Augmentations Across Virtual and Physical Topologies: Mixed Reality Re-assembled

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Abstract

An analysis of the material-discursive practices surrounding Augmented Virtuality and Augmented Reality reveals the sometimes digressional, sometimes convergent positions taken by computer science and media art on the issue of embodiment. Mapping out some of those positions, this paper considers Mixed Reality as a topology that has an entangled and material relationship with the body, that goes beyond an analysis of Mixed Reality as a technology of augmentation: rather, a topological understanding of Mixed Reality explores the patterns of diffraction (Barad 2007, p. 29) that ripple and disrupt the material thresholds between physical and virtual, troubling the over simplified real/ virtual dichotomy that permeates much Human Computer Interaction (HCI) research. Tendering an argument for Mixed Reality as a continuous topology operating between physical and virtual spaces, I will address the contrived duality of embodiment/virtuality embedded in much of the literature surrounding Mixed Reality. Then, I will offer a contrasting view of Mixed Reality as a contiguous topology where virtual and physical are interwoven by contingent and conditional 'meshworks' (De Landa, 1998) of augmentation, involving technicity, devices, bodies, and objects.

Keywords

Augmented Virtuality, Augmented Reality, Software Assemblage, New Materialism.

The Bounded Virtual: Limits and Thresholds in Mixed Reality

Augmented Virtuality is any system that couples human actions to a virtual environment in real time across three spatial dimensions (Milgram and Kishino 1994, p.1324), while Augmented Reality is a physical, real world environment augmented by a computational system that is registered in three dimensions in real time (Azuma 1997, p 355). In HCI discourse, Mixed Reality is conventionally framed between the poles of reality and virtuality, conceived as a duality that contains both middle instances of Mixed Reality — Augmented Virtuality and Augmented Reality.

Building on Caudell and Mizell's (1992) definition of Augmented Reality as a datafied window sitting on the physical world, computer scientists Paul Milgram and Fumio Kishino wrote the influential research paper "a Taxonomy of Mixed Reality Visual Displays" (1994) as a functional tool to assist in the accurate classification of Mixed Reality on screen displays. Mixed Reality is broadly understood in HCI as the combination (to varying degrees) of real and virtual worlds. Envisioned as a linear passage between two poles, their diagram of the Reality-Virtuality Continuum taxonomically indexed all the broad instances pertaining to current Mixed Reality displays, while the accompanying article discussed specific instances of network configurations and their display types. Taxonomy — as a branch of positivist science concerned with producing schemes for classification — is embedded with the notion of limitation, operating as a border within which to anchor categories and systems considered to be ontologically distinct from one another. Milgram and Kishino's taxonomic approach shifted focus away from a nuanced assessment of the user or the affective possibilities of the network set-up, toward a manifestation of the capacities and configurations of the technical objects at hand, and their specific capacity to perform as display types. Milgram and Kishino's intent behind the Reality-Virtuality Continuum was to remedy some of the difficulties encountered by HCI researchers by designing a clear, descriptive model to situate technical network set-ups that are materially neither pure virtuality or pure reality.

However, the dualistic arrangement posited by the Reality-Virtuality Continuum is problematic, since not only does it proscribe a delineation between Augmented Virtuality and Augmented Reality based primarily on technicity, rather than on the interactive experience of the user. However, as can be seen in many examples in the field of media art, practitioners are continually trying

to expand the perceptual and affective possibilities for the participant, using virtual phenomena to provoke nuanced sensory affects that encourage the participant to tune into to virtual events and meld their physiology with that of the digital.

A key problem with Milgram and Kishino's taxonomy is that it is primarily a classificatory list of display modes. Displays deliver the 'virtual' side, while 'reality' is subtended as the sole privilege of the human. Intermingling, should such occur, is segmented into datafied 'virtual' screen space and physical 'real' world: "Completely graphic but partially immersive environments (e.g. large screen displays) in which real physical objects in the user's environment play a role in (or interfere with) the computer generated scene, such as in reaching in and "grabbing" something with one's own hand" (1994, p.1323).

Mixed Reality is discursively bounded through technical objects (displays) and their ancillary content (generated by computer), where human intention (the grab) is the sole agential force. Such formations do not allow for the myriad of embodied and sensory happenings that emerge between the physical and the virtual for the participant. HCI research does not acknowledge that phenomena are coemerging 'in between' all the time, and instead HCI practice perpetuates a view of the digital as isolated to the screen, effectively pushed out of the physical world. Further, the position of 'user' in a networked configuration is itself a reduction, one that ignores the significant shifts that continually self-generate through embodiment.

From a new materialist perspective, the relational positions held by Reality, Augmented Reality, Augmented Virtuality, and Virtual Reality are actually all topologically contiguous with one another in a software assemblage. In order to further creative research in Mixed Reality in art, there is a need to address the mutually co-shaping and embodied phenomena that affectively facilitate to anomalies between bodies and data systems. In addition, human agency must, crucially, be unwound as a primary structuring force, to allow the spontaneous unfolding of unplanned transformations between all kinds of matter.

Mixed Reality in Experimental Media Art

In the pioneering artwork *An Interactive Plant Growing*(Sommerer and Mignonneau 1992), participants were invited to touch living plants in order to precipitate participants are able to co-construct their experiences of virtuality in an expressive space (such as in notable Mobile AR(t) such as *Bio-mer Skelters* (2013-, various locations) by Tamiko Thiel and Will Pappenheimer, *Border Memorial* (2012-) by John Craig Freeman, and many other works by the Manifest AR collective), as well as in virtual reality artworks, such as Simon Penny's *Traces* (1998) or Petra Gemeinboeck's *Uzume* (2003).

Klemmer et. al. (2006) take a perspective on embodied interaction that follows a similar track, except with greater emphasis on the practice of designing for 'skilled' bodies, rather than a 'walk up and use' model favoured by Dourish**.** In the influential research paper "How bodies matter: five themes for interaction design" Klemmer et. al. selectively glean concepts from psychology, sociology and philosophy with the stated aim of producing 'richer interaction paradigms' in the field of Tangible User Interfaces (TUI). Their paper combines a taxonomic approach — where capacities and skills involving bodies are indexed next to causes and effects of the machine in order to divine common and divergent qualities — with quick references to phenomenology, philosophy and sociology. The aim is to activate the physical objects we already use in the world as TUI's, with the goal of welding these using the glue of 'embodied interaction' with the digital. focusing on items with which we already have a high degree of haptic familiarity, Klemmer et. al. advance that the most powerful model for embodied interaction design is the real world. Their focus is on leveraging skills that they consider most bodies possess, and that can be further honed through contact with various types of TUI, when appropriately paired to networked data systems as control points.

With reference to influential research papers in HCI, this paper argues that the segmentation of Augmented Reality and Augmented Virtuality as distinct categories has unduly limited the experimental potential of Mixed Reality, and that a pragmatic and relational reworking of Mixed Reality as an interlocking, dynamically arranged meshwork of assemblages is necessary. Further, this segmentation is grounded in the overarching taxonomy of mainstream HCI, where embodiment and virtuality are set against one another (Weiser 1991; Winograd and Flores; Dourish; Klemmer et. al.) Weiser's take on embodied virtuality — as well as the majority of the influential body of HCI research that follows that

affect-oriented process requiring a nuanced, contingent approach: "Embodied interaction is not a technology or a set of rules. It is a perspective on the relationship between people and systems. The questions of how it should be developed, explored and instantiated remain open research problems" (p.192). Dourish argues that embodied interaction has been neglected by older examples of HCI research which took a 'procedural' approach to interaction as a series of instructions, performed by the user in context, to achieve a specific computational out-come (Card et. al. 1983; Norman 1988). New approaches that incorporate embodied interaction come out of the research of Terry Winograd and Fernando Flores (1986), and Mark Weiser (1991), a tack Dourish extends. In such work, the turn toward embodied interaction, draws on the processes of everyday life, anchored by the concept that pragmatic actions occur as matters of immediacy, without cognitive rationalisation. Dourish advances a case for the enhanced leveraging of everyday behaviours to facilitate the development of computational interfaces in three main areas: tangible, embedded, and social computing. He notes: " The [HCI] trend I have emphasised here is the gradual incorporation of a wider range of human skills and abilities. This allows computation to be made ever more widely accessible to people without requiring extensive training, and to be more easily integrated into our everyday lives by reducing the complexity of those interactions" (p.14).

Leveraging everyday social behaviours to situate technology in the world, pervasively and ambiently, according to Dourish, is the most effective way to effect the design of tools for pervasive computing: many examples exist from the past two decades of the commercial application of this method, especially in the burgeoning field of mobile hard-ware such as smartphones, tablets, and their software. Embodiment becomes another tool that can be deployed to extend the reach of pervasive computing. For example, utilising human behaviours such as play is a technique shared by both industrial and artistic vectors of virtuality (mobile locative-) games such as *Ingress* (2011-) and *Pokemon Go!* (2016 - openly use the data generated by players develop and extend products such as Google's *Maps* and *Earth***.** There, play is directed at the structuring of the body in global flows that utilise virtuality as a tool to further corporate goals. Divergently, artistic examples tend toward an unstructured notion of play, where

the on screen growth of up to twenty-five species of virtual plants, all of which manifested adaptive coordinate behaviours such as size, colour and translation, but only if the participant found the right combination of micro-gestures. Participants need to use their particular haptic sensitivities to explore the relational space between their hand and the plant interface: modifying this spatial relation unlocks the adaptive growth and promotes either the virtual plants positive flourishing, or its negative descent into a weed or 'killer' plant.

Usefully, this artwork is not a discreet experience that occurs within the confines of a room in a gallery and is left there: rather, the artist's see it as a perceptual and sensory happening that utilises acts of embodiment — the haptic touch of the participant on the plant interfaces, the visual and aural perception of the on-screen growth as intrinsically fused to the gestures of the participant, the intuitive tuning that processually allows the plants to emerge — as co-operative gestures with the real plant world. The artists note: "Since it takes some time for the viewer to discover the different levels for modulating and building the virtual plants, he will develop a higher sensitivity and awareness for real plants" (Sommerer and Mignonneau, Artist's statement, 1992).

Here, the notion that some of the haptic intimacy with virtual plants moves out of the room with the participant, points toward the potential of the work to facilitate unique permutations of embodied experience. While such artworks can be analysed under the terms of the Reality-Virtuality Continuum, to do so is to diminish their open and experimental frameworks, and certainly also to occlude their affective power in favour of the rationalisation of affect in a system of classification where the technical set-up is a straightforward configuration into which the human enters, with the goal of finding the control points rather than tuning themselves to the emergent nuances of an adaptive data system.

HCI and Embodiment
Paul Dourish discussed the emergent field of embodied interaction in the influential text *Where the Action Is: The Foundations of Embodied Interaction* (2001). Breaking with 'traditional' Human Computer Interaction (HCI), where the design of computational systems emerged from what was possible in an engineering sense, Dourish incorporates insights from ethnography, phenomenology, sociology, and cognitive psychology, to re-figure interaction design as an intuitive and

path — does not so much break with the privileging of cognition instantiated by an earlier generation of HCI researchers (what Dourish calls traditional HCI), but rather supplants an approach centred on the mind with an approach privileging the body as a formed totality. Operably and structurally, the conversation is deeply embedded in the same mind/body duality, just perceived from the opposing end. Unfastening the simplified taxonomy that restricts Mixed Reality, affords consideration of the anomalies at the thresholds of Augmented Reality and Augmented Virtuality. A relational materialist approach to these problems of interaction is necessary, so questions of human computer interaction in experimental art become less about privileging *either* a technology focussed or a user centred approach, and instead show preference for the effects and affects of matter.

Embodiment, if approached as a co-emergent, mutually generating phenomena — rather than a fixed and discreet interaction as in HCI — can be productively engaged to reassemble the liminal zone between the virtual and the physical as neither the privilege of cognition or the body. Trajectories that favour the transdisciplinary approach taken by researchers from the post humanities and new materialisms are a major source of validation for approaches that operate against dualism, such as the software assemblage. As a provisional series of individuated technical-material-discursive formulations, software assemblages afford an approach to interfacing and augmentation as processual, material, and relational, a perspective that reaches across both physical and screen events, across modalities (of sight, sound and touch), and pulls out threads from various disciplines (art, computer science, entertainment, gaming).

In the examples from HCI research discussed above, embodiment is seen as the result of connecting the three main perceptual modalities (vision, hearing, touch) to some kind of computational or machinic network where the user is the agential force that shapes the data system. This approach is conceptually as well as materially restricting, since it foregrounds the artificial segmentation between the participant and the machine, and occludes the extent to which data systems shape the participant through embodiment. HCI research presupposes that the body is an already 'formed body', that comes to the interaction as a totalised entity: The 'user' or the 'human'. Few questions are asked as to how bodies and machines might shape one another through forces that are at the

same time both procedural *and* spontaneous, cognitive *and* affective, virtual *and* embodied. N. Katherine Hayles (1999) systematically explored the discourse around an earlier generation of cybernetic researchers, in order to show the active and relational shaping of embodied experience by computational technologies and human computer interaction. Hayles contextualises Mark Weiser's (1991) term 'embodied virtuality' as a shifting topological state where technology and media are active in producing the patterns that gave rise to the emergence of embodied virtuality, as a lived condition of social bodies. Hayles' investigation into the material and discursive practices that lead to the formation of human practices and behaviours as they crystallise with technology, gives consideration to the environmental and contextual responses to technology as a materiality. In environments where embedded computers and the body coalesce, both emerge together as partially formed entities that transform one another through co-presence on all sides. The point is not to prefer 'embodied virtuality' over 'Virtual Reality,' as Weiser and others suggest, or vice versa, but to consider the ways that bodies and computational networks shape one another, in continuous and contingent social, technological, abstract, physical and perceptual vectors, that are, at their smallest portions, micro-texturally material.

The software assemblage is influenced by an understanding of embodiment in relation to digital technologies and interactions, where virtual space is not considered as disembodied from the physical world, but a site of co-presence where mutually reciprocal shaping occurs (Munster 2006; Murphie 2002; Massumi 2002). A materialist approach to interface suggests the need to explore the contingent relations between all elements (human and machine) as they unfold, reconfigure and assemble again, across the specific spatio-temporal phenomena that reveal the actual processes and relations of interfacing. Andrew Murphie's extemporisation on the virtual from a Deleuzo-Guattarian perspective, questions the conventional (HCI) positioning of Virtual Reality (VR) as a zone for the enactment of mimesis and digital simulation (Murphie, 2002). He argues that, arriving with VR, is a shift from an interest in representation to an interest in operation. In less creative uses (Murphie cites Brenda Laurel's narrativity) where a VR machine (whatever that might consist of as a current technical object) acts upon the user, the body is inserted into a technologically generated framework with limited options. However, if

Virtual Reality is taken as an opportunity to generate 'co-extensive' connections between the virtual and human perception (Murphie 2002, p.8-9), it has the capacity to present "humanity with the possibility of the modulations of the virtual, previously operating below the general threshold of perception, being seen to overtake and disrupt the more 'solid' notions of our social existence".

To extend Murphie's argument regarding a modulating virtual within Virtual Reality, my concerns in Mixed Reality, would be to also challenge the commonly held HCI design practice of placing the participant in a restricted role as a controller of screen space. Such a role will always fall short of an adequate address to the impact of the body as a non-discreet, contiguous forming that modulates between virtual and physical. It is the material flow between the virtual and the physical — the oscillations back, forth, sideways, across and within vectors — that constitute the self-organising human-art-machine that is the software assemblage. If computational abstractions that manifest from the body are seen as simply a set of point coordinates in a digital data set, mimetic rather than morphogenetic outcomes are privileged. Virtual spaces are not sites of mathematical abstraction, but are relational and expressive spaces where materials (data, bodies, or whatever) coalesce and transform each other, and themselves.

Augmentation as Embodiment in Experimental Art

In my ongoing software assemblage series, *Tactile Light_-Jan2017 version*, I grew a two metre square of Wheatgrass, and used this as a living site for interactive real-time augmented projections.

Figure 1. Still from *Tactile Light_Jan2017 version,* live performance by the author

An interactive data system constructed in Unity was paired with a Leap Motion gestural interface and a webcam (to create feedback). Then, the data system was projected onto the living screen [Fig. 1]. The data system consisted of representations of hands manipulated using the gestural interface and simultaneously distorted in near real-time by feedback with the webcam. While the co-emergent phenomena arising between the participant's hand (as it activated the gestural interface), had 'caused' the on-screen emergences that were also hands, these virtual hands were so distorted as to defy a straightforward mimetic interpretation. To paraphrase Murphie's argument, the virtual instills a crisis into the dichotomy between representation and the real (2002: 9). He identifies the processual crossing of thresholds, such as body/machine, representation/'reality', as an unfolding series of individuated events that sketch the computer-body network.2

As organic-techno-social entities that reassemble with every iteration, software assemblages as they occur in my practice-based research, are provisionally composed of a variety of conjoined elements: in *Tactile Light* [Fig. 2] there is a vertical wheatgrass sheet, vertical wheatgrass lattice, wire, a projector, speakers, gestural controller, a human, darkness, a computer, all drawn together by custom software; in *Tactile Sound* [Fig. 3] there is a horizontal wheatgrass sheet, Piezo discs, LCD monitor, gestural controller, a human, light, a computer, speakers, and again, drawn together by custom software.

My approach to the design of these software assemblages mobilised the shifting, contingent and contiguous relations between the body, devices, living plants, and computational systems in order to produce augmentations across both virtual and physical sites that mutually operates on and in, the physical world. Both software assemblages leverage operational set-ups comprising elements that are organic, technical and social, operating as a semi-unified system that fluctuates between more or less stable states. These software assemblages are ecological, living, enacted and realised through processes of emergence that are organic, as well as technical and social. Organic is taken here in its material sense of being subject to processes of decay as well as suggesting a compositional mode that is processually morphogenetic.

A broader research question emerges: how can viewing the spectrum between the virtual and physical as a contiguous topology assist in adding to considerations of embodiment in the field? In *Tactile Light* and *Tactile Sound*, I brought the software assemblage formulation into negotiation with Augmented Virtuality and

Augmented-Reality, as topological aspects that should

Figure 2 (above). Still from *Tactile Light*, performer-data system integration as ecological, or, a software assemblage.

Figure 3. Still from *Tactile Sound,* performative, real time co-emergence of augments. Live performance by the author.

never have been critically separated in the first place. Here, embodiment is diffracted through a series of performative real time experiments. Screen events were not isolated as simply data, instead the virtual ground of mediation was the conjunctive apparatus itself, which fused body, grass, and machine. Technical interfaces like the Leap Motion were treated as no more significant to the research than physiological interfaces such as the human hand. What emerged in the resultant phenomena was not only an experience that foregrounded an attentiveness to the micro-gestures of the hand, but also the hand as a processual and contingent formation that produces numerous instantiations of itself as textural 'on screen', as local and extensive with the data system and webcam, and also amorphous and fleeting in the virtual 'space' of projection that is the ambient topology of light as matter.

Experimental Media Art and the Making of Human-Art-Machines

In experimental media art since the 1990s, there is an influential lineage of embodied interaction that explores nuanced co-emergence of virtual bodies, as a theoretical discourse, an artistic practice and a force in culture. The augmentation of virtual worlds, where a participant's gestures and movements are translated into screen space through a conjunction with a data system, is a major area of research. Here, unstable mixtures of reality and the virtual are explored through sensor based networks that activate various hybrid occurrences whose challenges to the limits imposed between virtual and physical space, are palpable. Various projects by Christa Sommerer and Laurent Mignonneau (*TransPlant*, *A-Life*), David Rokeby (*Very Nervous System)* , Camille Utterback (*Text Rain*), Scott Snibbe (*Motion Phone,* 1995-8), Golan Levin and Tmema (*Manual Input Sessions* 2004-6) These examples from the history of experimental media art that manifest performative conjunctions in Mixed Reality, can be re-considered as software assemblages, rather than the more conventional (Humanist) description as 'installations'. From a materialist perspective, all consider the diverse ways in which the visible relations between human and nonhuman elements enter into dynamic relational arrangements via software, code and algorithms.

From Taxonomy to Diffraction: Approaching Mixed Reality as a Software Assemblage

The potential to re-configure the Reality-Virtuality Continuum in a more appropriate formulation that has the capacity to take into account the relational aspects of the body, technical networks and devices. Drawing on Deleuze and Guattari, the software assemblage is a permutation of software as interface; a machinic assemblage (Deleuze and Guattari 1987, p.23) arranged through the agential relations of software, and shaped by relations with various co-emergent material forces, human and otherwise. This hybrid arrangement encompasses virtual, technical, physical and fleshy objects, in a contingent and conditional networked configuration that is critically embedded with the capacity to re-configure through self-organisation. In order to further explicate the software assemblage, it is necessary to unfold some of its more precise procedural operations. To facilitate this task, I bring Deleuze and Guattari into contact with Karen Barad, through their

mutual interest in the differential relations of Being, as procedurally fuelled by the self-organisation of matter. To be clear, the operable intimacy I am extracting from these highly influential materialist thinkers is not expressed in the texts of either: Barad especially is outwardly hostile to Deleuze, while obviously Deleuze and perhaps also Guattari would most likely be unaware of Barad's extremely significant, but far more recent contributions to philosophical thought. Though all have arrived at materialities of becoming through divergent processes, the capacity of their ideas to inform a productive new research axis on materiality in experimental art, is highly promising. The operable affinity I suggest is leveraged out of their mutual yet independent development of differential processes of becoming, and the potential of such processes to transform ethical, material and discursive stratifications. For all, matter has its own form of morphogenesis that occurs independently from human intervention, is perpetually generating and re-organising itself according to the relations it forms (contingently) with other materials: matter coalesces, concretizes, disperses, erodes, re-assembles.

Susanne Witzgall has commented on the associations between Barad and Deleuze, which she sees as connected by a shared interest in questions surrounding the nature of the processes that differentiate Being (and by implication, becoming): "Barad appears to assume a similar primary difference of Being and detects in the elementary particles of quantum field theory a similar virtual, manifold indeterminism of differential relations as utilized by Deleuze for his problem-Idea" (Witzgall 2016, p.146).

Karan Barad's agential realism provides an especially useful addition to the software assemblage since it fleshes out the actual movement of matter in the world (intra-actions), the objects matter creates (phenomena), and an understanding of bodies and matter in movement (diffraction). For Barad, phenomena are the concrete material results of the 'intra actions' of matter (Barad 2003, p. 811), at their smallest unit, quanta. In an agential realist account, in common with new materialist theory,[3] humans are a particular configuration of matter and therefore are not privileged in relation to other material

configurations (2007, p.33). For Deleuze and Guattari, the conditional arrangement that facilitates this mattering is the abstract machine while the active formings that occurs after the cut are assemblages. For Barad, it is the intra-actions of matter and the phenomena created by the processual workings of the apparatus and the discursive-material practices behind the measurement of the phenomena in an experimental scientific set-up, matter is fundamentally an arrangement of quanta.

Using the software assemblage formulation as a theoretical apparatus to parse over Mixed Reality, brings a materialist conception of interfacing into contact with artworks that conjoin hybrid human and data systems to produce a performative space of negotiation. Augmented Virtuality in art cannot be analysed effectively under the impoverished terms given by the Reality-Virtuality Continuum, where segmentary parts are disconnected and discrete from one another, then placed back in an artificially contrived spectrum that is always already bounded by a structured and dualistic schema. Further, a taxonomy supports the commonly held definition from computer engineering pedagogy where virtual objects are primarily simulations of the physical world. Re-configuring Mixed Reality as a soft-ware assemblage rather than a series of separate technical categories is crucial, since it leads to a conception of the emergence of matter (such as the body) that does not hold digital verisimilitude as a goal. There is a need to unfold the complex and highly nuanced technical-material-discursive formulations that merge from customised networks conjoining human and nonhuman elements in processes of interfacing and augmentation, to afford an enhanced sensory experience of the virtual that traverses, or caresses, embodiment.

An experimental media artwork that conjoins the hand with a computational hardware and software system, is the *Augmented Hand* series (2014), by Golan Levin, Kyle McDonald and Chris Sugrue. Participants were asked to insert their hands into a machine that captured images. These images were then translated into virtual mutant versions of hands. Taking a photograph of the hand, the software performed some highly believable renderings of deftly manipulated hand 'forms', adding extra fingers, distorting the shape and size, and generally perceptually refiguring the familiar digits of each participant. As the custom software that powered *Augmented Hand* grabbed images of participant's actual hands, they were instantaneously translated into a distorted form. These

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[3] Manuel De Landa (2012, p.43) has commented that a common thread linking all new materialist accounts is the premise that matter is vibrant and connected. He says: " … neo-materialism is based on the idea that matter has morphogenetic capacities of its own and does not needs to be commanded into generating form." (Interview with Manuel DeLanda, in Dolphijn & van der Tuin).

forms still resembled one's own hand, yet contained disconcerting, Frankenstein-like additions.

In this artwork, as digital matter (such as the software itself) moves processually through matter (the human hand), negotiating shifting meshworks, the movements and transitions of the bodymachine network (the co-shaping of mutant hands) actually materially influence a human experience of 'reality'. Moreover, material flows of people and software, transversally coming together in the environment of the artwork, can be approached as forces that reassemble not only *relations* with the body but also the *concrete matterings* of the body itself. The human body is just as much an interface as is a physical object: both are matter engaged in matterings, with emergent performative effects that are themselves transitional phenomena. As participant's hands became figures of the material reassembly of the human body, toward a mutant cyber body, those actual hands were transformed by the processual workings of the machine. This tracing of the virtual into reality via the physical hand, is not simply a perceptual trick, but an embodied experience that merges with the participant's 'reality' even after the experience is temporally over.

Summary

Earlier in this paper I discussed the core taxonomic practices in HCI that have led to the artificial compartmentalisation of Mixed Reality as a 'middle' instance on the Reality-Virtuality Continuum (Milgram and Kishino 1994), a contrived spectrum that is essentially a new dichotomy between 'real and 'virtual' in the computer engineering sense of those terms. Re-situating Mixed Reality in a material network of practices that spans research, industrial computation, desktop computing and experimental art practice, my aim has been to accrue an extensive definition for Augmented Virtuality beyond its more common taxonomic use. Further, I suggested that notions of classification that manifest as limits operated not only to segment Reality from Virtuality, but also embodiment from Virtual Reality (Weiser 1991). Rather, I proposed the software assemblage as an experimental diagram that operably inflects varying mixtures of physical and virtual worlds. Mixed Reality, when explicated as a topology, operates as a critical response to the restrictions imposed by the bounded virtuality espoused by HCI research.

Using examples from media art as well as my own practice, this paper has explored the emergent dynamics of performative interfacing as an element in an experimental art assemblage rather than an industrial media assemblage. Co-emergent configurations that diffract material phenomena such as a human participant, a screen, as well as various objects virtual and physical, encourage an active co-emergence, where the digital materials of algorithms, code, and the fleshy matter of the body and other phenomena such as a grass screen, become entangled through, with, and by an intensive sensory process.

Acknowledgements

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Rewa Wright is fascinated by augmented emergences in organiccomputational-material systems, which she calls *software assem-blages*. She works across the territories of generative art, net-worked abstraction, experimental documentary, audio-visual performance, and mixed reality. She has presented her work at ISEA2013 (Sydney), the Post Screen Festival 2014 (Lisbon), and ISEA2015 (Vancouver), ISEA2016 (Hong Kong) and Vivid 2016 (Sydney). She is finishing her Ph.D in realtime, in the afterglow of a future not yet born.