A Vibrant Evolution: From Wearable Devices to Objects as Mediators of Experience

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Abstract. This article envisages objects and materials in terms of actants (entities that have the ability to modify other entities). Things are temporary assemblages of vibrant matter in emergent systems. In the context of human computer interaction, a flat ontology enables a discussion of 'counter-consciousness' where a traditional interface 'user' is better described as a 'co-producer' and, further, materials and objects are crafted with an appreciation of their life beyond the conscious realm of the human perspective. Proposing tactics that engage with physical and electronic realms, this article promulgates vibrant matter as artistic media to sculpt creative experiences. We are glimpsing the periphery of a paradigm shift in our understanding of the world, in ways that are no longer static but dynamic, where change is ubiquitous but never predetermined. Wearable tangible interfaces are central to the shift that will profoundly affect the way we interact in societies of the future.

Keywords: Wearables, Haptic interface, Object, Onticology, Art, Design, Vibrant matter, Flat ontology, Actants, Reciprocity, Feedback loops, Entropy, Reverse predictive practices, Blinklifier, Snoothood, Wearables Lab, Systems thinking, Embodied knowledge, Human technogenesis, Critical design.

1 Introduction

This research contributes to the growing canon of academic literature that contends dominant epistemological modes of history, through an awareness of the inherent hierarchy of objects, which reinforce the dominance of a human-centric perspective. As our methods and media evolve, our perspectives are expanding, enabling us to visualise and appreciate the world in terms that have been invisible until recently. This article is written with a toolbox methodology, as if by a bricoleur, drawing freely from a diverse range of ideas and disciplines. The author is an artist and academic with a conviction that creativity is fundamental to research. With this comes an awareness that the content of this article draws on science as well as science fiction in order to promulgate new ideas; how these futures play out in reality will become clear in due course.

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2 Inter-linking Information

Machines, like organisms, are devices 'which locally and temporarily seem to resist the general tendency for the increase of entropy. The ability of a device to make decisions produces a local zone of organization around it in a world whose general tendency is to run down' [1]. If we consider organisms or mechanisms equally as constellation of matter, their abilities to make decisions run in parallel with each other. Analogous in both are sense organs, which stimulate actuators as the basis of decisions. Local zones of organisation come about through entanglements of interactions and collectives of various actors. Communication between actants are the basis of the 'theory of the message among men, machines, and in society as a sequence of events in time which, though it itself has a certain contingency, strives to hold back nature's tendency toward disorder by adjusting its parts to various purposive ends' [2]. A theory of communication underlay the way in which Norbert Wiener articulated cybernetic principles. His analogy between machines and living organisms is simple – the synapse between nerves in biological organisms corresponds to switching devices in machines. The 'certain contingency' Wiener proposes can be otherwise described as equilibrium. In thermodynamics, constellations of matter in the temporary form of objects can be viewed as a measure of disorder; the entropy of these isolated systems is always towards decomposition, deterioration and disintegration into constituent elements or energy, evolving towards thermodynamic equilibrium. Leibnitz's concepts of 'characteristica universalis', a universal scientific language, and 'calculus ratiocinator', the calculus of logic, influenced Wiener's ideas [3]. There is no denying the second law of thermodynamics, but in addition to Wiener's entropic philosophy, Doyne Farmer posits a contrapuntal process he calls 'the second law of organisation' as an adaptive complex system where the overall tendency is towards self-organisation. Through computer simulations, he has observed that simple forms of self-organisation are evident which suggest the existence of some form of complex adaptive systems. 'A weak system gives rise to simpler forms of self-organisation; a strong one gives rise to more complex forms, like life' [4]. Both views are evidence of systems thinking and complexity as a general theory that explains dynamics in terms of emergent systems and non-equilibrium flows of inter-linking information.Wiener's thoughts on cybernetics are still relevant in consideration of the contemporary machine – the computer – and the inter-linking of these machines through digital networks that augment individual human thoughts in the noosphere. Teilhard de Chardin's 'Hominization' is fundamental to the origins of the notion of the noosphere as a global network [5]. Our techno genesis could be described as a growing awareness of our perception of ourselves in terms of our integration into this network, as 'the nerve cells of an awakened global brain' [6]. This metaphor is useful to help visualise the evolution that we are now witnessing with cloud computing. Finding equilibrium between the noosphere and the biosphere on organism earth embraces environmental concerns and one world thinking, and we see them forming in the structures around us. Noospheric institutions are already in place representing a new world order in terms of ideological, economic and political structures. In the dystopian vision of

'Empire' depicted by Negri and Hardt the future is one in which capitalism expands 'to subsume all aspects of social production and reproduction, the entire realm of life' [7]. In 'Empire' monarchy, aristocracy and democracy converge to form a new type of government represented by global institutions: the International Monetary Fund (IMF), the World Bank, the World Trade Organization (WTO), NATO (monarchy); transnational capital (aristocracy); and nation states and non-governmental organisations (NGOs) (democracy) [8].

3 Universality of Information

In an inter-linked world of information people's experience with technology is swiftly changing in the areas of voice and visual interaction, reflecting the diversity of languages and cultures of those engaging with the media. Claiming 99% accurate voice interpretation, voice interaction is mashing-up with other technologies. For wearable technologies the small-scale input sensor, as opposed to a keypad device, enables portability in design and leaves the body free to do other things. Fundamental to wearable technologies is the evolution, from software that runs on flat hardware fields housed in individual computers, to data centres connected around the world hosting software. The future offers access to seemingly unlimited computing power. The challenge for design is to translate the constant flood of information into clear interpretations. Affirmative design is too often governed by software applications and market analysis; design starts with the tools and then packages information into the given framework. Critical design on the other hand, is mode neutral and uses whatever tools are necessary to present information in the best way possible; the information mediates experience. 'Images are cosmopolitan and forever, [whereas] words are local and parochial' [9]. Images and words become separated when language is foreign. In a global context, visual design should convey information without relying on text. Artists and designers should be conscious of 'the universality of images and the stupefying locality of languages,' to use Edward Tufte's phrase [10]. Data visualisation and voice recognition are evolving quickly and have profound implications when thinking about human computer interaction. Research at Future Lab provides evidence of the effects contemporary interfaces are having on the body. 'Curious rituals' analyses ways our bodies are adapting to technologies and documents strange behaviours and movements, for example, mythical gestures linked to old technologies such as raising an arm in an effort to get better mobile phone reception, or swinging a hip, or handbag to swipe radio frequency identification (RFID) chipped transport or security gate cards [11]. Not only have we developed body language around technologies but the way we use space has altered. People cluster together, not necessarily where the urban space was designed to accommodate them, on urban furniture for example, but where the wi-fi signal is strongest. In the airport we often find people tethered to power outlets, sitting in passageways or on the floor, rather than seated in the designated waiting area. Wearables mediate experience; they merge with the body and interface with the city. Design is not only thinking in terms of smart cities but smart citizens that inhabit them, encouraging intelligent participants

in the design, rather than users; everybody is potentially a co-designer. Edward Tufte, invented many visual tools and advocates that the primary goal of his work is to provide information to educate the public. To educate implies a hierarchy of sorts, but a closer look at his design philosophy reveals a respect for the intelligence of humanity. Principles include showing comparisons, causality mechanisms, multi variable data (more than two dimensions), and the integrity of the content (by documenting and revealing sources). His research into ninth century manuscripts supports his philosophy. Maps of star constellations charted three-dimensional sky-scapes, visible to the human eye, as two-dimensional surfaces, and embellished these maps with imagined figures and mythologies, which served as memory aids to locate the position of the stars. With the invention of the telescope cartographer's maps became evidence of the truth, 'visible certainty replacing wordy authority' [12]. The telescope augmented the eye and new ways of perceiving the world based on scientific fact were adopted into our epistemology. Aristotle believed science could be understood in different ways – theoretical, practical and poetical. He viewed creativity as a kind of poetry. It is an attempt to portray actions rather than objects, 'to describe, not the thing that has happened, but a kind of thing that might happen' [13]. Critical design practice looks forward and plays a part in creating the future by imagining it; affirmative design looks backward to facts and evidence to justify design. If we acknowledge the hierarchal dominance of scientific facts in our Cartesian phase of epistemology, Aristotle's three categories are worth reconsidering with equal weighting, embracing creativity by focussing as much consideration to the poetics of design, as we do to its functional and theoretical attributes. New technologies are presenting new perspectives that challenge the way we understand physical reality, time and space. We will come back to a discussion about future visions driven by new perspectives after a brief analysis of current and near future wearable technologies. A model that is worth considering when thinking about designing interfaces is a 'casual drawing that organises the feedback between environment, stimuli from the environment, the artist's person, the artistic processing of the external stimuli, and the impact of the artistic intervention on the environment' drawn by Stephen Willats circa 1959 [14] (See Fig. 1.) Feedback loops and their wider reciprocity are inherent in Willats's approach to creativity. Bruno Latour's Actor Network Theory also provides a model that is useful to interaction designers: the idea of entelechy systems that exist because people act in a particular way within a network, and the perpetuation of that activity keeps the network alive. Individuals' behaviour effects and is affected by the characteristics of the network in a kind of dynamic equilibrium [15]. Combining art and science involves stepping away from thinking about them as different disciplines; 'if there is a third domain, to which scientists and artists are willing to go – what [Latour] call[s] the new aesthetics of reason, because of a long linkage between rationality and visual display – then it can work' [16].

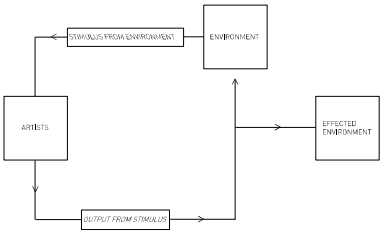

Fig. 1. Vector Diagram adapted from Stephen Willats's 'Art Society Feedback' circa 1959

4 Current Directions

Within the field of wearables, the author aims to open up new questions that can be inspirational for the design of new technological artefacts and interactions. The author's research projects have been heralded as 'On-Board Interface Technologies [that] are leveraging gestures and other natural inputs to enable new forms of intuitive computing and control' [17]. By exploring new ways of sensing, interacting and communicating emotions in ways where the mechanics of the interface dissolve into the surfaces and materials of the objects and environment, it is not the author's intention to disguise or hide technology but embed it into the integral structure of things in meaningful ways. This is in line with Dunne and Raby's position that critical design makes people think. 'Critical Design uses speculative design proposals to challenge narrow assumptions, preconceptions and givens about the role products play in everyday life. It is more of an attitude than anything else, a position rather than a method' [18]. PSFK's independent research report predicts that the evolution of wearable technology will be fully embedded into materials and objects (human and non-human) in the future to not only support, nudge and augment, but to record, control, verify, restore and align systems. The report describes three areas of innovation: connected intimacy, tailored eco-systems and co-evolved possibilities [19]. Using the key terms of reference in this report, the following paragraphs are examples of their application in prototypes developed at the Wearables Lab at the Academy of Visual Arts in Hong Kong.

4.1 Human to Human

'Connected intimacy' describes the sensation two people feel when they experience each other's heartbeat. 'Pulse Swarm' is a wearable set of white leather gauntlets that is an experiment in near field interaction and explores how such awareness modifies the behaviour of participants. The sensation is felt as a haptic vibration on the wrist and visualised as pulsating pink light emanating from beneath a row of white plumes of ostrich feathers on the outer arm of each gauntlet[1]. 'Connected intimacy' also describes data streamed care, where 'body sensor networks are embedded into

[1] By Priscilla Bracks, Dean Brough and Gavin Sade 2012 `http://kuuki.com.au`

garments and track bodily data in order to sustain healthier lives' [20]. Many examples of human to human devices are already on the market including a recent proliferation of wristbands that monitor health and provide instant personal information often combined with connected medical advice or care. Another trend coined by PSFK is 'emotional mirroring' where data is reflected back to the participant. 'Psychological well-being, such as stress control and emotional regulation, has become an important issue. By stimulating different sensorial channels, emotions can be induced or regulated in the body' [21]. For example, 'Snoothoods' is a device to self-monitor snoring. It is a wearable felt sculpture that contains a vibration sensor located over the throat. Inside its padded hood activation of the sensor by snoring alerts the wearer, through silent haptic feedback against the temple, to change position whilst not disturbing other sleepers. The sculpture was designed as a humorous, aesthetic pun to address one of the co-designer's professed relationship problems – snoring. But the result revealed just the kind of emotional mirroring that Ugur describes. In order to first get to sleep in the 'Snoothood', one must enter a conscious meditative state to avoid inadvertently setting off the buzzer. The fact that the felt hood encapsulates the head entirely, with only the nose, mouth and chin exposed, further heightens the self-reflective experience[2] [22]. Think of these experiences as artistic tactics for the creative designer who models a stage or a social space that becomes the participant's reality for the time of the staging, and creates a second level of reality that is the mirror, commentary and invitation to self-empowering practice in the participant as well as in us, the observers. The design of new technological artefacts enables us to break through physical and emotional barriers such as distance. Long distance togetherness is the effect of designs such as a set of prototype pairs of shoes that communicate with each other across the globe enabling each wearer to feel the footsteps of the other. Sensors on the soles track footsteps and actuators on the top of the partner pair of shoes pulse the same rhythm[3]. This leads to an odd experience of an intimate understanding of the mobility of the other person and an overlaying of that information onto personal biorhythms. The experience is further estranged by the global time zones of the participants.

4.2 Person to Computer

The availability of personal data (statistics and real time data) enables eco-systems in both the production and the design of artefacts to be tailored to individual measurements, tastes, fitness levels, moods, etc. In addition to personal data, the incorporation of environmental data such as location, weather and temperature, and last of all, small-scale rapid manufacture or the potential for self-manufacture, such as 3D printing, has fostered bespoke biotechnology. In projects being prototyped in the Wearables Lab at the time of writing, participants' brain waves during sleep and activity levels during waking hours are tracked. The real time bio-data drives servos in dying machines that control the colour depth of a filament thread that is then used

[2] By Tricia Flanagan, Katia Vega and Hugo Fuks as part of Haptic InterFace 2012.
[3] By Daniel Gilgen and Jarad Donovan as part of Haptic InterFace 2012.

to weave a blanket (from the sleeping data) and create a series of non-loom constructed garments (from the activity data). The number of stitches and their pattern, as well as their depth of colour, are translated from bio-data to create unique body coverings.

4.3 Person as Computer

The co-evolved possibilities of the person as computer are also known as humanistic intelligence [23] and viewed as part of our natural evolution. We have a long history of augmenting our bodies with prosthetic materials. Evidence of wound dressings used to aid healing has been dated back to 1500 BC. Plates from 1597 by Gaspare Tagliocozzi, a surgeon from Bologna, illustrate Autograft procedures for replacing a nose. 'Materials used in reconstruction of the nose bridge alone have historically included rubber, celluloid, iron, copper, platinum, ivory and gold' [24]. The future will include on-board interfaces, augmented sensory perception, authentic self, and cloud memory. Launched in 2012 at the Asia Pacific Conference on Computer Human Interaction (APCHI), 'Blinklifier' incorporated an on-board interface and conductive eyelashes and eye-liner to augment the eye movements of blinking into an exaggerated expression in the form of an LED light array in a head dress. The research explored a new method of interface with the computer that subverts consciousness and is directly connected to signals produced by the body [25]. The opportunities afforded through augmented perception and cloud computing will be explored later; first a short discussion about objects.

5 Flat Ontology

Traditionally we view the object as stable and fixed, the opposite to events and processes that are active. But do we really know what objects are? This is not an epistemological question about how we 'know' the object. Our knowledge of objects is different to the being of objects [26]. This sounds like a circular argument but what is in question here is our fundamental separation of culture and nature into distinct realms; a bifurcated model makes impossible any intermingling of their distinct properties. Freedom is implicit in the culture/subject realm, whereas nature/object, on the other hand, is tied to matter and mechanistic causality [27]. From the epistemological standpoint, the separation of subject/object has historically resulted in a primary focus on propositions and representations with a total disregard for the role that non-human actors play in knowledge production. The shift from the 'nature/culture split to collectives, onticology and object-oriented philosophy place[s] all entities on equal ontological footing. [...] There are collectives that involve humans and other collectives of objects that have nothing to do with humans' [28] Pioneers of object-oriented onticology that have influenced this article are Bruno Latour, Jane Bennett, Manuel De Landa, Marshall McLuhan, Deleuze and Guattari. The relationship between micro and macro objects, their autonomy and coalescence into forms recognised as other objects, for example in parasitic existence, or within

co-evolved bio-spheres needs to become more acute in our perception of the world. We must acknowledge as part of our own existence our interdependence on non-human objects and equally the interdependence of non-human to non-human objects and their affects in terms of actants[4] on one another. Just as the internet is enabling us to think about the notion of a connected realm of thought – 'gaiga' – the same is true of biological and physical worlds. The fungibility of digital media and the speed that it is transmuted effortlessly into different formats, from painting, to video, to photographic prints, or 3D printouts 'points to the loss of "stickiness" that once cemented a medium to a given material substrate, guaranteed its particularity, and the limited way in which it could be received and used' [29]. This apparent slipperiness of matter gives cause for consideration of the democracy of objects themselves. The world is not constructed of active vibrant subjects and passive dormant objects. We must acknowledge objects themselves as actants. If we think in terms of entropy, objects are rarely in a solid state but always changing and evolving. The time and scale of that change may not be geared to the scale of human perception, but none the less they are still active. Collectives of actants create an ecology of human and non-human elements. Latour locates political agency, not in the acting out of our choices, but in the call and response between prepositions within these collectives where the tug and tussle eventually results in a tipping point towards one trajectory of action or another [30]. Latour uses the word 'conatus' to describe this 'active impulsion' or tendency to persist [31]. 'Theories of democracy that assume a world of active subjects and passive objects begin to appear as thin descriptions at a time when the interactions between human, viral, animal and technological bodies are becoming more and more intense. […] We need not only to invent or re-invoke concepts like conatus, actant, assemblage, small agency, operator, disruption, and the like but also to devise new procedures, technologies, and regimes of perception that enable us to consult non-humans more closely, or to listen and respond more carefully to their outbreaks, objections, testimonies, and propositions' [32]. The technologies that will enable us to listen and respond more carefully are with us already; the integration of these technologies into wearable interfaces will enable them to be submerged into the activities of our daily lives and become part of our general perception of the world.

6 New Scales of Perspectives

A flat ontology enables us to think about the autonomy of different entities while exploring the ways they influence one another. The collective is an entanglement of objects: it is an open system, always evolving, influenced by and influencing other entanglements. Our propensity to visualise the world is amplified more than ever before in our history, enabling an expanded horizon in both micro and macro directions. An example of micro sculpture is the iconic building 'Lloyd's' of London,

[4] An actant is a term Bruno Latour used to describe the source of an action. It is 'an entity that modifies another entity in a trial', has efficacy and can do things. It can be human or non-human. Latour, B., Politics of Nature: How to bring the sciences into Democracy. Trans. Catherine Porter, p. 237. Harvard University Press, Cambridge.

sculpted on the head of a pin by Willard Wigan. Using a two-photon photo polymerization process, Satoshi Kawata laser moulded a 7 micrometre tall bull [33]. Micro-sculptors are working at the intersection and periphery of artistic and scientific exploration, using nanotechnology to create works of art, but it is indicative of what will be possible and available in the future. Super computers generate massive data sets that can be ordered or sorted, and visualised into a fungible variety of outputs. Data that was once beyond the human mind's capacity to comprehend can become digestible through modelling. It is as if we can now rise high enough above the information to see it clearly, like looking back at the earth from the moon for the first time. The profound impact those images had on humanity is the kind of new perspective evoked here. The data imaging work of Lewis Lancaster [34] into computational analytics and reverse predictive practices is exemplary here and illustrates the point made earlier – the need for better aesthetic interpretation of information. In his research he took a volume of canonical Asian literature and digitally converted every written character into a dot, each a different shade of blue. The pages of the books now appear as digital pages of blue dots, stacked in a virtual three-dimensional pile, with the paper itself rendered transparent. The resulting block of blue dots can be viewed as a whole object in a way that the original text never could. In this case an example of an insight drawn from the modelling process involved a strange anomaly found in the patterning of the dots. On further investigation into the cause of the pattern, it was discovered that when male individuals in the narrative spoke of places they were often far from where they lived, whilst females discussed neighbouring towns and communities. This insight reveals information about the role of the sexes in that society. Lancaster calls this methodology 'reverse predictive practices'. This method, employed by the artist or designer, is an example of a tactic that can be used to sculpt vibrant matter. Reverse predictive practice is the conceptual basis for the creation of the bio-data body coverings described earlier. The blankets and garments can be viewed as aesthetic expressions of the body, generated from the body; they evidence the life of the wearer. Just as in the production of skin, where the epidermis is a 'strata of cells that migrate toward the surface where they compact into a layer of dead material' [35] the evolution of the bio-data body coverings starts within the body and ends up as an outer surface.

Reverse predictive analysis can be self-reflective (as the participant considers their bio data depicted in the patterning of one or a series of bespoke garments) or comparative to other participants' bio-data body coverings. The installation and exposition of a series of these experiments is a conscious framing of the content in order to reflect on a social affliction of contemporary society, that is its dislocation from natural body rhythms and the health and social problems that result. The development of the telescope augmented our ability to see far into space and the later development of the portable camera altered the eyes' normal perspective. Photographing the earth from outer space profoundly influenced our ability to think of the world as one ecological organism with finite resources that are shared. The latest technologies further augment our senses and our perception. We are becoming acclimatised to living between virtual and physical time and space. The next threshold

is one of scales, when the nano-immediacy of real time information stored in 'clouds' of data and software enables smart materials and objects to embody nano-scales and macro information (vast boundless content) and make it visible, like zooming in and zooming out at any given moment.

7 New Media for Artists and Designers

The notion of 'vibrant matter' is a term borrowed from Jane Bennett (Bennett 2010). She promulgates the need for an expanded vocabulary and syntax to describe and discern the active powers issuing from non-subjects as a way to reinforce a flat ontology. In advocating material agency or the efficacy of things, Bennett challenges our position as consumer and subjugator. The categorical positioning of ‘us’ as alive and vibrant and ‘objects’ as dead and dormant prevents us 'from detecting (seeing, hearing, smelling, tasting, feeling) a fuller range of the nonhuman powers circulating around and within human bodies' [36].This article advocates that artists and designers take up this challenge and think of vibrant matter as a new sculptural medium. Levine articulates a similar idea ‘Electronic media capable of transmitting real-time could be new material for art production' [37]. In the classic text 'The Work of Art in the Age of Mechanical Reproduction' Walter Benjamin describes the way we relate to the montage of film as 'tactile' and describes the filmmaker as a surgeon [38]. It is easy to imagine this 'new art material' in terms of electronic media, but why not extend the notion beyond the digital and into the haptic, physical, tactile world of stuff where the line between machine and human is already becoming indistinct.

8 The Reciprocity of Interfaces

An important notion to consider when taking up the challenge to sculpt vibrant matter is one that Wiener describes in his discussion of the world in terms of systems governed by entropic tendencies, namely feedback loops and systems of reciprocity. Like dropping a stone into water and creating ripples, think about creation in terms of effects and interconnected agency. Integral to interface design’s capacity for flexibility, change or mutation is the integration of feedback loops, systems governed by tolerances that have tipping points, or oscillation switches seeking equilibrium rather than on/off switches. The tipping point is a decision, and produces an action. [39] 'Feedback may be as simple as that of the common reflex, or it may be a higher order feedback, in which past experience is used not only to regulate specific movements, but also whole policies of behaviour. Such a policy-feedback may, […], appear to be what we know under one aspect as a conditioned reflex, and under another as learning' [40]. As our technology merges with our biology, not only will the synapse in organisms 'be analogous' to the switching apparatus in the machine, they will be conjoined. The evolution of our tools away from the traditional computer screen and keyboard interface, back into our hands and onto our bodies means we can look to the crafts in a new way, not with nostalgia for techniques lost but for lessons in how to develop tools that augment our capacity and sensitivity to these thresholds.

We need to foster highly skilled artisans to carry into the future the embodied knowledge inherent in the relationship between body, tools and materials and embrace 'more ecological and materially sustainable modes of production and consumption' [41] to craft our future societies.

9 Conclusion

Throughout this article the evolution of human perception is evident in the stories of the augmented eye from telescope to microscope, through to nano perspectives. In contemporary times the power of super-computing, the rapid growth in data storage capacity, and the hyper-immediacy of capture and retrieval mechanisms, leaves us with the estranged feeling that we are defying the laws of nature, of time and space, when actually what we are facing is a period of adjustment to these new ways of perceiving the world. Once we accept the inter-linked world as part of us, we can be responsible for our role within these assemblages. 'Decoding of an electronic signal or software can be just as real, touching or effective as an encounter with a work of art situated in physical space' [42]. The power resides no longer within the objects of desire, nor between them, but in the persistence of ideas in the collective consciousness of the media itself (its efficacy). The aesthetics that emerge from the new machine/human interfaces are a combination of virtual and actual media in new kinds of haptic interfaces; the emotional experience of these encounters creates residual memory and objects are the mediators of these experiences in our vibrant evolution.

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