered the realm of the museum in *American Sculptures of the Sixties* in the Los Angeles County Museum of Art and the Howard Wise Gallery in New York presented *TV as a Creative Medium*. At the time, the use of the moving image by artists questioned the role of the arts in a technologically driven society, reacted against television and promoted a critical dialogue with conceptual art. Stan Vanderbeek exhibited with Robert Whitman and Dan Graham (*The Projected Image*, ICA Boston, 1967) and Les Levine with Hans Haacke, Douglas Huebler (*Software, Information Technology: Its New Meaning for Art*, Jewish Museum New York, 1970)^{iv}.

In *Electronic Culture: technology and visual representation* (1996), Timothy Druckrey argues that there are “shifting means of reproducibility” to be noted, “particularly the emergence of the screen as the central point of the communicative and aesthetic experience” (Druckrey, 1996, p. 12). The edited volume gathers a series of examinations of forms of visualisation from diverse fields, in order to map the digital revolution that has been taking place since the late 20th century and to contextualise it whilst “reasoning with history” (Druckrey, 1996, p. 21). What is crucial here is the understanding that, even though electronic culture is a phenomenon to be explored, its re-definition of the very concept of representation is largely due to its historical context.

The two trajectories regarding modernist narratives and “machine art” and towards “systems and information technology” (Sutton, 2004, p. 2) that emerged in the late 1960s, still prevail today. Lev Manovich, commenting on “the art establishment’s lack of engagement with new technology” attributes the situation to the “division between ‘Turing land’ (inhabited by the computer arts) and ‘Duchamp land’ (inhabited by postmodern conceptual art)” (Muller, Edmonds & Connell, 2006, p. 3). Edward A. Shanken suggests that there is a hybrid discourse between mainstream art and new media, since their paths have become increasingly divergent (Shanken, 2011, p. 1). Mainstream art employs the vocabulary of digital culture (such as ‘interactivity’, ‘participation’, ‘programming’, and ‘networks’), and which we will examine later in the chapter, while dismissing new media art due to its form or immateriality. In “Exhibiting New Media Art”, Gloria Sutton suggests that “the practical and theoretical issues of exhibiting new media art within a traditional museum context” discussed at present employ a “critical syntax [...] that] echoes the conversations of the late 1960s and 1970s” (Sutton, 2004, p. 1); indeed, since moving away from the static object to accommodating a broader range of practices that fall into the category of the ‘dynamic arts’, judgements of quality have yet to find a way to correspond to the situation. In contemporary art criticism, “political, moral and ethical judgements have come to fill the vacuum of aesthetic judgement in a way that was unthinkable forty years ago” (Bishop, 2004, p. 77). Bishop traces this situation back to Postmodernism which “attacked the very notion of aesthetic judgement” and to contemporary art’s “solicit[ing] the viewer’s literal interaction in ever more elaborate ways” (Bishop, 2004, pp. 77-78).

Shanken argues that even though both mainstream and new media art can learn from the other, the latter deserves a more prominent position in contemporary art history (Shanken 2011, p. 7). In addition, he has analysed Jack Burnham’s early writings (for example “The House that Jack built”), to reposition the former. He does note, however, that in the same way that photography was shunned and then endorsed by the mainstream art market (with auction highs of 3,3 million dollars in the period 1994-2008) video reached a 700,000 dollars peak for a Bill Viola (whose piece *The Stopping Mind* [1990] is examined later in the chapter) work in 2000 (Shanken 2011, pp. 15-16). In this light, and while keeping in mind that the auction prime is still reserved for painted canvases, if the post-medium condition really prevailed, “the exclusionary prejudice against the use of technological media in and as art would not exist” (Shanken 2011, p. 18). However, curators, critics and historians do make the distinction between media and the

direct or indirect use of technology. In this arena, the “lofty, theoretical ideal” is usually elevated at the expense of the “quotidian, practical tool” (Shanken, 2011, p. 18).

Digital art and viewing regimes

In 1972, the Tate Gallery acquired Carl Andre’s *Equivalent VIII*. A sculpture made of 120 bricks placed in a rectangular formation, it became a major representative of Minimalist work. Four years later, *The Times* published an article on the Tate’s recent acquisitions that featured a picture of the work. When the latter was put back on display in 1976, *The Daily Mirror* exclaimed on its front page: “What a Load of Rubbish”. Archival material from that time shows the public moving around the work and commenting upon the fact that it is indeed a pile of bricks^v. The anecdote serves to exemplify Fried’s conceptualisation of Minimalist art as occupying space rather than focusing on opticality alone, but also to demonstrate the changing viewing regimes of the public over the years.

In the context of digital and interactive art, the more we operate with screen technologies, the more our behaviour around them evolves and changes. This would perhaps be stating the obvious, but the public witnessing of Nam June Paik’s sculptural screen installations during the first years of video art would not have generated the same reaction as the public visiting an exhibition dedicated to early video art today, having already been exposed to a plethora of screen media on a daily basis.

In this framework, it is often suggested that, with the current impact of new media technologies on art production, curators have reached a point where they create content instead of a context (Cook, 2003). In order to examine the complexities of curating new media artworks, it is crucial to overview the activities that precede their exhibition. These are:

- The curatorial judgements of quality in order to select and classify new media works
- The creation of a “context” for the work
- The placement of the work in a given space/environment

Curatorial judgements of quality

In theories concerning judgements of quality for a work of art (as, for example, in Kant, 1978, Hegel, 1993, Bourdieu, 1979, Greenberg, 1993, Benjamin, 2002, Buck-Morss, 1989) the object of study was to be found in stable and static forms. Moreover, the work of art was considered to be something already made and present for contemplation. There is indeed an awkward, uneasy approach when the communicative character, the mediality and the duration of a work of art come into play. However, the curators of a mixed-media museum focus less on art production and more on art’s reception; thus, they “engag[e] in research in order to issue judgements of quality” (Cook, 2003, p. 170).

In “Toward a Theory of the Practice of Curating New Media Art”², Sarah Cook examines the “curatorial role of creating context” (Cook, 2003, p. 169) via the examination of theories about curating and the description of the aesthetic characteristics of new media art that challenge that traditional framework. In this context, a work of art is seen as either a definitive expression by an artist (in which case the methodology used is a reference to his/her biography or to the current context) or a blank screen onto which can be projected any number of art historical interpretations (in which case the work of art needs to be placed either within a specialised body of knowledge around it or within a historical trajectory) (Cook, 2003, p. 171). Even though the 1960s gave birth to an artistic expression that favoured experience to interpretation, the methodologies based on aesthetic theory evolve around the static object, thus limiting and giving a ‘closed reading’ of a dynamic work of art. When experiencing a constantly mediated reality, these theories might appear obsolete and out of context. In this light, if one placed Leonardo Da Vinci’s *Mona Lisa* (circa 1503 – 1506) in the Louvre, on an easel in an artist’s studio or hung it in their garage, it could be suggested that the work of art by itself would have remained unaltered in its essence. However, Nam June Paik’s multi-screen installations or Tony Oursler’s screen-assisted sculptures (to mention two representative examples illustrating this point) become very different works when the exhibiting

conditions change (lighting, space, movement of the visitors in space), thus they are experienced in a varied way from one location to another. The aesthetics of projects that present a screen as - or within - their end product can be variable, interactive and experimental. In some cases, the viewers might just watch; in some others they might have to touch buttons, interact, speak, move. This immersion *within* the work excludes them from the disinterested position of the viewer/judge and puts them in a position of co-authoring the work. Also, even in 'old' media art - and taking as a hypothesis that most visitors do not watch all moving image works from beginning to end -, one visitor does not see the same 'version' as the other. When time is concerned, the "discursive becomes spatial and the visual becomes discursive" (Rodowick, 2001, p. 39, quoted in Cook, 2003, p. 173).

A great number of screen-based works cannot be seen as self-contained unities: they might refer to other cultural products, ask for the visitor's participation, integrate performances or collaborate with other networks to mention but a few. In this respect, the curators can no longer distance themselves from the work, basing their judgement on its static representation. In order to create a context for the work and subsequently issue judgements, the curators have to research the contexts/environments that the work refers to (for example performance and the software industry or public art and open source coding) in order to form a discourse around it. In the dynamic arts, there is a third dimension (or 'third space', according to Cook [2003]) that needs to be investigated and it is precisely through the knowledge of this dimension that judgements of quality can be accurately made.

Context or content?

We have seen that one of the main roles of the curator of contemporary art is to create a context for the work to be exhibited. Also, with the deprofessionalisation of the curator and the abundance of curating courses teaching the practical aspects of the role rather than art history or museology, the curator has come to be responsible for the process that leads to an exhibition and not for the knowledge surrounding the exhibits themselves^{vi}.

An important part of this process is the understanding of peripheral requirements - usually of a technical nature - for the presentation of a work. The curators need to be aware of the medium that the artists use as much as they need to know about the work itself; they need to know how the technology of the work behaves and what this means for the work in question. The rule applies equally to works that employ new technology (such as a 360-degree stereoscopic immersive interactive visualisation system, installed at ZKM) or dated media (such as a video tape with its limited life span)^{vii}. As Christiane Paul has argued, "the history of technology and media sciences plays an equally important role [as art history] in this art's formation and reception", continuing that "new media art requires media literacy" (Paul, 2008, p. 5). In this context, however, is there not a danger for curators to "get caught up in *only* [sic] the work's medium and not the wider context for the technology as it is used in the artwork?" (Cook, 2003, p. 175). If this indeed happens, will it not be explicit in the presentation of the work? Especially in exhibitions where screens constitute the main medium of presentation, it is easy for the audience to be directed in examining the screen itself and its inherent meaning rather than the meaning/content of the actual work. It is interesting to examine how exhibitions of this kind handle the above difficulty and how they get across to their visitors (see for example, *Software: Information Technology – Its New Meaning for Art*, Jewish Museum New York [1970], *Spellbound*, Hayward Gallery London [1996], *Art and Money Online*, Tate Britain London [2001], *Videographies – The Early Decades*, The Factory - Hellenic National Museum of Contemporary Art [2005], *China Power Station: Part I*, Battersea Power Station London - Serpentine Gallery, Red Mansion Foundation & Astrup Fearnley Museum of Modern Art [2006]).

As the curator has gradually moved from a strict museology environment to a more process-based practice that focuses chiefly on "temporary exhibitions" and "the specific context of their audiences" (Cook, 2008, p. 29, Greenberg, Ferguson & Nairne, 1996), it is suggested that the context itself sometimes becomes the content (O'Doherty, 1999, pp. 65-86). In the foreword of *Rethinking Curating* (2010), Steve Dietz remembers that around the time he had founded the new media art program at the Walker Art Center (1996), the then Museum Director commented that she did not find net art visually

compelling. The example serves for Dietz to illustrate that new media art is not merely about *viewing* but also about processes, interactivity and *networks* (Graham & Cook, 2010, p. xiii).

It then becomes imperative to start thinking in terms of behaviours when the inclusion of screens and interaction are concerned rather than of a specific medium and the way in which this operates. Dietz suggests that the above concept, formulated by Graham and Cook when asked to define the term ‘new media’, could be useful in order to understand much of contemporary art. He pursues the argument historically, arguing that photography was the ‘new medium’ that introduced a new way of looking at suspended time, one which challenged the aesthetic understanding of painting, thereby video in turn challenged the aesthetic understanding of film whilst, with television, they were the ‘new media’ that introduced the idea of real time and, finally, new media^{viii} challenged the understanding of the behaviour of contemporary art by including in the art equation the elements of interactivity and participation. The conclusion of his positioning is that “art is different after new media because of new media” and this change takes place “not because new media is ‘next’, but because its behaviours are the behaviours of our technological times” (Graham & Cook, 2010, p. xiv). In short, one could suggest that new media art, and by extension all types of screen-based works, present characteristics that distinguish it from static art and thus create new types of environments where they can be exhibited. As such, the technology used constitutes a context around which the work is developed and serves as a vehicle for the communication of an idea; it is not to constitute the content of the work or to comment about questions surrounding technology.

INTERACTION AND AGENCY IN DIGITAL ARTWORKS

The first half of this chapter looked at the historical and theoretical context of digital artworks, exposing a complex range of conceptual and aesthetic traditions that impact upon our understanding, presentation and reception of digital pieces. This part of the chapter will now look at alternative philosophical approaches to digital artworks and examine a range of technical processes that might alter the conceptual focus of such works, presenting a more contemporary framing of digital technology and its relationship to art in the 21st century. A typology of interaction types will also be presented so that readers might better understand the technical characteristics of common interaction forms encountered in digital art. This section will look in detail at alternative interaction modes and the specific ways in which they have been used by artists. When seeking to define interactivity, it is necessary to also define its inter-dependent elements such as agency, subjectivity and embodiment.

CORE FRAMES OF REFERENCE

In order to support a detailed examination of the types of interaction typically deployed by digital artworks it is helpful to clarify some core terms and outline the frames of reference used, starting with the digital computer itself. While the following explanations may appear to be rudimentary, it is important to recognise that these are for example, binary systems that do not use zeros and ones, as well as historical computers that are not digital, for example analogue computers such as slide rules and human computers. There are also distributed systems that do not deploy a CPU. What is referred to here comprises the current mainstream of computing hardware and computing systems.

A digital computer typically consists of four (sometimes described as 3) parts as follows:

Table 1. Four-part structure of a Von Neumann computer model

Input-Output devices: such as keyboards and screens

Main Memory: stores data, such as programs.

ALU: an Arithmetic-Logic Unit performs mathematical-logical operations.

CU: a Control Unit communicates and directs operations performed by the ALU.

The Control Unit: (CU) and the **Arithmetic-Logic Unit** (ALU) together comprise the Central Processing Unit or CPU. Multi-processor computers have more than one CPU. The Control Unit in a digital computer communicates between the memory and the ALU, and directs operations performed by the ALU.

The ALU performs logical and mathematical operations on binary data and typically, though not exclusively, on 0s and 1s.

This four-part architecture is based on the Von Neumann model of computing in which the computer memory stores programs and data. The control unit gets its instructions from the memory and the processing unit performs mathematical operations. Then, the control unit fetches further instructions from the memory. In this system everything is reduced to a binary representation in which there are only two possibilities: either an electrical signal represented by a 1, or no signal represented by a 0.

This is therefore, first and foremost, a system of symbolic representation. There is no “direct experience”, no “intuition” and certainly no possibility for non-mathematical engagement with any of the input such a system receives. This point is emphasised now because the later part of this chapter will explore how the body, including its non-symbolic experiences, might be represented within a typical Von Neumann model and its wider systems.

It is important to understand that there is a difference between a computer – the aforementioned four-part entity, and a computer system. A computer system draws in a far wider set of actors and concepts, which we will now aim to define. These include interaction, agents and agency, subjects, situations and embodiment.

Defining interactivity and interaction

Interaction is defined by Noble as “the exchange of information between two or more active participants” (Noble, 2012, p. 3) but, unless the concept of an active participant is defined, how far does this definition help to clarify the meaning of interaction? Noble arguably acknowledges this complexity by then pointing out a further complicating concept, that of the feedback loop:

The feedback loop is a process of an entity communicating with itself while checking with either an internal or external regulatory system (2012, p.3).

The notion of the feedback loop is a reminder that when considering interactivity it is also necessary to identify the origins, form and flow of logic that is applied to user input, whether this is linear or non-

linear, pre-determined or random, non-determined but not random, human, adaptive or some other form of machine-learning operation. These terms are outlined in the table below:

Table 2. Clarification of terms such as “Linear” and “Pre-determination”

Linear: might also be called “uni-linear”. It implies sequential operations and a one-way flow of agency. In contrast, the term “non-linear” implies branching possibilities and choices.

Multi-linear: describes many possible choices and directions of agency. The term “multi-linear” might, as Aarseth implies, represent a challenge to the polarity of linear/non-linear agencies (Aarseth, 1997, p.44)

Pre-determination: implies an *a priori*, fixed system. The operations of such a system are known beforehand.

Random: the specific outcome is not known by the system, but the system is not learning or adapting. For instance, in the case of throwing a virtual dice.

Non-determined but not random: implies an adaptive system that may use machine learning, genetic algorithms or some other intelligent operation to change its behaviour as it sees fit. The outcome will not be wholly known by the designer/programmer but will, instead, emerge. It may imply a high degree of autonomy within the system.

Interactivity is further defined by Downes and McMillan (2000) as operating within six formal dimensions:

- *Direction of communication*
 - *Time flexibility*
 - *Sense of place*
 - *Level of control*
 - *Responsiveness*
 - *Perceived purpose of communication*
- (Downes & McMillan, 2000, pp. 157-179)

Downes et al recognise that many definitions of interactivity are contradictory and sometimes meaningless, a point that has also been made by Manovich (2001) among others. There is however, unanimous agreement that, regardless of the mode of interaction, software is a representational medium, but the representational nature of digital computers should not inhibit the conceptual and practical evolution of interaction modes. Dourish (2001) implores us to conceive of:

a more nuanced understanding of the role that those representations play, how they are subject to a variety of interpretations and actions, and how they figure as part of a larger body of practice. The opportunity is to break the link between an inevitably representationalist stance toward software and a much more questionable stance toward action and interaction (Dourish, 2001, p. 208).

Others, such as Trifonova (2008) have also elucidated useful framings of the interactive, but, when attempting to grasp precisely these more nuanced understandings that Dourish and others encourage, it is useful to go back to the key term Noble (2012) used in defining interaction – ‘active participants’. What is meant by the concept of an ‘active participant’ and how does this help in extending interactivity?

Agents and agency

Within intelligent software systems, an active participant is an ‘agent’ and the power an agent wields is called ‘agency’. A human agent makes things happen in the world. A software agent is similarly able, within its own world, to effect changes. Agency therefore influences events and processes while acting within a wider environment; however, it is important to dispense with the notion that agency is a ‘thing’ or a linear force, or that it is restricted solely to human agents.

In their classic text on artificial intelligence Russell and Norvig assert that an agent “is just something that acts” (Russell & Norvig, 2002, p. 4), but they also point out that:

Computer agents are expected to have other attributes that distinguish them from mere ‘programs’, such as operating under autonomous control, perceiving their environment, persisting over a prolonged time period, adapting to change, and being capable of taking on another’s goals. A rational agent is one that acts so as to achieve the best outcome or, when there is uncertainty, the best expected outcome (Russell and Norvig, 2002, p. 4).

Despite this clear-cut description, the conceptual boundaries of agency itself are not so obvious. A significant number of theorists, including Barad (2007), Slack and Wise (2005), Adam (1998), Hayles (1999), Suchman, (2007) and Haraway (1991), agree that the meaning of agency is neither neutral nor implicit. Slack and Wise are at pains to distinguish agency from causality, which they characterise as being restricted and one-dimensional:

The causal approach has a certain universal undertone to it, meaning that its purported causal effects are assumed to be the same under any-and-every-circumstance. The causal approach cannot adequately grasp the particularities of situations (Slack & Wise, 2005, p. 116).

Instead of considering agency as a possession or a thing, agency can be seen as a process and a form of relationship, one that “does not require human intention, which means that technologies can be involved in relations of agency” (Slack et al, 2005, p. 117). In considering software agents, Maes (1997) has stated that the term implies non-passive, proactive, personal helpers. Her description of agent technology evokes a high level, idealised scenario of personalised and proactive helper software agents, while Wooldridge’s (2002) requirements for an intelligent agent are precisely that ‘he’ or ‘it’ should be as follows:

- *Situated – ‘he’ is embedded in an environment.*
 - *Goal directed – ‘he’ has goals that ‘he’ tries to achieve.*
 - *Reactive – ‘he’ reacts to changes in ‘his’ environment.*
 - *Social – ‘he’ can communicate with other agents (including humans).*
- (Wooldridge, 2002, p. 23).*

Multi-agent systems are built from networks of agents that can act autonomously, often across distributed environments. Multi-agent systems can solve problems that are too complex for individual agents, human or otherwise, to solve. Agents in such systems do not require a global view of any system, in fact they are more likely to have only a 'local view'. A common analogy is to members of a swarm, such as ants or bees; the individual entities of swarms are decentralised, with no single controlling agent. Such agents are often embedded or situated in an environment, making them context-aware via sensors or other types of input.

But what exactly do these terms, particularly 'situated' and 'embedded' imply? The next section will examine the significance of context-aware, 'situated' software agents.

Situated cognition

In the context of artificial intelligence, situated agents are embedded in an environment. In Haraway's terms (1988), situatedness also constitutes an ethical recognition of the partiality and locatedness of knowledge, as opposed to an idealised notion of objective and placeless universality. The anthropologist Lucy Suchman (1987, 2007) presents the case for a radical re-framing of computer-human interaction; her interaction model is defined by the degree of pre-existent representation needed for computer systems to work satisfactorily. Suchman proposes a new conception of interactivity in which contingent plans work in tandem with situated, context-aware programs; in other words, programs that operate within physical environments.

Embedded in the notion of situatedness is a clear challenge to the conventional idea of a subject, or what Suchman identifies as the "unitary cogniser" (Suchman, 2007), also known as the 'Cartesian cogito', named after the 17th century philosopher René Descartes. The Cartesian cogito is a rational thinker, in classically cognitivist terms his thought processes are almost inseparable from those of a computer; his disembodied models of interaction are characterised by information-processing paradigms, in which symbolic representations are rationally evaluated. These paradigms are predicated on notions of environmental stimulus and behavioural response:

The first premise of cognitive science, therefore, is that people (or 'cognizers' of any sort) act on the basis of symbolic representations: a kind of cognitive code, instantiated physically in the brain, on which operations are performed to produce mental states such as 'the belief that p', which in turn produce behaviour consistent with those states (Suchman, 2007, p. 37).

The classical emphasis on symbolic representation is significant here, since it posits a mind-body split in which the body has minimal agency. The alternative model is one in which the body is a significantly active agent. The emphasis on embodiment in interaction and cognitive science has been advanced by the writings of Maturana and Varela (1987), Thompson and Rosch (1991), and more recently by Gallagher (2005), Damasio (2005), Alva Noë (2004) and Kiverstein (2010), among many others. In order to look at the significance of embodiment for digital interaction in detail, it is appropriate to explore the idea that all human experience is both situated and embodied, a principle that can also be referred to as 'enactivism'.

Embodiment and Enactivism

In contrast to the mind-body split of the rational cogito as a model for how humans operate within the world, an enactivist approach is a theory of cognition that is inseparable from action and is therefore implicitly embodied. Varela et al proposed the radical notion that experience, knowledge and cognition always emanate from both the body and the mind:

knower and known, mind and world, stand in relation to each other through mutual specification or dependent coorigination (Varela et al., 1991, p. 150).

It is important to also note their emphasis on the situatedness of human actions, that they take place within a non-symbolic, physical world. This, as Dennett explains, is a radical move away from pre-given notions of “internal” and “external” realms, of separate subjects operating on separate objects:

Cognitive scientists standardly assume a division between independently existing ('pregiven') 'external' objects, properties and events on the one hand and their 'internal' representations in symbolic media in the mind/brain on the other. Varela et al. propose to replace this with an 'enactive' account (Dennett, 1993, p. 121).

The idea that there is an emergent world of separate subjects and objects, rather than an implicit, *a priori* set of independent entities, has also been proposed by the physicist Karen Barad (2007), who deploys the term ‘intra-action’ as an alternative to interaction. In Barad's terms, intra-action does not presuppose “the prior existence of independent entities of relata” (Barad, 2007, p. 139). It does not take for granted atomistic or Cartesian separations between subject and object, instead Barad sees specific situations and actions as allowing phenomenological relata to emerge as specific causal intra-actions. This, in tandem with enactivism, is a very radical alternative to the types of interaction modelled on the classical cognitivist hypothesis.

Barad's challenge is to question the power placed in symbolic representation as tantamount to reality, as the main agent in human knowing and experiencing of the world. Barad calls her intra-active approach “agential realism” (Barad, 2007), in which knowing and knowledge generation are rooted in actions and relationships. The case studies presented towards the end of the chapter will look at how these ideas might work in practice, exploring a range of artworks that have deployed radical alternatives to conventional interaction modes, which, as the next section will evidence, are often characterised by pre-determined systems and pre-given distinctions between subjects and objects. The next section will therefore move away from the high-level, theoretical discussion of interactivity to the specific examination of twenty-five high-profile digital artworks. It will also outline the types of input and logic such works deploy and look at alternative approaches.

A TYPOLOGY OF INTERACTION MODES

A typology involves the analysis and classification of types. Constructing a typology aids researchers in identifying clusters, such as grouped patterns of behaviour, formal properties or attitudes. In the typology constructed for this chapter, a range of interaction types have been examined, while their use (or non use) by a number of high profile digital artworks has also been assessed. A Multiple Correspondence Analysis (MCA) of the typology then enabled the exploration of a range of interactive artworks and their formal interactive and logical structures. The MCA was performed in order to identify patterns and correlations embedded in the data. This process was triangulated by a cluster analysis, providing further evidence for the presence of identifiable classes of artwork.

Before undertaking the typology, a range of input types were identified, which were then condensed into eight identifiable modes and arranged within a contingency table (a table of data relating to two or more categorical variables). The analysis was undertaken with the statistical and machine learning language “R”. The types of input identified as well as the process and its outcomes are now described.

Input Devices

The types of input devices used by digital systems help us to identify the forms of agency used by external actors within an interaction process. Contemporary digital computer systems use input devices such as keyboards, mice, touch screens, microphones, and various sensors to acquire the data they will operate upon. They might also acquire data through networks. There are also, of course, many output devices used by contemporary computer systems, for example screens, audio speakers, printers and physical actuators such as motors and pistons.

The simplest definition of an input device is a mechanism that sends data to a computer; the data may take the form of mouse movements, keys on a keyboard being pressed, mouse clicks, and also combinations of inputs, such as a click and a keyboard press, for example the common “ctrl+click” combination.

The typology presented here, though not exhaustive (new input devices will almost certainly be invented at the time of writing), represents all of the most commonly found input devices as well as some very specialist forms of input mechanism, such as medical imaging and head tilt sensors for severely disabled computer users.

Table 3. Table of input devices

<p>Mouse</p> <p>Keyboard/virtual or physical</p> <p>Joysticks</p> <p>Microphone</p> <p>Microphone and speech recognition systems</p> <p>Yokes: such as an aircraft simulation pulling or pushing device</p> <p>Composite game controller: with combinations of buttons and accelerometers, steering wheels, paddle etc.</p> <p>Touch screen</p> <p>Graphics tablet/stylus</p> <p>Midi keyboard/drum and other midi input devices</p> <p>Digital cameras, Webcams, other visual input</p> <p>Buttons, switches, potentiometers</p> <p>Remote control</p> <p>Breath detection</p> <p>Head movement detector</p> <p>Eye tracker</p> <p>Nouse (detects breath from nose)</p> <p>Body sensor: such as heart rate, EEG, galvanic skin response, breath etc.</p> <p>Biometrics: such as finger print and iris scanners</p> <p>Other medical sensing/imaging technology</p> <p>Motion and proximity sensors: including the Kinect sensor</p> <p>Environmental sensors: these detect environmental data such as temperature, pollution, light levels</p> <p>Scanners</p> <p>Barcode readers</p> <p>Card readers</p> <p>Magnetic-Ink Character Recognition (MICR)</p>

Optical Mark Reader (OMR)

Punched card input

Light pens

Handwriting recognition

CAVEs: computer-assisted virtual environments

VR helmet and gloves

3D Gloves

Haptic Gloves

Electronic Whiteboard: this has been counted as a type of Standard screen input, albeit often collaborative

Networked: input might come automatically via WIFI

These devices may be subdivided into the following categories:

Table 4. Categories of input device

Standard: keyboard, mouse, joystick, touch-screen, microphone, Webcam, remote control, whiteboard light pen

MIDI devices

Environmental sensors: temperature, pollution and light sensors etc.

Internal Embodied: sensing internal bodily attributes such as heart rate, brain waves, breath

Biometric: also embodied but usually engaged with surface features, for example iris, finger print and facial patterns.

Embodied: close to the concept of “natural” interactions used by NUIs or “Natural User Interfaces”, such as stroking, picking up objects, walking, gesturing, speaking etc. CAVEs may also be included in this category, includes handwriting recognition systems.

Readers: card readers, bar code scanners, punched card input, OMR.

It should be noted here that Preece et al wisely question the term ‘natural’ embedded within the acronym ‘NUI’ (Natural User Interfaces) and ask whether learning a particular gesture to open a file in a NUI is any more natural than using a menu-based GUI for the same job (Preece et al, 2011, p. 215).

Some devices cross categories, such as sound input, which could be classified as embodied as well as environmental, or even as a ‘standard’ form of computer input. It is important to acknowledge that the construction of a typology is an approximate and in many ways subjective process; another set of researchers might very well come up with a different set of results; this is a point that Aarseth (1997) made very clear when constructing his innovative typology of interactive texts.

When considering interactivity in artworks, the logic that is applied to user input was also identified, whether it was random, pre-determined, non-determined but not random (such as machine learning) human, adaptive or some other form of learning system.

Table 5. Artists and artworks included in the typology

Artist	Artwork
1. Grey World	The Source
2. Julian Opie	Bruce Walking
3. Golan Levin	Eyecode
4. Mark Napier	Shredder
5. Corey Arcangel & Michael Frumin	Pizza Party
6. Bill Viola	The Stopping Mind
7. Camille Utterback	Shifting Times
8. Lozano-Hemmer	Under Scan
9. Nam June Paik	Jacobs Ladder
10. Stelarc	Parasite
11. Jeffrey Shaw	Legible City
12. William Latham	Mutator C
13. Laurie Anderson	The Waters Reglitterized
14. James Faure-Walker	Dark Filament
15. Marius Watz	Arcs (Rockheim)
16. Harold Cohen	Aaron
17. Josh On	They Rule
18. Blast Theory	My Neck of The woods
19. Casey Reas	TI
20. Miguel Chevalier	Sur-Natures
21. Karsten Schmidt	Unstable Energy
22. Daniel Rozin	Weave Mirror
23. Troika	Digital Zoetrope
24. Frost & Koblin	House of Cards
25. John Maeda	Nature

A Multiple Correspondence Analysis (MCA) is a statistical technique that enables the identification of patterns in more than two categorical variables; in this case, seventeen interaction and logic forms and twenty-five artworks. The MCA examined relative frequencies in terms of the mathematical distances between individual rows and columns. The topic of distance metrics will be returned to when the chapter looks at a working example of an “interest matching” or collaborative filtering algorithm. The resulting data evidences statistically significant variations which are then interpreted “as representing a distinct pattern of usage” (Glynn, 2012, p. 134).

Each artwork was evaluated as TRUE or FALSE for the following variables:

Table 6. Variables applied to the typology of artworks

Not interactive
Standard
Midi
Environment
Internal-embodied
Biometric
Embodied
Reader
Network
Linear
Multi-linear
Non-linear
Determined
Random
Non-determined
Adaptive
Context-aware

The two-dimensional Euclidean cloud of data that resulted enabled the identification of non-random, systematic correlations between variables, graphically represented in the chart below:

Table 7. Artworks represented in two-dimensional space according to patterns of interaction and logic detected by the Multiple Correspondence Analysis

TABLE 7

Table 8. Modes of interaction and logic represented in two-dimensional space according to patterns of interaction and logic detected by the Multiple Correspondence Analysis

TABLE 8

The data space represented $25 \times 17 \times 2$ or 850 variable positions and 850! (factorial) possible combinations, from which five loose and two major classes of digital artwork emerged. These were also confirmed by the hierarchical cluster dendrogram generated by a cluster analysis in R. The graphical representation of that cluster analysis is illustrated below. The dendrogram arranges clusters hierarchically, indicating which types of data they contain and their sub-groups. In this example the values were binary.

Table 9. Dendrogram and heat map of clusters, or patterns of interactivity and logic in twenty-five digital artworks

TABLE 9

Table 10. Eigenvalues and variances obtained from the Multiple Correspondence Analysis

number	eigenvalue	percentage of variance	cumulative percentage of variance
1.	0.42332127	16.017561	16.01756
2.	0.22942201	8.680833	24.69839
3.	0.20643118	7.810909	32.50930
4.	0.15796309	5.976982	38.48629
5.	0.14013277	5.302321	43.78861

Eigenvalues represent the distinctness of the patterns identified by the MCA analysis. The major patterns of artwork interaction and logic types were identified as follows:

Table 11. The five patterns of interaction and logic types identified by the typology (provided by the MCA analysis)

<p>Pattern 1: Arcs Mutator C Ti They Rule</p>
<p>Pattern 2: House of Cards Pizza Party Shredder</p>
<p>Pattern 3: The Source Parasite Sur-Natures Eyecode Shifting Times Legible City, (overlaps with 4) Weave Mirror Under Scan</p>
<p>Pattern 4: Legible City The Stopping Mind My Neck of The Woods</p>

Pattern 5:
Jacob's Ladder
Bruce Walking
Nature
The Waters Reglitterized
Aaron
Dark Filament
Unstable Energy

The patterns were characterised by the following qualities:

Table 12. Attributes of the five patterns of interaction and logic

Pattern 1:
Networked
Adaptive
Non-Determined

Pattern 2:
Standard
Networked

Pattern 3:
Aware of environment
Non-determined
Random
Embodied
Context-aware
Internal embodied

Pattern 4:
Multi-linear
Non-linear

Pattern 5:
Not context-aware
Linear
Determined
Non-networked
Disembodied

The group defined by Pattern 5 represented a very dense cluster of deterministic, disembodied works, while Pattern 3 arguably represents the avant-garde of digital artworks, with notable outliers such as Stelarc's *Parasite*. However, as Pattern 3 was a less densely defined cluster, it was spread across a number of variables and included artworks with some, but not all, aspects of the more contemporary interaction models outlined in this chapter.

The typology of interaction modes and MCA demonstrates that, despite the growing withdrawal from the classical cognitivist approach to human-computer interaction, many major digital artworks are still embedded with the literal construal of the classical cognitivist hypothesis (Varela et al, 1991, p. 43). Interaction researchers such as Dourish (2001), among others, have encouraged a move away from linear, disembodied models of interaction and agency, but, perhaps surprisingly, this is still the dominant model of interaction for many digital artworks. If, as Dourish states, embodiment is “the property of our engagement with the world that allows us to make it meaningful” (Dourish, 2001, p. 126) then it is important to ask how digital artworks can expect to innovate and develop in the future, while operating within an outmoded paradigm.

It is also important to point out that embedded action and engagement with the world does not imply gesture or movement alone; there are, as Dourish states, other types of embedded action, such as social action, “firmly rooted in the setting in which it arises, where that setting is not just material circumstances, but social, cultural, and historical ones as well” (Dourish, 2001, p. 96). And yet many of the works looked at here appear to operate within a cultural, social and physical vacuum. It is thus safe to conclude that digital artworks have not caught up with major paradigm shifts in computer science.

The domain of computer science has arguably recovered from the failure of many AI projects of the 1980s and early 1990s, in particular the grand and unimaginably expensive folly of 5th generation computing that resulted in the ‘AI winter’ (in which vast, rule-based systems were abandoned and funding for AI projects was widely curtailed). Cognitive computing, robotics and machine learning are areas that now pursue more mature notions of agency and intelligence. Contemporary approaches to intelligent systems have, on the whole, less grandiloquent goals than exactly modelling human intelligence or building a ‘brain in a vat’. They are often connected to data mining and pattern recognition tasks as well as industrial/military robotics with predominantly pragmatic goals, other researchers, such as Deliyannis (2013) focus on new, intelligent, methodologies for sustainability in multi-media applications.

Torrance and Forese (2011) have identified a revived interest in many areas of artificial intelligence and interaction inspired by an enactivist approach, including adaptivity and autonomy, enactive framings of agency and social inter-relationships, as well as enactivism's implications for cognitive science. These ideas are investigated by, among others, Di Paolo (2005, 2009), Thompson (2005, 2007), Barandiaran et al (2008, 2009) and Menary (2010). And yet, despite this significant shift in theoretical emphasis, only a fraction of the major artworks analysed here could claim to have adopted embodied or situated approaches. One reason for this conceptual inertia may relate to a lack of technical or conceptual insight into alternative models. However, there are a number of artists who do engage with innovative and embodied approaches, often working outside of the mainstream of the art world. There now follows a brief evaluation of four artworks that have significantly reconceptualised interaction and its associated agencies and contexts.

Case Studies

***Sur-Natures*, Miguel Chevalier, 2012**

Miguel Chevalier's *Sur-Natures* was a virtual reality installation exhibited at the Paris Charles de Gaulle airport in 2012. The installation was both generative and interactive, involving the growth of a virtual garden, comprised initially of eighteen autonomous virtual 'seeds' featuring what the artist describes as “multiple colors, luminescent, scalar plants - herbaceous, red and purple cacti and long yellow flowers with turquoise stems” (Chevalier, 2014). In addition, the system involved situated virtual organisms in

which “translucent plants grow and change because of motion detectors which register passing pedestrians” (Lieser, 2009, p.181).

The typology and MCA conducted for the present chapter places *Sur-Natures* as an outlier within the data set of twenty-five digital artworks representing, along with Stelarc's *Parasite*, an extreme and, arguably, innovative form of interactive artwork. Chevalier's virtual flowers are not an attempt to replicate nature. They are strikingly artificial-looking, clearly framed within the materiality of the digital medium; they are also “translucent and fragile, and they refer to the underlying digital structure” (Lieser, 2009, p.181).

The virtual flowers that ‘grew’ in the installation reacted to the passage of people within the airport via sensor technologies, enabling plants to bend and move according to the visitor's physical orientation, creating a kind of plant ballet. Miguel Chevalier compares this work to Monet's time series, but the former also constitutes an adaptive system, deploying a combination of random elements as well as biologically inspired ‘morphogenetic code’, in which plants evolve according to the specific conditions in the airport.

To paraphrase Chevalier, the plants grew non-determinedly, blooming and dying according to the evolutionary model of the software; they “grow every day in real time and evolve to infinity” (Chevalier, 2014). But Chevalier's plants also grew in reaction to the specific environmental and embodied actions of people walking through the airport. With its non-determined set of outcomes, *Sur-Natures* exemplifies (whether consciously or not) an *intra-enactive* framing of specific actions and agencies. It represents an isolated minority of mainstream artworks that have integrated new conceptions of the active participant within creative digital practice.

Burning Down Memory, Eleanor Dare, 2014

Burning Down Memory by Eleanor Dare (exhibited at the Slade Research Centre, London, May 2014) was the documentation of a sensor-based performance in which the author attempted to articulate sub-symbolic experiences, i.e. experiences and types of knowledge that cannot be expressed in language or any other types of symbolic system.

The author was attached to a Galvanic Skin Response sensor (sometimes known as a “lie detector” or GSR) as well as an EEG headset (an Electroencephalograph which measures fluctuations in voltage emanating from the scalp). When the GSR unit detected a significant drop in resistance, indicative of anxiety, the author was given an electric shock, which in turn sent signals through the EEG headset. If the EEG signals were beyond a certain threshold of emotional arousal the signals triggered the permanent removal of pixels from an image of a wartime bomb site in South London, via a series of virtual “fires” in the software.

Figure 1. The artist Eleanor Dare is electrocuted; this results in the destructive removal of pixels from an image of a bomb site in South London

FIGURE 1

Burning Down Memory destabilised the idea of an originary event, questioning and inverting the status of documentation and the conventional notion that an event precedes and authorises its documentation; an order that is often taken for granted, as Auslander (2006) articulates. At the same time, the vulnerability of bio-sensor technology (even medical grade EEG sensors) to environmental noise and false readings

adds another element of ontological doubt to the technologies of representation at play, arguably blurring the boundaries between subjects, objects and the causal flow of documentation.

In *Burning Down Memory*, the body and the computer system became mediums for an investigation into agency and knowledge representation. But, although the EEG headset was positioned around a face, the project was not about “the face as an interface” as Blackman expresses it (2008), but about the frequencies that emanate from the face and the brain, from hands, epidermis and sweat. In this project, bodily fluids are framed as cultural as well as physical agents; the body in this configuration was not “an inert mass in the service of a superior mind” (Blackman, 2008, p. 30) but a co-agent in a dynamic system of meaning-making.

***Microphone*, EunJoo Shin and Alex McLean, 2010**

Microphone by McLean and Shin (2010) was exhibited at the *Unleashed Devices* group show, Watermans Gallery, London. The interactive sculpture enabled participants to communicate with each other by speaking into two large funnel-shaped wooden structures. The mouth grimaces that participants made, rather than the actual sounds they produced, were captured by a digital camera.

Using computer vision and machine learning techniques, the software written by the artists then produced vowel sounds. In this way, the physical gestures of users were emphasised, “bringing focus on the role of movement in communication. It evokes a feeling that is literally visceral, of vocal organ encoding patterns of movement into sound, and being perceived as movements” (McLean, 2011, p. 41).

Microphone deploys context-aware models of human subjects and, combined with sensor technology, it expands the agencies at play in interactive works and represents a model of interaction that is far more in keeping with a contemporary framing of agency and embodiment than almost all of the high-profile works examined in the typology.

***VAINS*, Eleanor Dare and Lee Weinberg, 2011**

VAINS is a physical computation system that deploys EEG to sense the electronic brainwave frequencies of individuals while they are interacting with online art sites. The system works by analysing electroencephalographic signals and matching them to suitable artworks based on a collaborative filtering algorithm. On the initial phase of the *VAINS* project, the developers solicited approximately 200 users to establish a database of responses to digital artworks online.

Figure 2. The VAINS system, an EEG headset identifies brainwaves in individual users and matches them to artworks via similarity metrics. The metrics evolve and change as more people use the system (Dare & Weinberg, 2011)

FIGURE 2

Figure 3. The online collaborative filtering interface for VAINS, used in the initial phase of data collection (Dare & Weinberg, 2011)

FIGURE 3

The EEG system calibrates itself uniquely to each individual by observing the flow of their brainwave activity, then allowing for a period of further observation before forwarding users to artworks that might correlate to their alpha, beta and gamma wave patterns and those of previous users. In this way, participants experience an autonomic process of interaction with online artworks. The project is overtly influenced by an enactive and situated methodology that privileges action over *a priori* goals; “it seeks an emergent, fluid and constantly changing set of navigational pathways” (Dare & Weinberg, 2011, p. 20).

The deployment of collaborative filtering within the VAINS platform is presented as both a cultural medium and an instrumental agent within the work. The very process of constructing recommendations is exposed and interrogated. The work provocatively channels users to sites that are stereotypically “interest-matched”, such as pink Web pages for teenage girls and sombre grey pages for middle-aged men. The extremity of selections challenges users to resist the naturalisation of such processes.

This chapter proposes that the deployment of collaborative filtering and other forms of collective intelligence, while subject to much media hype, is also a fertile ground for the investigation of agency in digital artworks. This is not to revert to an idealised notion of interactivity or ‘death of the author’ discourse (Barthes, 1967), but an opportunity to recognise and critique an increasingly prevalent cultural and technological form. The next section will outline aspects of the specific algorithm used by the VAINS project for collaborative filtering.

Collaborative filtering

Collaborative filtering is an increasingly significant technique deployed by Web applications. When a site suggests “other products you might like” it is probably using a recommendation algorithm, in which recommendations are generated through a process of collaborative filtering, either explicitly or implicitly invoked. Implicit collaborative filtering might involve surveillance of user choices and patterns of preference, as for example, when making a purchase or clicking on a link. Explicit collaborative filtering asks users directly to choose a preference – to rate a film, book or holiday and so on.

Euclidean Distance

A range of equations can be used to quantify the similarity of preferences or correlation between data sets, such as the Pearson correlation coefficient or Euclidean distance. These yield scores of how strongly (or not) an individual's preferences are matched or how likely there is to be a correlation between values. In the example provided here, the range for such values will be normalised to between 0 and 1. The formula provided is known as “Euclidean distance” or the “Euclidean metric” algorithm. In the example of

VAINS (see the case study section above), Euclidean distance enabled the automatic evaluation of similarities between different individuals and their appreciation for digital artworks online. The Euclidean distance between two sets of points is calculated as:

The Euclidean metric establishes the distance between these two points in space and calculates how similar two sets of preferences are. A version of the algorithm is provided here in Processing and in the client-side language JavaScript, embedded in html.

Algorithm 1. The Euclidean Metric in Processing

```
/*processing example, to be run in the Processing IDE available at:
http://www.processing.org/
void setup() {

    println(dist(3.0, 1.0, 3.0, 1.0));/* built in distance method*/
    println("inverted: " +1/(1+dist(3.0, 1.0, 3.0, 1.0)));
    println("our own method:");
    println(euclid_Distance(3.0, 1.0, 3.0, 1.0));
//invert and normalise:
    float a = (euclid_Distance(3.0, 1.0, 3.0, 1.0));
/* for readability we multiplicatively invert the result, so low
scores are high and vice versa: */
    println("inverted and normalised: "+ 1/(1+a));

}

float euclid_Distance(float x1, float y1, float x2, float y2) {

    float dx = x1 - x2;
    float dy = y1 - y2;
    float dis = sqrt(dx*dx + dy*dy);
    return dis;
}
//end
```

The JavaScript code, below, can be saved as 'anything.html' and opened in a browser locally (by double-clicking on the anything.html file) or uploaded to a server:

Algorithm 2. The Euclidean Metric in JavaScript

```
<!DOCTYPE html>
<html>
<body>
<h1>Euclidean Distance</h1>
<p>Simple Euclidean distance algorithm in JavaScript.</p>
<p id="euclid_demo"></p>
```

```

<script>
/*imaginary preference scores for two artworks by two gallery visitors,
out of 5, experiment with other values*/

Henry1 = 3.0;
Henry2 = 1.0;

Alice1 = 3.0;
Alice2 = 1.0;

    function euclid_Distance(x1, y1, x2, y2) {

        dx = x1 - x2;
        dy = y1 - y2;
        dis = Math.sqrt(dx*dx + dy*dy);

        return dis;

    }

//write the non-normalised result to the document:
document.write("Raw distance metric for Henry and Alice: " +
euclid_Distance(Henry1, Henry2, Alice1, Alice2));

/* With the calculation above the result will be smaller for people
who are more similar, but you can 'flip' (multiplicatively invert) the
result to make it more human-understandable, with a high score for
similarity and a low score for dis-similarity. It will be
multiplicatively inverted and normalised to values from 0 to 1. A
division by zero error is also avoided by adding a 1 to the equation.
The reciprocal of x is 1/x. All numbers have a reciprocal except zero,
hence the addition of 1 below)
*/
    var eucTemp = euclid_Distance(Henry1, Henry2, Alice1, Alice2)
    var eucl = 1/(1+eucTemp);

/* write the normalised result to the document to two decimal places
*/

    document.write("<br>Inverted similarity score for Henry and Alice:
" +eucl.toFixed(2));

</script>
</body>
</html>

```

The code above generates similarity scores for our online gallery visitors "Alice" and "Henry". In order to progress into making a more complex recommendation engine, the VAINS project used the Pearson correlation algorithm, i.e. a lengthier formula than Euclidean distance but one that is more robust in the presence of non-normalised data, or data with an extreme set of variations. The use of Pearson correlation

for collaborative filtering is very clearly described by Toby Segaran in *Programming Collective Intelligence* (2007).

Solutions and Recommendations

Machine learning algorithms increasingly draw upon the millions of terabytes of data that proliferate year on year. This is also known as 'Big Data'. Vendors such as Amazon and Netflix routinely deploy Big Data and machine learning, often to target customers with offers of products that they may be interested in. Such data might originate from sensors, video and audio input, networks, log files, transactional applications, Web, and social media, often in 'real time' and on a very large scale. But, despite the prevalence and increasing cultural significance of these techniques, they are rarely explored, or critiqued by artists; this is despite the growing ease of access to datasets, analytic technology and distributed computing frameworks such as Hadoop.

This chapter proposes that machine learning techniques, in tandem with embodied forms of interaction, offer an alternative configuration of agency to that used by the majority of high-profile digital artworks. This alternative emphasises adaptive software processes in which systems can learn from subjects and situations, resulting in outcomes that are not solely pre-determined. In these systems, agency is multi-linear; this is not to imply a symmetrical form of agency or idealised notions of user empowerment, such as those that emerged in the 1990s (see, for example, Bolter et al (1991)), but something closer to Dourish's (2001) notion of nuanced interaction discussed earlier in the chapter.

In this light, and as proposed in the opening section, galleries and curators need to think of the medium in terms of *context* instead of *content* of the work (Graham and Cook, 2010). The understanding of the peripheral (technical) requirements that frame or support the work is equally crucial for assessing a piece and subsequently making curatorial judgements.

The core recommendations this chapter proposes for developing innovative interactive digital artworks are as follows:

1. Meaning (or intelligibility) in a situated system cannot reside in an *a priori* model of the user (or their possible interactions), but rather in a relation between more generalised plans and specific circumstances.
2. Likewise, subjective representation is problematic; it is more useful to examine dynamic and situated differences.
3. Dominant modes of interaction, such as those based solely on propositional logic, statistics and *a priori* representations of cause and effect (exemplified in rule-based systems) are fixed and reactive and as such are not ideal for generating new ideas or new artistic forms.
4. Open-ended methods are preferable within a system designed to encourage divergent forms of artwork and divergent subjectivities.
5. The artworks in such a system, like the subjects who interact with it, will be multiple, situated and multi-linear.

6. Enactive systems deploy knowledge generated through embodied processes, not only sight, but also smell, touch, taste, sound, social and cultural relations.

From these core findings, an encapsulation of this chapter's theoretical and practical rationale can be condensed into the following two statements:

1. Interaction is a contingent process of shared and collaborative, *ad hoc* understandings within the framework of generalised or more abstracted *a priori* intentions.
2. Difference and specificity are key resources in interactive systems working with subjects – human or virtual.

FUTURE RESEARCH DIRECTIONS

While it is important to acknowledge that Big Data and machine learning, like many other emergent technologies, are subject to an exaggerated form of “hype curve” (Veryard, 2005, p. 1), they are still significant cultural artefacts and are worthy of investigation by contemporary artists. In conjunction with embodied and situated technologies, as well as adaptive programming techniques, the time is ripe for a significant paradigm shift in the framing of agencies and interactivity models in digital artworks. It is proposed that in the future innovative digital artworks might fruitfully deploy the following combinations of technologies and techniques:

- Machine Learning can support systems that learn from “users” and situations as an alternative to *a priori* configurations.
- Collaborative filtering and Crowdsourcing, of the type currently used by many Citizen Science projects, might extend the agencies at play in digital artworks.
- Adaptive systems such as genetic algorithms, artificial immune systems and artificial neural networks can also generate emergent, non-determined outcomes.
- Embodied systems that work via a range of sensors can react to actions and environmental data, enabling a dynamic range of outputs.
- Situated systems, which are socially as well as physically and bodily located in specific environments, expand the field of interaction to a set of relational phenomena in keeping with an enactivist framing of action, agency and perception.

None of these techniques or processes are proposed as offering isolated solutions; rather, they are presented here as parts of dynamic, multi-linear systems, incorporating an enactive approach to human experience that is embodied, situated and emergent, involving multiple forms of agency.

CONCLUSION

The historical background and typology presented in this chapter identified a distinct pattern of high-profile artworks in which disembodied image-objects (or ‘spectacles’) were deployed. The majority of works identified were, on the whole, also found to be operating on deprecated models of human computer

interaction, predicated on classically cognitivist divisions between agents and their environments. The chapter outlined alternatives to these approaches; in particular it highlighted the concept of enactivism.

As Alva Noë has observed (2004), enactivism has evolved significantly since Varela et al first outlined it. It now offers a nuanced and potentially non-polarising alternative to orthodox views of human-computer interaction. Noë (2004), like Barad (2007) and Suchman (2007), offers a view of agency in which agents are entangled with each other in a process of co-origination. Whatever term is applied to this co-constitution of agencies, whether it is called *interactivity*, *intra-activity* or *intra-enactivity*, it is one that will necessitate the integration of radically new conceptions of action and participation within creative digital practice.

Throughout this chapter, innovative research in interactive systems has been highlighted, including artists' tools, applications, and techniques that aggregate to offer a critical engagement with emerging multimedia trends. In particular, the chapter has looked at situated computing and embodied systems, in which context-aware models of human subjects are combined with sensor technology to expand the agencies at play in interactive works. The chapter has connected enactive principals to technologies such as Big Data, Crowdsourcing and other techniques from artificial intelligence that develop the conception of interaction and participation.

The case studies presented here have elucidated some of the specific technical and design strategies used in real world projects. The chapter has critiqued the reduction of mainstream digital art to 'spectacles', and instead highlighted more nuanced works. These works offer forms of interaction that are in keeping with current cognitive and computer scientific understandings of both human and machine agencies. In detail, this chapter has advanced the work of Noë (2004), Maturana and Varela (1987), Suchman (2007), Barad (2007) and Dourish (2001), who all contribute to providing significantly new models for human computer interaction within artistic practice.

REFERENCES

Aarseth, E. (1997). *Cybertext, Perspectives on Ergodic Literature*, Baltimore. MD: John Hopkins University Press.

Adam, A. (1998). *Artificial Knowing, Gender and the Thinking Machine*. London and New York: First Routledge.

Auslander, P. (2006). The Performativity of Performance Documents. *PAJ: A Journal of Performance and Art*, 28(3), 1-10.

Barad, K. (2007). *Meeting the Universe Halfway, Quantum Physics and the Entanglement of Matter and Meaning*. Durham, N.C: Duke University Press.

Barandiaran, X., Di Paolo, E. A., & Rohde, M. (2009). Defining agency: Individuality, normativity, asymmetry, and spatio-temporality in action. *Adaptive Behavior*, 17(5), 367-386.

Barandiaran, X., & Ruiz-Mirazo, K. (Eds.) (2008). Special Issue on "Modeling Autonomy". *BioSystems Journal*, 91(2).

Barthes, R. (1977). 'From Work to Text' and 'The Death of the Author' (1967), from *Image-Music-Text*, London: Fontana Press.

Bishop, C. (2004) 'Antagonism and Relational Aesthetics', from *October*, Fall 2004.

Blackman, L. (2008). *The Body*. Oxford and New York: Berg.

Bolter, J. D. (1991). *Writing Space, the Computer, Hypertext, and the History of Writing*. New Jersey: Lawrence Erlbaum Associates.

Bourriaud, N. (2002). *Relational Aesthetics*. Dijon: Les presses du reel.

Burnham, J. (1968). *Beyond Modern Sculpture: The Effects of Science and Technology on the Sculpture of this Century*. New York: George Braziller.

Chevalier, M. (2014). Miguel Chevalier.
Retrieved from <http://www.miguel-chevalier.com/en/index.html>

Clark, T. J. (1985). 'Clement Greenberg's theory of art'. From Frascina, F. (ed) (1985). *Pollock and After: The Critical Debate*. London: P. Chapman.

Cook, S. (2003). 'Towards a Theory of the Practice of Curating New Media Art'. From Townsend, M. (ed). *Beyond the Box – Diverging Curatorial Practices*. Banff: Banff Centre press.

Damasio, A. (2005). *Descartes' Error: Emotion, Reason, and the Human Brain*, New York: Putnam. Revised Penguin edition, 2005.

Dare, E., & Weinberg, L. (2011). Encountering the Body in Art, Online: VAINS (visual art interrogation and navigation system) the abjection application and the neural art navigation tool [Website for the ISEA 2011, 17th International Symposium on Electronic Art]. Retrieved from <http://isea2011.sabanciuniv.edu/paper/encountering-body-art-online-vains-visual-art-interrogation-and-navigation-system-abjection-ap>

Deliyannis, I. (2013) Sensor Recycling and Reuse, *International Journal of Sensor and Related Networks*, Vol.1, Iss.1.

Dennett, D. (1993). Review of F. Varela, E. Thompson and E. Rosch, *The Embodied Mind* [review of the book *The Embodied Mind* by Varela, F., Thompson, E., and Rosch, E.]. *American Journal of Psychology*, 106, 121-6.

Descartes, R. (2000). *Discourse on Method and Related Writings*. London: Penguin Classics.

Di Paolo, E.A. (Ed.) (2009). Special issue on "The Social and Enactive Mind". *Phenomenology and the Cognitive Sciences*, 8(4).

Di Paolo, E.A. (2005). Autopoiesis, adaptivity, teleology, agency. *Phenomenology and the Cognitive Sciences*, 4(4), 429-452.

Dourish, P. (2001). *Where the Action Is: The Foundations of Embodied Interaction*. Cambridge: MIT Press.

Downes, E. J & McMillan, S. J. (2000). Defining Interactivity. *New Media & Society*, 2(2), 157-179.

Druckrey, (ed) (1996). *Electronic Culture*. Romford: Aperture.

Fried, M. (1967) "Art and Objecthood". Retrieved from <http://atc.berkeley.edu/201/readings/FriedObjcthd.pdf> - last accessed: 2 May 2014) [unpaginated].

Gallagher, S. (2005). *How the Body Shapes the Mind*. New York: Oxford University Press.

Glynn, D. (2012). Correspondence Analysis: Exploring data and identifying patterns. *Academia.edu*, Retrieved from http://www.academia.edu/926945/Correspondence_Analysis

Graham, B. and Cook, S. (2010). *Rethinking Curating – Art after New Media*. Cambridge Mass. and London: MIT press.

Greenberg, C. (1960/1992). "Modernist Painting". From Harrison, C. and Wood, P. (eds). *Art in Theory 1900-1990*. Oxford: Blackwell.

Haraway D. (1991). Situated Knowledges, from, *Simians Cyborgs and Women: The Reinvention of Nature*. New York: Routledge.

Hayles K. N. (1999). *How We Became Post Human*, Chicago and London: The University of Chicago Press.

Kiverstein, J. (2010). Out of our Heads: Why You Are Not Your Brain, and Other Lessons from the Biology of Consciousness. *Journal of consciousness studies*, 17(5-6), 243-248.

Knight, J. (ed) (1996). *Diverse Practices: A Critical Reader on British Video Art*. Luton: University of Luton press.

Lieser, W. (2009). *Digital Art*. Königswinter (Germany): h.f. ullmann / Tandem.

Maes, P. (1997). On Software Agents: Humanizing the Global Computer. *IEEE Internet Computing*. 1(4),10-19.

Manovich, L. (2001). *The Language of New Media*. Cambridge: MIT Press.

Martin, S. and Grosenick, U. (eds) (2006). *Video Art*. London: Taschen.

Maturana, H. R., & Varela, F. J. (1987). *The Tree of Knowledge: The Biological Roots of Human Understanding*. Boston: Shambhala Publications.

McLean, A. (2011). *Artist-Programmers and Programming Languages for the Arts*. (Unpublished PhD Thesis). University of London, United Kingdom.

- Menary, R. (Ed.) (2010). Special issue on 4E Cognition: Embodied, Embedded, Enacted, Extended. *Phenomenology and the Cognitive Sciences*, 9(4).
- Mondloch, K. (2010). *Screens – Viewing Media Installation Art*. Minneapolis: University of Minnesota press.
- Muller, L., Edmonds, E. and Connell, M. (2006). ‘Living Laboratories for Interactive Art’. From *CoDesign*, 2 (4, December), pp. 195-207.
- Noble, J.(2012). *Programming Interactivity*. Sebastopol, CA: O'Reilly Media.
- Noë, A. (2004). *Action in Perception*. Cambridge, MA: MIT Press.
- Paul, C. (2008). *New Media in the White Cube and Beyond*. London, Berkeley and Los Angeles: University of California press.
- Preece J, Rogers Y & Sharp H. (2011) . *Interaction Design: Beyond. Human-Computer Interaction*. Hoboken, NJ: John Wiley & Sons; 3rd edition.
- Rodowick, D. N. (2001). *Reading the Figural, or Philosophy After the New Media*. London: Duke University press.
- Rush, M. (1999). *New Media in Late 20th- century Art*. London: Thames & Hudson.
- Russell, S. & Norvig, P. (2002). *Artificial Intelligence: A Modern Approach* (2nd Edition). London: Prentice Hall Series in Artificial Intelligence.
- Segaran, T. (2007). *Programming Collective Intelligence: Building Smart Web 2.0 Applications*. Sebastopol, CA: O'Reilly Media.
- Shanken, E. A. (2011). ‘Contemporary Art and New Media: Toward a Hybrid Discourse?’. Retrieved from: <http://hybridge.files.wordpress.com/2011/02/hybrid-discourses-overview-4.pdf>
- Slack, J. D. & Wise, J. Macgregor (2005) . *Culture and Technology. A Primer*. New York: Peter Lang.
- Suchman, L. (1987). *Plans and Situated Actions: The Problem of Human-machine Communication*. New York: Cambridge University Press.
- Suchman, L. (2007). *Human-Machine Reconfigurations: Plans and Situated Actions*. New York: Cambridge University Press.
- Sutton, G. (2004). ‘Exhibiting New Media Art’. Retrieved from: <http://kris.constantvzw.org/?p=20>
- Thompson, E. (2005). Sensorimotor subjectivity and the enactive approach to experience. *Phenomenology and the Cognitive Sciences*, 4(4), 407-427.
- Thompson, E. (2007). *Mind in Life: Biology, Phenomenology, and the Sciences of Mind*. Cambridge, MA: Harvard University Press.
- Torrance, S., & Froese, T. (2001). An Inter-Enactive Approach to Agency: Participatory Sense-Making, Dynamics, and Sociality. *Humana.Mente*, 15, 21-53.

Trifonova, A., Jaccheri, L. and Bergaust, K. (2008). Software engineering issues in interactive installation art. *International Journal of Arts and Technology (IJART)*, vol 1(1).

Varela, F. J, Thompson, E., & Rosch, E. (1991). *The Embodied Mind: Cognitive Science and Human Experience*. Cambridge, MA: MIT Press.

Veryard, R. (2005). Technology Hype Curve [blog post]. Retrieved from <http://demandingchange.blogspot.co.uk/2005/09/technology-hype-curve.html>

Whitehead, A. N. (1929). *Process and Reality*. New York: The Macmillan Company.

Wooldridge, M. (2009). *An Introduction to MultiAgent Systems*. New York: John Wiley and Sons.

Youngblood, G. (1970). *Expanded Cinema*. New York: Dutton.

KEY TERMS AND DEFINITIONS

Agency: Agency influences events and processes and therefore acts within the world. It is important in the context of interaction models to dispense with the notion that agency is a ‘thing’ or a linear force, or that it is restricted to human agents only.

Crowdsourcing: The collective acquisition, explicit or implicit, of data as well as actions and resources, this is often undertaken by “lay” people, for example, in the case of Citizen Science projects for classifying galaxy types. The term is also often used to refer to what is really a form of crowd funding.

Enactivism: In contrast to the mind-body split of the Cartesian Cogito as a model for human cognition an enactivist approach posits "the enactment of a world and a mind on the basis of a history of the variety of actions that a being in the world performs" (Varela, Thompson & Rosch, 1991, p. 9). It is a theory of cognition that is inseparable from action and is therefore implicitly embodied.

Interactivity: Interactivity refers to the linear relations between computers and humans. The dominant mode of interactivity describes a linear process of inputs and outputs, as opposed to the relational causality of intra-activity outlined by Karen Barad (2007).

Inter/Intra: The word “inter” mean “between” or “among” while the word “intra” means “within” The terms therefore imply quite different patterns of agency and action. *Intra* may also imply a degree of containment, in which agency does not extend beyond the variables within a particular configuration, in keeping with an enactive framing of contingent, situated agencies.

Intra-activity: According to Karen Barad (2007), intra-action, unlike interaction, does not presuppose “the prior existence of independent entities of relata” (Barad, 2007, p. 139). Barad does not take for granted atomistic or Cartesian separations between subject and object; instead she sees specific situations and actions as allowing phenomenological relata to emerge as specific causal intra- actions.

Machine Learning: involves computational and statistical processes of learning from data, often deploying adaptive programs. Machine learning systems are therefore not explicitly determined, for example, they may involve self-modifying programs in which rules and procedures will adapt according to the data and specific situations.

Situated/Situatedness: In the context of computer programs situated agents are embedded in an environment. In Haraway's terms (1991) situatedness is also an ethical recognition of the partiality and locatedness of knowledge, as opposed to an idealised notion of objective universality and placeless, disembodied, non-partiality.

RECOMMENDED READING

Dourish, P. (2001). *Where the Action Is: The Foundations of Embodied Interaction*. Cambridge: MIT Press.

Gallagher, S. (2005). *How the Body Shapes the Mind*. New York: Oxford University Press.

Graham, B. and Cook, S. (2010). *Rethinking Curating – Art after New Media*. Cambridge Mass. and London: MIT press.

Mondloch, K. (2010). *Screens – Viewing Media Installation Art*. Minneapolis: University of Minnesota press.

Muller, L., Edmonds, E. and Connell, M. (2006). 'Living Laboratories for Interactive Art'. From *CoDesign*, 2 (4, December), pp. 195-207.

Noë, A. (2004). *Action in Perception*. Cambridge, MA: MIT Press.

Papadaki, E. (2015). 'Interactive Video Installations in Public Spaces: Rafael Lozano-Hemmer's Under Scan'. From Crisp, V. & Menotti Gonring, G. (2015)(eds). *Besides the Screen: Moving Images through Distribution, Promotion and Curation*. London: Palgrave Macmillan, pp. 197-212.

Paul, C. (2008). *New Media in the White Cube and Beyond*. London, Berkeley and Los Angeles: University of California press.

Segaran, T. (2007). *Programming Collective Intelligence: Building Smart Web 2.0 Applications*. Sebastopol, CA: O'Reilly Media.

Suchman, L. (2007). *Human-Machine Reconfigurations: Plans and Situated Actions*. New York: Cambridge University Press.

Varela, F. J, Thompson, E., & Rosch, E. (1991). *The Embodied Mind: Cognitive Science and Human Experience*. Cambridge, MA: MIT Press.

ENDNOTES

ⁱ See Sutton, G. (2004). "Exhibiting New Media Art", Bishop, C. (2011) *Installation Art*, Meijers, D. J. (1996). "The Museum and the 'Ahistorical' Exhibition".

ii Reprinted with significant revisions in 1965, from where we reference.

iii See also <http://www.medienkunstnetz.de/source-text/35/> [last accessed: 2 July 2014]. The text was originally written for the New School of Social Research in New York, in collaboration with Bill Bryson.

iv For a chronological account of time-based media art see Cubitt, S. (1993). *Videography – Video Media as Art and Culture*, Grosenick, Martin & Uta (eds) (2006). *Video Art*.

v “Journeys: Tate History”, online at:

http://www2.tate.org.uk/archive/journeys/historyhtml/people_public.htm [last accessed: 2 May 2014]. The full title of *The Daily Mirror* front page: “Whichever way you look at Britain’s latest work of art... WHAT A LOAD OF RUBBISH - How the Tate dropped 120 bricks”, 16 February 1976. Archival material from the reaction of the audience when viewing *Equivalent VIII* is included in Alan Yentob’s “How to Get On in the Art World”, *BBC ONE*, 20 November 2007.

vi The point is also raised at various times in the published discussions of the BALTIC series, as well as in the CRUMB forum

(<http://www.crumbweb.org/searchsite.php?search=discussion%20list&focus=Discussion&searchDisc=&ts=1224503832>) [last accessed: 2 July 2014].

vii At the workshop “Digital Audiovisual Preservation in Communities of Practice” (Presto Centre and Institut National de l’Audiovisuel, Paris, 4 December 2013), Pip Laurenson (Head of Collection Care Research, Tate) presented the challenges that arose when copying obsolete technologies (such as a Sony ½ inch tape) onto new formats, in order to preserve the work and enable its future exhibiting. The preservation of digital data is a fertile subject of research, even though it expands beyond the scope of the present chapter. However, it demonstrates that there is a history behind technology-bound pieces that needs to be known and acknowledged by curators.

viii Again, the term is being used as a solution to accommodate the “varied nomenclature” amassed around the idea of new media art, such as “art & technology, art/sci, computer art, electronic media, variable media, locative media, immersive art, interactive art, and Things That You Plug In” (Graham & Cook, 2010, p. 4). Graham and Cook (2010) note that the CRUMB discussion list frequently focused on issues of terminology and categories; some years back (2004) they concluded that these names often described, apart from the media used in the artwork, the genre, content, theme, and everything in between.