Sensual Alterity of Digital Objects

by

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Abstract

This thesis hypothesizes ways in which contemporary theory constructs sensual qualities in digital objects. I disrupt the common epistemological understandings of objects to describe what constitutes a sensual alterity. The sensible object is defined to be something more than representing a real object. This thesis expands upon demonstration files available in *breve,* an open-source, multi-agent simulation software. The digital object substructure is unpacked through the lenses of theorists Karan Barad and Graham Harman. I negotiate digital bodies as vertices and attributes to be ontologically stable. I formulate rasterization (transferring vector to pixel visualization) to be a model of the intra-actions (assemblage of causal forces) of agential separability (practice of mattering) showcasing the apparatus as inexhaustible in its penetrative cut. I explore this sensual exteriority and apply the apparatus of touch to indicate the capacity of digital objects to experience otherness, or sensual alterity.

Keywords: object, digital, simulation, sensual, apparatus, boundary, touch, alterity, rasterization, exteriority.

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To Elliott

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I. Introduction

This thesis hypothesizes ways in which contemporary theory constructs sensual qualities in digital objects. I disrupt the common epistemological understandings of objects to conceive of new ways to consider the digital object and its individuation from the environment. The theoretical goal is to devise a theory that allows for ontological and epistemological structures of objects to be modeled into simulation as sensual phenomena. The purpose of this thesis research is to investigate what constitutes a sensual alterity, and to reorganize the notion of objecthood otherness. I conclude with a theory of sensual alterity that excites an ethical responsibility in the relation of digital objects.

This work is inspired by previous research in artificial morality where I studied moral machines and the capacity for ethics to be computational. By looking towards what would be sufficient to attribute moral standing to artificial agents, a new term was introduced to me: alterity. Defined through human–computer interaction, alterity describes the relation between a human and an artifact. But what of the experience of otherness for digital objects? I wanted to explore digital objects capacity to experience alterity. This could be achieved through artificial intelligence studies but felt this was a scope outside my reach in this time. Instead, I explore the term by way of the metaphor of the body, birthing the notion that digital objects may experience sensuality. In attempts to define a virtual and sensual alterity, I look to objects on screens and the ways in which these objects were generated and how they relate to each other. Further, I assert

that digital objects are composite, and like physical objects, that they have autonomous qualities, and as such, are said to be real and *sensual*.

In object biographies, we constitute what an object is by their relationships or alliances with others—namely, with other human actors. For this thesis, I look at digital objects and their relationships to a simulated environment. The property configurations of these digital objects are dynamic and exemplify their autonomous qualities. By assembling sensual alterity in terms of human–computer interaction and object-oriented feminism, I question how sensual alterity is present in object-to-object relations.

This thesis hypothesizes ways in which contemporary theory constructs sensual qualities in digital objects. It asks what epistemological frameworks have lead to the chaste and rational conception of objects and then transfers those theories to the virtual realm. The manner in which physical objects are discussed is paramount in the modeling of virtual objects; these objects are constructed by and constructed of definition. The construction of these objects relies on the ontological conception of objects as a whole, meaning the manner in which these objects were constructed were constrained by their makers epistemological historicity. The use of simulation in this thesis is interesting as it appeals to an interdisciplinary approach, and not one rooted in computer science and engineering. I cannot write code. Yet, I use simulation as an opportunity to explore contemporary theories of materialism, and consider in what ways these theories map upon and draw attention to areas of overlap and conflict in

contrasting materialism and virtuality. The thesis uses *breve* as the simulation software in which to reference and situate the discussed digital objects. The digital object substructure is unpacked as its graphical and modeled representations are considered through the lens of feminist science study theorist, Karan Barad[1] and speculative realist, Graham Harman[2]. Sensual boundaries are initiated through discussions of the apparatus of rasterization and intra-actions, a materialization process that, I argue, ought to be emulated in the natural laws hosted within the simulation environment. In this work, sensual objects are defined to be something more than representing a real object. Sensuality is not a representation, nor a sign, rather a phenomenal doing. The ways in which these contemporary physical theories are mapped upon digital construction and visualization in the *breve* simulation environment are key to the thesis' capacity to indicate potentials for sensuality in digital objects.

The purpose of this research, then, is to disrupt the common epistemological understandings of digital objects and to conceive of new ways to consider the digital object and its differentiation from its environment. I reflect upon representationalism in object ontologies and consider ways that this incarcerates the digital object.

The theoretical goal is to devise a theory that allows for the ontological and epistemological structures of objects to be modeled into simulation

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[1] University of California. Feminist Studies Department.

[2] The American University in Cairo. Philosophy Department.

environments to allow the phenomenal expression of the objects as sensual. I will be establishing a fiction in the concept of this so-called sensual digital objects. As such, this work queries and critiques theories of digital materialism. The thesis suggests ethical conclusions that indicate a lack of responsibility in the consideration of digital objects. A more responsible approach would understand digital objects as participating in, observing, and performing sensual acts while entangled with sensual boundaries.

The available evidence of academic resources shows limited interest by contemporary theorists in understanding how objects exist in digital environments. The current literature on computer programming abounds with examples of the use of metaphor in the development of computer programming—the predominant metaphor being architecture which problematically lead to the reestablishment of space being conceived as extensive. Special effects in cinema —including the use of particle systems in animation for crowd behaviour—puts forward the view that virtual reality is designed to facilitate human consciousness and industry. Research on the reusability and transferability between platforms and programs for 3D graphics indicates the cost-heavy development of CGI. There is a corpus of literature on digital networks that indicates an interest in database aesthetes and info visualization. Bodies in code are prominent in the HCI literature on sensible technologies and embodiment.

The literature shows no consensus on the ontological status of digital objects. It appears as if the question is not addressed at all. This is problematic

given the considerable engagement and presence of digital objects. As such, this thesis develops a claim that digital objects are necessarily similar to physical objects given that the apparatus of individuation remains the same for all bodies, including for bodies in virtual space. These ideas and a further exploration into the history of object ontology will be picked up in my literature review section. This argument contributes to the theoretical gap in digital materialism by way of maintaining and utilizing theoretical conceptualizations and terminology found in the literature of object-oriented philosophy to transfer agency and democracy to digital objects.

My methodology is an applied critical theory and philosophical approach to understanding object ontology and sensual boundaries in simulation environments. I use grounded theory method as a means to generate concepts. Key theoretical contributions in the areas of object-oriented feminism, applied ethics, and new media philosophies inform the development of these key definitions. I will be using post-structural and postmodern theories to refute the mainstream thinking of objects as they rely on the conception of matter and form from Descartes and Aristotle. I reject empiricism as it propounds the view that phenomenal experience requires a human observer. Empiricism is epistemological theory that privileges the claims of sense experiences or direct observation, rather than from the faculty of reason or understanding.[3]

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[3] "empiricism, n.," *OED Online*. http://www.oed.com/view/Entry/61344?redirectedFrom=Empiricism+ (Accessed February 18, 2016).

This thesis will expand upon demonstration files available in *breve,* an open-source, multi-agent simulation software. My method is to engage with the simulation software in a manner that contorts common scientific experimentation practices of objectivity and hypothesis to develop a fiction of simulation alteration that becomes fruitful for theory development. I use simulation to map theory of objectness down to its particular features and assumptions of objecthood with a focus on explanatory power, and not on forecasting.

The limitations of this study include the lack of a thorough consideration of the user and maker. Instead, I explore simulation in considerations of the ways it is responsible for modeling both a target source and knowledge. The user is considered, and as a user author myself, inescapably the user is assumed in all epistemological instances of this argument. The user's agency does not simply disappear, though it is not prioritized in this argument. Where the discussion of intentional objects necessarily requires an observer, I attempt to prioritize the response of the digital object. Where possible, this thesis investigates ways in which the observer is the digital object as opposed to a human cognizer. I analyze non-human based intentionality and the reality of digital objects through materialization studies and object-oriented ontologies. In this manner, the thesis takes on an object-oriented approach. This scope doesn't exclude the user observer in an effort to navigate a mind-independent reality, nor does it attempt to operate in an externalist field of coherence; rather, the limitation is included to consider the potentiality of new digital object observers.

In the first section, "Representation and Mediating Structures of the Apparatus," I question how the apparatus has reconfigured the ontological understanding of objects. I look to representationalism as responsible for dissonance in referent modeling, and at the effect of object-oriented ontology's restrictive domains on objectivity when discussing object autonomy. In the second section, "Applied Assemblage," I discuss how agential separability and empirical matter are configured as examined by Karen Barad, considering as well, their theoretical reaches as they are transposed into a virtual realm. I then offer my critical lens for the ontology of digital objects, focusing on the tensions of real and sensual objects to explore how contemporary theory has produced sensible qualities in digital objects. Introduced in the third section ("Biography of *Breve"*) is a popular multi-agent simulation program. A user-focused description of the simulation software is employed to analyze the syntheses between the graphical event and the construction of digital objects; these exist, I argue in juxtaposition with the object ontologies of contemporary and traditional philosophies. I ask if the ontological requirements of physical objects can be exhibited in the architectural forms of digital objects. The fourth section, "Sensual Facets," designs the discursive practice of rasterization (transferring vector to pixel visualization) to be a model of the intra-actions (assemblage of causal forces) of agential separability (practice of mattering) showcasing how the apparatus is inexhaustible in its penetrative cut. In this cut, the object demonstrates an unrivalled exteriority—the face of a digital object. In addition, "Sensual Alterity"

takes the sensual exteriority previously defined and applies the apparatus of touch to indicate the capacity of digital objects to experience otherness (namely, as the subject's neighbours), and subsequently, how these objects are capable of demonstrating alterity.

II. Literature Review

This literature review aims to converge historical digital object development texts, with a lineage in the evolution of object orientation as a product of the decentered subject through the development of computer technology. Granted, the scope of this literature review cannot access in its entirety the recent history of the computational machine, nor address its affect upon cultural theories. In my research, I attempted to chart the digital object model development from programming to ontology. These digital artifacts were modeled with human as both muse and end user. From the foundations of computer graphics, interactive objects were first investigated in terms of network and its subsequent impact on information and power distribution. Human-computer interaction was not a focus as I aimed to bracket empiricism, though paramount to the development of these objects is supposed cognitive modeling in the design of all computer programming. Feminist digital and material engagements are introduced as the reconfigured body includes the extension of prothesis and the embodiment of information. As a scholar, this thinking is prevalent in my modeling of digital bodies. I will introduce through a unique narrative a call to action that incorporates the subtle perspective of the object. Finally, I discuss object oriented ontologies as the foundational coming to know objects in their autonomous agency purposed in this thesis. This section is inspired by the methodology of postmodern literary critic N. Katherine Hayles[4] in

[4] Duke University. Graduate Studies in Literature.

How We Became Posthuman (1999), proclaiming: "I want to entangle abstract form [literary texts] and material particularity [scientific theories] such that the reader will find it increasingly difficult to maintain the perception that they are separate and discrete entities." [5]

The construction of digital objects is full of industry expressions that to a reader unfamiliar with programming languages and complicated model logic would find inaccessible. In part, the reason computer animation, computer graphics and interactive design are accessory interest in the academic arena, are because of their pervasive commercial applications.[6] Almost all of the examples of early object construction can be assimilated by papers exploring web-based models and repositories. Paul Fishwick[7], Director of Digital Arts & Science Programs at the University of Florida, lists circa 1991 assumptions of digital object models; they must be of "homogenous types," "be static and not dynamic", "conform to pre-defined standards," "shall not have aesthetic properties," and ought "adopt object-orient design principles." [8] These assumptions are rooted in the iconographic *Teapot* from Martin Newell (computer scientist) who "rendered a unique set of Bezier surface spline patches from an ordinary teapot, which

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[5] Katherine Hayles, *How We Became Posthuman: Virtual Bodies in Cybernetics, Literature, and Informatics* (Chicago, Ill: University of Chicago Press, 1999), 23.

[6] Michael Tanzillo, Peter Weishar, Bridget Gaynor and Josephine Leong, *Digital Art Curriculum Framework* (ACM SIGGRAPH, 2008)

[7] University of Florida. Computer and Information Science and Engineering.

[8] Paul Fishwick, *On Web-Based Models and Repositories* (Florida: University of Florida, 2010), 4.

currently resides in the Computer Museum in Boston."[9] Each of these assumptions were challenges within 10 years. For example, it was indicated that dynamism was the difference between an object and a model, and that each new model "destroy[ed] achievements in standardization,"[10] or consider the aesthetic usability effect.[11] Further, for object-oriented design Fishwick finds deep philosophical concern between encapsulation and the scalability (relationally) inherent to modeling.[12] Fishwick observes that "in a broad sense, and as suggested by the term 'object-oriented,' these modules may be viewed as individual objects, each with their own functions, interfaces, attributes, and allowable operations."[13] In the manner that a digital object is a "distinct unit of existence and/or abstraction; having state, behaviour, and identity; and which can be observed, manipulated and/or affected,"[14] the digital object as correspondence, is a "metaphor expressed as a pairwise relation."[15] In an attempt to go beyond, the actual modeling of this relationally was proposed by introducing a new

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[9] Paul A. Fishwick and John F. Hopkins, "3D Behavioral Model Design for Simulation and Software Engineering," in *On Web-based Models and Repositories,* 35- 44 (Florida: University of Florida, 2010), 35.

[10] Fishwick, *On Web-Based Models and Repositories*, 5.

[11] Masaaki Kurosu and Kaori Kashimura, "Apparent Usability vs. Inherent Usability: Experimental Analysis on the Determinants of the Apparent Usability," in *Conference Companion on Human Factors in Computing Systems* (CHI '95), ed. I. Katz, R. Mack, and L. Marks (ACM, New York, NY, USA, 1995), 292-293.

[12] Fishwick, *On Web-Based Models and Repositories,* 8.

[13] Paul A. Fishwick and John F. Hopkins, "On the Use of 3D Metaphor in Programming," in *Enabling Technology for Simulation Science IV,* Ed. Alex F. Sisti. Proceedings of SPIE Vol. 4026 (2000), 54.

[14] R. M. Cubert and P. A. Fishwick, "Digital Object Multimodel Simulation Formalism and Architecture," in *Enabling Technology for Simulation Science.* Ed. Alex F. Sisti. Proceedings of SPIE Vol 4026 (2000), 121.

[15] Cubert and Fishwick, *Digital Object Multimodel Simulation*, 121.

'perspective [of direction]: as a spatial object."[16] Direction was modeled as a vector (which is "both magnitude and direction but no fixed position in space").[17] This new perspective "allows [for] the definition of the orientation of spatial objects; it gives a richer set of predicates and operators on direction and orientation."[18]

Much of the research has been focused on the manner in which digital objects interact. Namely, the production of behaviour-rich graphical environments examining collision detection. An overview of geometry for graphical events are prominent in the literature on digital objects, including the bounding box which will be discussed in some length in the section "Bounding Box and Response-Ability" in the thesis. Evidence for the exceeding phenomenal agency of the body is apparent by some results in collision research that included mis-angle reflection or bounding boxes not corresponding to action as key problematics to the collision handling of digital bodies.[19]

While some more popular work of this type is to explore object rendering by way of an image editor program. For example, *Automatic Scene Inference for 3D Object Compositing* contributes an automated process to develop a 3D model from a photograph. The program focuses on environmental illumination inference

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[16] Shashi Shekhas and Xuan Liu, *Direction as a Spatial Object: A Summary of Results,* (ACM GIS '98 11/98. University of Minnesota; Washington, DC. USA, 1998), 69.

[17] Skekhas and Liu, *Direction as a Spatial Object,* 70.

[18] Skekhas and Lui, *Direction as a Spatial Object*, 75.

[19] Anthony L. Burrows and David England. "Java 3D, 3D Graphical Environments and Behaviour," in *Software: Practice and Experience* 32. (2002), 369.

and depth estimation. The purpose of modeling to construct realistic compositions for human perceivers is pervasive. As such, these specific rendering procedures are constructed to optimize and discard inefficient light sources as "guided by aesthetic principles" whose 'realism' is tested by user participants.[20]

The chief focus of this review up until now has been to illustrate a rather linear development of computation objects. Now, moving to a higher level of logic, I explore how these digital objects relate to visualization and the body. The visualization of networked information introduces ideas of the apparatus in multimedia artist and theorist Anna Munster's[21] *An Aesthesia of Networks* (2013). Here, the dynamism of computational objects are explored in the diagram as "an immanent tracing of the qualities or traits of relations at play and operates aesthetically across a field — the recursive arraying of networking."[22] These relations display an array of connections that illustrate the limits within object-oriented design principles, namely to encapsulation, and for this reason, the modeling of relations is inherently aesthetic. Munster divests human perceptibility by questioning "how do networks experience?" by looking at what forms of aesthesia persist relationally.[23]

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[20] Kevin Karsch, Kalyan Sunkavalli, Sunnil Nadap, Nathan Carr, Hailin Jin, Rafael Fonte, Michael Sittig and David Forsyth. "Automatic Scene Inference for 3D Object Compositing." ACM Trans. Graph. 33, 3, Article 32 (May 2014), 7.

[21] National Institute for Experimental Arts. College of Fine Art, UNSW. Contemporary Culture, Art & Politics (CCAP).

[22] Anna Munster, *An Aesthesia of Networks: Conjunctive Experience in Art and Technology*. Technologies of Lived Abstraction. (Cambridge, Mass: MIT Press, 2013), 37.

[23] Munster, *An Aesthesia of Networks*, 6

Lucy Suchman,[24] Professor of Anthropology of Science and Technology at Lancaster University, focuses on human computer interaction in *Human-Machine Reconfigurations: Plans and Situated Actions* (2007), as being predominantly useful in establishing knowledge about human understanding. The computer artifact is "built on a *planning model* of human action," identifying that the problematic here is that plans "neither determine the actual course of a situated action nor adequately reconstruct it."[25] This work defines automata and the computational artifact as 'interactive,' and increasingly 'linguistic' while differentiating the mutual intelligibility as unequivocal between humans and computers. Suchman illustrates that there is a disassociation between the computer as designed and the occasions of its use.[26]

From the ease and assumption of document transferability, a number of transfer protocols were simultaneously developed. "Protocol refers specifically to standards governing the implementation of specific technologies."[27] Protocol is a management style which is an apparatus of control that "intersects both the digital computer and the distributed network, two historical specific technologies."[28]

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[24] Lancaster University. Department of Sociology.

[25] Lucille Alice Suchman, *Human-Machine Reconfigurations: Plans and Situated Actions.* 2nd ed. (Cambridge ; New York: Cambridge University Press, 2007), 3.

[26] Suchman, *Human-Machine Reconfigurations*, 19.

[27] Alexander R. Galloway, *Protocol: How Control Exists after Decentralization* (Cambridge, Mass.: MIT Press, 2004), 7.

[28] Galloway, *Protocol*, 243.

Protocol is practical, and as such have been adopted and implemented in the design of the computational objects discussed here within.

Sherry Turkle,[29] Director of MIT Initiative on Technology and Self, in *Simulation and Its Discontents* (2009) discusses the history of the 'black box' or 'opaque software;'[30] "we have a true black box when a statement is simply presented as a raw fact without any reference to its genesis or even its author."[31] Simulations are construction for and by the visualization of scientific and engineering disciplines. Turkle puts forward the view that the development of designing experiments this way, necessities that nature be "known in advance."[32] Further, the frame of reference for simulation has no precedents; for these reasons "simulation mesmerizes." [33]

This research was inspired by those who focus on the decentering of the subject through digital technologies. Considering just one pivotal work, *How We Became Posthuman: Virtual Bodies in Cybernetics, Literature and Informatics* (1999) by Katherine Hayles, where it is identified that "*information lost its body*."[34] This is a key insight of her research in cybernetics, information theory and computational biology. It is this separation of information from its body, that

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[29] Massachusetts Institute of Technology. Program in Science, Technology, and Society.

[30] Sherry Turkle, *Simulation and Its Discontents* (Cambridge, Mass.: MIT Press, 2009), 41.

[31] Graham Harman, *Prince of Networks: Bruno Latour and Metaphysics* (Prahran, Vic.: Re.press, 2009), 37.

[32] Turkle, *Simulation and Its Discontents*, 40.

[33] Turkle, *Simulation and its Discontents*, 51.

[34] Hayles, *How We Became Posthuman*, 2.

leads to the embodiment of information into the organic compounds and subsequently birthing the cyborg. “The posthuman view privileges informational pattern over material instantiation.”[35] This book denies that consciousness is a starting place, rather it is a concurrent phenomenon concluding extension of the body as a natural continuation.[36] “Reflexivity entered cybernetics primary through discussions about the observer,”[37] birthing the theory of autopoiesis — “that systems are informational closed.”[38] This thesis is a product of the disembodiment of information and materiality, it attempts to bridge the gap in a new way. “Literary texts are not, of course, merely passive conduits. They actively shape what the technologies mean and what the scientific theories signify in cultural contexts.”[39]

Professor and Chair of Modern Culture and Media at Brown University, Wendy Chun[40] in *Programmed Visions: Software and Memory* (2013) explores code, interfaces and programmability as the ‘embodiment of logic.’[41] Further, compounding upon the role of metaphor: memory, code and genetics, and the gendered histories of computer development are considered.

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[35] Hayles, *How We Became Posthuman*, 2.

[36] Hayles, *How We Became Posthuman*, 2.

[37] Hayles, *How We Became Posthuman*, 9.

[38] Hayles, *How We Became Posthuman*, 10.

[39] Hayles, *How We Became Posthuman*, 21.

[40] Brown University. Modern Culture and Media. History of Art and Architecture.

[41] Wendy Hui Kyong Chun, *Programmed Visions: Software and Memory,* (Cambridge, Mass: MIT Press, 2011), 176.

The Biography of the Object by Sergei Tret'iakov (Russian constructivist writer) was written in 1929, "at a time when the champions of the new proletarian realism were campaigning for the reinstatement of the sovereign human subject at the centre of the fictional narrative."[42] The idea being that heroism was only the attribution of a series of events into the actions of one narrator, when in fact, it was a multitude of relations the were responsible. "If the traditional novel was held together by the hero, the biography of the object was held together by the act."[43] Trev'iakov advocated for the object proceeding through a "system of people,"[44] as a method of discussing capital and production, but also to move away from idealist philosophy.

Landgon Winner[45] in *Do Artifacts have Politics?* (1980) argues against technological determinism, much to the effort of author and programmer Alex Galloway's[46] *Protocol*, denying the suggestion that there is an internal dynamic that "molds society to fit its patterns."[47] Winner offers that "invention, design or arrangement of a specific technical device or system becomes a way of settling an issue in a particular community,"[48] for example, Moses' low bridge, may be a

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[42] Sergei Tret'iakvo, "The Biography of the Object," in *October* 118 (2006), 57.

[43] Tret'iakvo, *The Biography of the Object*, 58.

[44] Tret'iakvo, *The Biography of the Object*, 62.

[45] Rensselaer Polytechnic Institute. Department of Science and Technology Studies.

[46] NYU. Media, Culture and Communication.

[47] Landgon Winner, "Do Artifacts Have Politics?," *Daedalus*, Vol. 109, No. 1, Modern Technology: Problem or Opportunity? (Winter,1980),122.

[48] Winner, *Do Artifacts Have Politics?*, 123.

manner in which artifacts are political. Another way is to consider artifacts with inherently political technologies like, the atomic bomb. I have considered the way object orientation is developed through narrative, and pertinent to my thesis, I examine attributes not commonly considered to objects which serves as a transition into other novel conceptualizations. Winner touches on the network as a way to attribute unique properties to a multiplicity of objects and systems; "the issues that divide or unite people in society are settled not only in the institution and practices of politics proper, but also, and less obviously, in tangible arrangements of steel and concrete, wires and transistors, nuts and bolts."[49]

Accordingly, Ilana Gershon[50] and Joshua Malitsky[51] introduce the theoretical relationality of the actor-network theory (ANT) ("Michel Callon, John Law, Madeleine Akrick, Andy Barry, Annemarie Mol, Antoine Hennion").[52] They describe the theory as rejecting dichotomies, consider the rehearsed: "self/other; material/semiotic; nature/culture; agency/structure; knowledge/power; active/ passive; human/non-human; truth/falsehood. By rejecting these dualisms, ANT presumes that every thing and everyone is profoundly relational—that entities

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[49] Winner, *Do Artifacts Have Politics?*, 128.

[50] Indiana University. Anthropology Department.

[51] Indiana University. Communication and Culture.

[52] Bruno Latour, *Reassembling the Social an Introduction to Actor-Network-Theory* (Oxford; New York: Oxford University Press, 2005), ix.

only have qualities, attributes or form as a result of their relationships with other entities."[53]

Graham Harman in the *Prince of Networks* describes "Latour as a pioneer of object-oriented philosophy."[54] Bruno Latour's[55] philosophy is known for positioning all entities as equal, ontologically. "All features belong to the actor itself: a force utterly deployed in the world at any given moment, entirely characterized by its full set of features."[56] If one feature changes, the features of the world change; things are utterly concrete, they are neither encrusted nor encapsulated. The concreteness of an object is neither irreducible to any other, in fact an actant "gain[s] in strength only through their alliances."[57] Latour's things lack a centre, in this way they are vectors—magnitude and direction—or events. I love what this does to the construction of an argument: "thinkers do not deduce, critique, or build reality out of first principles or foundations. Instead, they simply work…"[58] "There is no such thing for Latour as a 'becoming' that would exceed individual actors. Nor is there any 'virtuality' that exceeds them, just as potentiality does not exceed them."[59] This quote indicates two key features of

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[53] Ilana Gershon and Joshua Malitsky, "Actor-Network Theory and Documentary Studies," in *Studies in Documentary Film* Vol. 4 No. 1. (2010), 66.

[54] Harman, *Prince of Networks*, 151.

[55] Sciences Po. Medialab. Programme D'Experimentation en Arts et Politique.

[56] Harman, *Prince of Networks*, 14.

[57] Harman, *Prince of Networks*, 15.

[58] Harman, *Prince of Networks*, 30.

[59] Harman, *Prince of Networks*, 113.

Latour's metaphysical account of actants. First, the notion of becoming requires an agency that is unlike the actant. Secondly, what exceeds an individual actant would be the body and its ability to potentialize space. Finally, Harman asserts his own philosophical treaties, and this is where I pick up the thread, "objects are not defined by their relations: instead they are what enter into relation in the first place, and their allies can never fully mine their ores."[60]

[60] Harman, *Prince of Networks*, 132.

III. Representation and Mediating Structure of the Apparatus

In this paper, simulations are prioritized as compatible to 'nature' in their capacity to model knowledge. Material bodies exist in substance, assuming that tactility and realness are attributed to physical objects, whereas intentional objects require an observer to think of the object for its substantiation. The duality that exists between these real and intentional objects is that the latter is considered phenomenal and sensual only in the thought of its intentionality. This work considers ways in which sensual objects can be considered both real and intentional. This section investigates how the problematic manifestation of these structures is predicated upon representationalism and the mediating structure of the apparatus.

Following readings by Karen Barad, this thesis understands the apparatus as a boundary-making practice that reconfigures an object's reality. Though there seems to be no compelling reason to argue for objectivity in epistemology, objects are defined as existing as autonomous units in an epistemological domain that rests on occasionalism. In turn, occasionalism is predicated upon the assumption of causality in a realm that establishes objects as thoroughly autonomous. Objects considered thoroughly autonomous are necessarily solipsistic. Occasionalism is a response to the problems of causality in a domain of purely autonomous objects, asking who is the actor? If objects were entirely autonomous, they would lack impetus required for causality. This is the framework by which digital objects are

interpreted by contemporary phenomenologists and are left both invalid and unreal.

III. A. Representationalism

There has been an ongoing debate about the role of representationalism in object ontologies. Representationalism is "the ontological distinction between representations and that which they purport to represent."[61] Scholarship on representationalism addresses semantic questions about the relationship between the referent and language, and in semiotics, between the sign and the signified. In semantic representation, the referent of an object is "the entity referred to or signified by a word or expression."[62] The way that a referent imparts knowledge is different than the object that represents it. Representation is considered to be a "mediating function."[63]

The purpose of semiotic theory is to define the process of sign-making and interpretation. Semiotics is a doctrine of signs developed by logician and philosopher, Charles Peirce. His theory of signs held that a sign "is something which stands to somebody for coming in some respect of capacity."[64] That is to say, each sign represents something, in fact three things: "the ground, the object

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[61] Karen Barad, *Meeting the Universe Halfway: Quantum Physics and the Entanglement of Matter and Meaning* (Durham: Duke University Press, 2007), 46.

[62] "referent, n. and adj.," *OED Online,* http://www.oed.com/view/Entry/160851?redirectedFrom=referent (Accessed February 18, 2016).

[63] Barad, *Meeting the Universe Halfway*, 47.

[64] Charles Sanders Peirce, and Justus Buchler. *Philosophical Writings of Peirce*. (New York, NY: Dover, 1955), 98.

and the interpretant."[65] Semiotic theory operates on the assumption that the phenomena can transfer meaning from one sign to another. Theorist Roland Barthes in *Elements of Semiology* (1964) defines the sign to be a "compound of a signifier and a signified."[66] Where the signified is a "mental representation of the 'thing'"[67]; "… the signifier: it is purely a *relatum,* whose definition cannot be separated from that it signifies. The only difference is that the signifier is a mediator: some matter is necessary to it."[68]

Representationalism is also discussed in terms of the duality of subject and object relations; does the object represent the referent (that is, the subject) in phenomenological experience, or in semiotics? The divide between subject and object is important in the discussion of digital objects, which have interiors and exteriors. Representationalism plays a variety of roles in understanding computational objects because the language has a visual representation; the referent and the representation are quite different, much in the same way the word "rock" is different than the object "rock."

The visual representation of a computational object is unlike its name; it is not a single predicate for the object. These visual representations and their referent—being computational code—are also enabled to replicate an object in the real word, convoluting the object's capacity for representing a real thing. I will

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[65] Peirce, and Buchler. *Philosophical Writings*, 99.

[66] Barthes, Roland. *Elements of Semiology,* 39.

[67] Barthes, Roland. *Elements of Semiology,* 42.

[68] Barthes, Roland. *Elements of Semiology,* 47.

further discuss these visual representations as graphic events. The epistemological understanding of modeling is discussed later, at length, in this chapter. That an object is said to represent another leads me to question its accuracy, truthfulness, and validity regarding its relationship to reality. The relationships that are being scrutinized in representationalism specific to the digital object are both semantic and ontological. Semantic representation is to say that meanings are represented by words. Specific to the digital object, the semantic representation is the object's relationship to code.

III. B. Referent Modeling

In this paper, I put forward the claim that representationalism is responsible for the dissonance and gap in referent modeling that occurs in simulation environments. In this study, the discussion centers on whether the target object is modeled with ontological forms, and how those forms are manifested in the simulation software. As Paul Fishwick explains, "the source object *models* the target, and so, modeling represents a relation between objects. Often, the source object is termed *the* model of the target."[69]

Paul Fishwick argues that the set of objects chosen to be a source object in model development must provide meaningful metaphors to the modeler to ensure the ease of comprehension of the design.[70] For example, the architectural model

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[69] Paul A. Fishwick, "3D Behavioral Model Design for Simulation and Software Engineering," in *On Web-based Models and Repositories,* eds. Fishwick, Paul A., and John F. Hopkins (Florida: University of Florida, 2001), 35.

[70] Fishwick, eds. *3D Behavioral Model Design,* 37.

was recommended as a meaningful visual metaphor in the development of computer programs. The dramatization of such metaphorical representation in computer language allowed for programming development to be increasingly transparent and accessible. Simulations history in metaphorical modeling reflects the epistemological intervention in this paper (where simulation is discussed as a tool for developing theory).

In this analysis, I ask: is representationalism responsible for dissonance in referent modeling? In the analysis on modeling and representation, simulation is prioritized. Simulation is "a false assumption or display, a surface resemblance or imitation, *of* something."[71] This definition discredits simulation's use in designing knowledge, as well as its capacity for demonstration; however, this definition is useful in considering ways in which distance between the target and model are considered false representation while still enabling the production and dissemination of knowledge. Representationalist ideas administer the assumption that what is false though justified, perhaps lacks credibility and subsequently degrade the transmission of knowledge through object modeling. Knowledge correlates by way of a faculty of understanding that perception has justifications of fact and truth.[72] This thesis utilizes fiction and metaphor to illustrate that simulations *falsities* prove to be powerful. Simulation helps to hypothesize possibilities and forecasts the futurity of innovative effects in an environment that

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[71] "simulation, n.". *OED Online.* http://www.oed.com/view/Entry/180009?redirectedFrom=simulation+ (Accessed February 18, 2016).

[72] "knowledge, n.". *OED Online.* http://www.oed.com/view/Entry/104170?rskey=osB80P&result=1&isAdvanced=false (Accessed February 18, 2016).

is constrained and contained fostering a 'safe' environment. It is the precise nature of simulation that theoretical developments cast progressive capacities for "progress and futurity are the achievement of difference, the capacity for techniques to achieve maximum difference."[73]

Simulation is considered a *virtual* reality. Reality itself is tied closely to representationalism and materialization—that is, what is real is material, and what is real can only be represented and never obtained. This is the understanding of both how we perceive objects and think about them. Simulation is a representation of reality. Reality underlies all appearance and phenomena, and it provides truth in its capacity to correspond to fact—and reality is abysmal.[74] The fissure between representation and reality is undertaken in correspondence theory: where the truth value of the correspondence between fact and reality does not exist between the representation-of-reality and reality, that is correspondence does not transfer. This fissure is the distance between that which is real, and that which is underneath and behind appearance and representation.

These correlations—between the object and its representation, and the model and its target—are evaluated to understand realism by correspondence theory. This theory that aims to determine the truth value of these relationships and define truth in itself. Correspondence theory holds that the definition of truth

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[73] Claire Colebrook. *Deleuze: A Guide for the Perplexed.* (London ; New York: Continuum, 2006), 110.

[74] "reality, n.". *OED Online*. http://www.oed.com/view/Entry/158934?redirectedFrom=reality (Accessed February 18, 2016).

is that "true propositions correspond to the facts."[75] The representations of objects and their correspondence to facts are appraised through validity. Validity is to be founded on fact, and related to the soundness and strength of an argument or proof.[76] Verification and validation are two modes of measurements to evaluate a simulation's capacity to represent its target model. These methods of simulation appraisal indicate the ideal of representationalism—that it is possible. We will now evaluate a different mode of understanding representations of objects: the apparatus. Through the apparatus, phenomena or appearance becomes an object—the referent itself. The problem with representationalism is its inescapability. Karen Barad's theory aims to dismantle representationalism through the apparatus, she asks: how has the apparatus reconfigured the reality of objects?

III. C. Mediating Structure of the Apparatus

Evidence for the apparatus is borne by social theorist and literary critic Michel Foucault in an interview in 1977:

> the nature of the apparatus is essentially strategic, which means that we are speaking about a certain manipulation of relations of forces, of a rational and concrete intervention in the relations of forces, either so as to develop them in a particular direction, or to block them, to stabilize them, and to utilize them. The apparatus is thus always inscribed into a play of power, but it is also always linked to certain limits of knowledge that arise from it and, to an equal degree, condition it. The apparatus is precisely

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[75] "correspondence, n.". *OED Online.* http://www.oed.com/view/Entry/41948?redirectedFrom=Correspondence+theory+ (Accessed February 18, 2016).

[76] "validity, n.". *OED Online.* http://www.oed.com/view/Entry/221195?redirectedFrom=Validity+ (Accessed February 18, 2016).

> this: a set of strategies of the relations of forces supporting, and supported by, certain types of knowledge.[77]

The apparatus is a mediating structure that highlights operability or disjunction between the model and the target. This study attempts to address the problems of the apparatus as reliant on an observer and as a means of description. Philosopher Giorgio Agamben, in *What is an Apparatus* (2009), examines the apparatus and its agency by tracing the etymology of the term through Michel Foucault and back to Jean Hyppolite's analysis of Georg Wilhelm Friedrich Hegel's interest in natural and positive religion: "to the dialectics of freedom and obligation, as well as of reason and history."[78] The apparatus is ontologically without being. It is a device and a process with its subject being a privation; it creates what it lacks. Privation is "the condition of being deprived of or lacking an attribute or quality formerly or properly possessed; (more generally) the loss or absence of a quality."[79] This historical linage moderates processes of subjectification. Agamben argues that only living substances can be determined or intercepted by the apparatus; this is denied by Barad's conception of the apparatus, where she would argue that all material has agency.

There are multiple processes of subjectification. Agamben criticizes the contemporary time as suffering from an extreme proliferation of these processes,

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[77] Michel Foucault cited by Agamben, *What Is an Apparatus?,* 5.

[78] Agamben, *What Is an Apparatus?,* 5.

[79] "privation, n.". *OED Online*. http://www.oed.com/view/Entry/140090?redirectedFrom=penetration+ (Accessed February 18, 2016).

calling every personal identity a masquerade.[80] Agamben's apparatus gains its agency in division between God and causality, between separating the living from the environment. Agency is depicted in this thesis where the simulation enacts divisions of the apparatus, separating the digital object and its environment. However, given that the apparatus always produces the subject, interiority, and alterity, do digital objects possess an interiority? I explore this question further in "Sensual Alterity."

The social theorist, Agamben view identifies three distinct features of the apparatus. First, the apparatus is linguistic and non-linguistic, including everything from discourse and institutions to roadways and buildings. Second, the apparatus is concretely strategic, and as such, it is located in a power relation. Finally, "it appears at the intersection of power relation and relations of knowledge."[81] The apparatus is a tool of epistemology,

Karen Barad, author of *Meeting the Universe Halfway: Quantum Physics and the Entanglement of Matter and Meaning* (2007) puts forth the view that "apparatuses are constituted through particular practices that are perpetually open to rearrangements, rearticulations, and other reworkings."[82] Barad's definition of the apparatus is expansive, including "material-discursive practice . . . they produce differences that matter—they are boundary-making practices."[83] The

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[80] Agamben, *What Is an Apparatus?,* 15.

[81] Agamben, *What Is an Apparatus?, 3*.

[82] Barad, *Meeting the Universe Halfway*, 170.

[83] Barad, *Meeting the Universe Halfway*, 146.

apparatus is more than an instrument of measurement and its capacity to reconfigure matter, and potentially, virtuality "result[s] in the production of new phenomena, and so on."[84] An apparatus is that which measures and acts as a discursive frame defining and reconfiguring objects in reality.

The apparatus is agentive in that it enacts the possibility or impossibilities of matter's reconfiguration.[85] The vitality and dynamics that Barad introduces speaks to the ways that intra-actions leave marks on bodies as agentive forces. The vitality of agency is not "designated as an attribute of subjects or objects"; rather, it is "*a matter of intra-acting; it is an enactment, not something that someone has or something does*. [sic] "[86]

In aiming to characterize the apparatus as Barad does, one can argue that the arena of observation in simulation becomes an object of observation. The analogy of a walking cane can be used to aid in environmental understanding, one uses the cane to explore nuances of the space they're in or it can be an object of inquiry, asking 'what is this walking cane'? Observation, then, problematizes the apparatus tool because it alters its capacity to measure its outcome. "Measurement can be said to express particular facts about that which is measured; that is, the measurement is a causal intra-action and not 'any old playing around.'"[87] Observation is more than simply experiencing an event; it specifically

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[84] Barad, *Meeting the Universe Halfway*, 171.

[85] Barad, *Meeting the Universe Halfway*, 177.

[86] Barad, *Meeting the Universe Halfway*, 178.

[87] Barad, *Meeting the Universe Halfway*, 140.

acknowledges causality in the discrimination and judgment of appearance and phenomenon. Observation becomes a gaze, and the gaze is a tool of subjectification. To portray the issue in Karen Barad's terms, "phenomena do not merely mark the epistemological inseparability of observer and observed, or the results of measurements; rather, phenomena are the ontologically inseparability/ entanglement of intra-acting 'agencies.'"[88] This will become the crux of my argument. This rejects the empiricist thinking of early modernists that frame the object as objective. Phenomena are entangled with the mark making apparatus.

American philosopher and logician Willard Quine associates observation with consciousness: "what to count as observation now can be settled in terms of the stimulation of sensory receptors, let consciousness fall where it may."[89] This definition from Quine opens the conversation to include other so-called sensory bodies for observation—and this can, one could argue, include the digital. The question of whether digital objects are sensory bodies has caused little debate in contemporary theory. A sensory body is simply one that "belong[s] to sensation."[90]

The underlying argument in favour of Barad's reconfiguration of the notion of the apparatus identifies that one can, without changing the simulation, and without changing the apparatus, produce new phenomena by changing what

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[88] Barad, *Meeting the Universe Halfway*, 139.

[89] W. V. Quine, "Epistemology Naturalized," in *Epistemology: An Anthology,* eds. Ernest Sosa, Jaegwon Kim, Jeremy Fantl, and Metthew McGrath (Malden; Oxford; Victoria: Blackwell Publishing, 2000), 534.

[90] "sensory, adj.". *OED Online*. http://www.oed.com/view/Entry/176012?rskey=zKcMtR&result=2&isAdvanced=false (Accessed February 18, 2016).

the apparatus is measuring. A phenomenon, such as the appearance of the colour red, was previously considered explicitly distinct from real objects; that is, a phenomenon was an object of immediacy understood through sensation and perception, thus producing a phenomenal object.[91] Now, with the reimagining of the boundary formation affected by the apparatus, Barad helps us to see phenomenon are "about specific material configurations of the world's becoming."[92] There is ample evidence to support of agential separability that by keeping all measurement assumptions the same, new material is produced.

For instance, modeling and knowledge become products of the apparatus responsible for the materialization of simulation, and thus the materialization of the simulated model. The simulation apparatus is hard to define because it is consider boundary-less; one can only characterize it by the qualities/marks produced. What constitutes the apparatus in the simulation interface is expounded in the section "Simulation as Apparatus," where the precession of the model and its capacity for optical consistency are examined. In addition, the section titled "Discursive Practice of Rasterization" establishes the computational process of rasterization and normals as "apparatuses [whose] specific material configurations, or rather, dynamic (re)configurings of the world through which

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[91] "phenomenon, n.". *OED Online*. http://www.oed.com/view/Entry/142352?redirectedFrom=Phenomena+ (Accessed February 18, 2016).

[92] Barad, *Meeting the Universe Halfway*, 91.

bodies are intra-actively materialized."[93] This line of argumentation illustrates the apparatus' capacity to reconfigure the reality of digital objects.

III. D. Privation of Boundaries

It is also important to note the role of boundaries—or lack thereof—in the apparatus. Boundaries demonstrate the limit or bounds of material and immaterial things; they "also [are] the limit itself."[94] The apparatus is not an instrument or artifact, because it lacks boundaries: "apparatuses are not bounded objects or structures; they are open-ended practices."[95] The structuring capacities of the apparatus, though definitive, "[focus] on the lack of an inherent distinction between measuring instrument and measured object."[96]

The boundaries of objects, specifically a class of objects known as "real" objects, have their roots in philosophy's theories of substance. Namely, through Rene Descartes' skeptical explorations in *Mediations on First Philosophy* (1641), we come to understand that boundaries are defined by the systematic removal of properties and descriptions. Properties are "an attribute, character or quality; . . . a characteristic which is peculiar to a particular kind of thing but is not part of its

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[93] Barad, *Meeting the Universe Halfway*, 170.

[94] "boundary, n.". *OED Online*. http://www.oed.com/view/Entry/22048?redirectedFrom=boundaries (Accessed February 18, 2016).

[95] Barad, *Meeting the Universe Halfway*, 170.

[96] Barad, *Meeting the Universe Halfway*, 142.

essence or definition."[97] What remains after the removal of all properties through skeptical deduction is a substance (matter) of extension—a materialism that is static and monolithic. Extension is the length, width, and thickness of matter in space. The boundaries of an object are thus defined by their capacity, not agency, to inform the taking of space.

The difference between real objects and digital objects is not as clear-cut as popular views of materialism might suggest. A digital object is not mutable or informed by substantiation (the process of being a substance)—as such, it is not considered an object of unified reality. Nor does it engage with the world in the manner I conceptualize that the physical object engages in, as physical objects' boundaries, inert and definitive, are considered restricted by natural law. Digital objects' boundaries rely upon the apparatus to be distinct and delineated from the environment and for their instantiation (quasi-substantiation) in code.

The forgoing discussion implies that boundaries created by the apparatus are divisions between objects and their environments. In the following, I will set up object-oriented ontology (OOO) theory that advocates for the autonomy of objects. When discussing the autonomy of objects, apropos to the suppositions asserted in Graham Harman's theories (to be discussed), I question if the restrictive domain of OOO affects one's understanding of digital objects as objective. This thesis then argues for a larger domain of inquiry for the

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[97] "property, n.". *OED Online.* http://www.oed.com/view/Entry/152674?rskey=vhPTHv&result=1 (Accessed February 18, 2016).

consideration and inclusion of digital objects into current object-oriented ontologies. And also for the expansion of scope as it effects the apparatus.

III. E. OOO Neighbourhood

OOO is popular in contemporary philosophy not only because of its "*political* thesis to the effect that all objects ought to be treated equally";[98] additionally, a central claim is the namesake of philosopher Levi R. Bryant's[99] *The Democracy of Objects*—the philosophy for the democracy of all objects. Bryant argues that "flat ontology refuses to privilege the subject-object, human-world relation as either a) a form of metaphysical relation different in kind from other relations between objects, and that b) refuses to treat the subject-object relation as implicitly included in every form of object-object relation."[100] OOO identifies an "object that is for-*itself* rather than an object that is an opposing pole before or in front of a subject."[101]

OOO is a "polarized" philosophy in which "objects exist as autonomous units, but they also exist in conjunction with their qualities, accidents, relations, and moments without being reducible to these."[102] There are four key tensions that Harman addresses in his metaphysical defence of objects; first is that objects

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[98] Levi R Bryant, *The Democracy of Objects.* (Ann Arbor, Mich: Open Humanities Press, 2011), 19.

[99] Collin College. Department of Philosophy.

[100] Bryant, *The Democracy of Objects,* 246.

[101] Bryant, *The Democracy of Objects,* 19.

[102] Graham Harman, *The Quadruple Object* (Winchester, U.K.: Zero Books, 2011), 156.

are not "derivative of a primal whole"; secondly, "objects are irreducible to their pieces and have a genuine emergent reality"; thirdly, "objects are irreducible to their appearance in human consciousness"; finally, "objects are irreducible to their relations with other things."[103]

While OOO helps us to see the tension in an object, it does a disservice in its conceptualization of the domain in which objects are situated. Again, in speculative realism, occasionalism is discussed as a mode to engage in object-to-object relations. Speculative realism is prefaced by three principles that are specific to object-oriented philosophy. First, philosophy ought not privilege types of objects. Second, "all contact between objects must be indirect or vicarious."[104] Finally, polarizing occurs between objects and qualities, as well as real and sensual objects. These speculative realism principles are confounded in the simulation case studies of this thesis because of the tensions between digital objects, and their internalism of code.

In other words, OOO presupposes objectivity meaning the impartiality of observation is required for the interaction of objects. Objects' autonomy is so thorough that it excludes their capacity to be actors upon other infinitely autonomous objects—hence, occasionalism. Moreover, there seems to be no compelling reason to argue for objectivity, regardless of the potential domain of virtuality for the object. Objectivity is "the quality or character of being objective;

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[103] Harman, *The Quadruple Object,* 187.

[104] Graham Harman "The Third Table =: Der Dritte Tisch," in *100 Notes - 100 Thoughts, Documenta (13)*, ed. Carolyn Christov-Bakargiev (Ostfildern: Hatje Cantz, 2012), 4.

esp. the ability to consider or represent facts, information, etc., without being influenced by personal feelings or opinions; impartiality."[105] Objectivity has been criticized by feminist scholars for bias of impartiality. Feminist philosopher Lousie M. Antony[106], in "Quine as Feminist: The Radical Import of Naturalized Epistemology," expresses that "the conception of objectivity that is ultimately the object of radical critique—perfect impartiality—is only supportable as an epistemic ideal on an empiricist conception of *mind*."[107] Some feminist scientists disagree, and I think Barad would concur that the acceptance of this ideal begins with faith in the efficacy of "existing methodological norms of science."[108] Barad concludes that "objectivity cannot be about producing undistorted representations from afar; rather, objectivity is about being accountable to the specificity of materialization of which we are a part."[109]

The main theoretical premise behind object-oriented philosophy rests on externalist theories. This view holds that the truth conditions of a proposition are dependent upon justified evidence in the external world. Joe Lau[110] and Max Deutsch[111] describe "externalism with regard to mental content says that in order

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[105] "objectivity, n.". *OED Online*. http://www.oed.com/view/Entry/130119?redirectedFrom=occasionalism+ (Accessed February 18, 2016).

[106] UMassAmherst. Department of Philosophy.

[107] Louise M. Antony, "Quine as Feminist: The Radical Import of Naturalized Epistemology" in *Epistemology: An Anthology,* eds. Ernest Sosa, Jaegwon Kim, Jeremy Fantl, and Metthew McGrath (Malden; Oxford; Victoria: Blackwell Publishing, 2000), 559.

[108] Antony, *Quine as Feminist,* 558.

[109] Barad, *Meeting the Universe Halfway*, 91.

[110] University of Hong Kong. Philosophy Department.

[111] University of Hong Kong. Philosophy Department.

to have certain types of intentional mental states (e.g. beliefs), it is necessary to be related to the environment in the right way."[112] The "right way" is an argued tradition; be it through empiricism or idealism, "knowledge is then achieved, it appears, not by active engagement with one's world . . . but by the pristine transcendence of the messy contingencies of the human condition."[113]

III. F. Consequence for Digital Objects

I will now summarize the ground covered in this section by addressing how these frameworks justify the static and immutable definition of objects. I have shown representationalism as responsible for dissonance between object and model. This hypothesis infers that digital objects are unreal and invalid, premised on the discontinuity brought by representationalism. The externalism requirement of an observer for the objectivity of digital objects necessitates the digital object's status as unreal. In an effort to communicate digital objects' autonomy, I suggest that the apparatus fulfills the role of observer, instantiating attributes/marks upon the digital body that exist without the necessity of a human observer. Establishing the digital object as an object ought to be considered in popular object-oriented ontologies.

These operative frameworks that define objects leave the simulated object as no more than a metaphor. Metaphors "make us attend to some links, often

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[112] Joe Lau and Max Deutsch, "Externalism About Mental Content," *The Stanford Encyclopedia of Philosophy (Summer 2014 Edition)*, Edward N. Zalta (ed.), URL = <http://plato.stanford.edu/archives/sum2014/entries/content-externalism/>. (January 22, 2016)

[113] Antony, *Quine as Feminist,* 560.

novel or surprising likeness, between two or more things."[114] Metaphors extend the original meaning in some manner that is unique, or metaphorical—"there is no similarity to seek because it consists simply in being referred to by the same word."[115] If objects are invalid and unverified, and metaphor is yet another representationalist ideal, then this has allowed us to discuss digital objects in a meaningful manner that take into account the links between digital and physical objects.

This constructs simulation as a thing lacking a practice for measuring the validity of the target object (produced) and the modeled object (referent). There is a representationalist problem with the justification between the model of the physical world and the simulation program. This comparison of semantics and physical objects, supports digital objects as being in-between material objects (with similar objectness and epistemological frameworks for understanding them) as well as in-between intentional objects, which require an observer. The intentionality of objecthood is a product of Descartes' *Meditations*, where the subject is separated from the body. This is compounded by the notion of the apparatus as always producing an interiority or subject through its agentive action. These forces of objectness through the division of form and matter, produce intentionality of a digital object; first from our epistemological understanding of

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[114] Donald Davidson, "What Metaphors Mean," *Critical Inquiry 5 (1)*. University of Chicago Press: 31–47. http://www.jstor.org/stable/1342976. (March 22, 2016)

[115] Davidson, *What Metaphors Mean,* 37.

objects being inherently exterior. What I argue is that a digital object is somewhere in-between intentional and real.

Further, the ways in which these digital or real and substantial objects relate to one another within closed arenas of reality—be these causal or phenomenal domain—the ways in which they remain meaningless, as they are separated from signification, and separated from the world.

IV. Applied Assemblage

IV. A. Agential Separability

In Barad's *Meeting the Universe Halfway: Quantum Physics and the Entanglement of Matter and Meaning* (2007) discussion of the posthuman, she makes it apparent that epistemologies are anchored in the measure of man, and it is suggested that formal and natural ontologies can extend beyond the necessity of a human cognizer. What a posthumanist performative approaches diverts attention from the "correspondence between description and reality . . . to matters of practices, doings, and actions."[116] This is useful to my understanding of objects because the attention is not correspondence of truth values, rather the process by which objects are understood to relate. The predicate of truth is removed as a redundancy.

The main theoretic premise behind Barad's chaotic/entanglements is the universal concept. The universe is "all existing matter, space, time, energy, etc., regarded collectively, esp. as constituting a systematic or ordered whole; the whole of creation, the cosmos; the totality of things under."[117] This universal concept has been addressed in speculative realism, and in the occasionalist accounts required in object-oriented ontologies. The space of simulation can be viewed as similar to the idea of an atomistic space—points in space and time. Each point is situated in a coordinate system that corresponds to width and depth.

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[116] Barad, *Meeting the Universe Halfway*, 135.

[117] "universe, n.". *OED Online*. http://www.oed.com/view/Entry/214800?redirectedFrom=universe (Accessed February 18, 2016).

The data yielded by Barad's study indicates that the domain is much larger—in fact, it is infinite.

The key tool that Barad offers is agential separability. This relates to the agent and its agency, as well as the empirical matter that is being configured. Barad describes a dynamism of the reconfiguration of phenomena as agency—agency is not an attribute. The tangential cut problematically separates subject and object, which she refers to as agential separability; it is required for the possibility of objectivity in science practices, for example.[118] As Barad states, "a condition for objective knowledge is that the referent is a phenomenon."[119]

Barad developed a claim that agential separability is a mode or performance in which the "apparatuses enact agential cuts that produce determinate boundaries and properties of 'entities' within phenomena, where 'phenomena' are the ontological inseparability of agentially intra-acting components."[120] The phenomena then, are inseparable from both the boundaries determined by the cut, but also from the intra-acting (causal) components them selves. Agential separability is "the condition of *exteriority-within-phenomena*."[121] It is important to note that the phenomena, though objective given its exteriority, are not "objects-in-themselves"; rather, they are intra-actions.

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[118] Barad, *Meeting the Universe Halfway*, 140.

[119] Barad, *Meeting the Universe Halfway*, 120.

[120] Barad, *Meeting the Universe Halfway*, 148.

[121] Barad, *Meeting the Universe Halfway*, 140.

Intra-action "*signifies the mutual constitution of entangled agencies*."[122] Entanglements are in a manner the way particles correlate, yet this term is specific to quantum physics where "*they specify a feature of particle behaviour for which there is no classical physics equivalent*."[123] In this way, the empirical objective referent is phenomena. [124]

Barad puts forth the claim that "apparatuses are not bounded objects or structures; they are open-ended practices."[125] The reconfiguring of the world continues without end; "matter's dynamism is inexhaustible, exuberant, and prolific."[126] This quotation follows Barad's definition of apparatus as a practice empowered with causation to which matter is articulated via differentiation, reconfiguring a "field of possibilities" in an ongoing movement of agency.[127] Barad defines: "apparatuses provide the conditions for the possibility of determinate boundaries and properties of 'objects' within phenomena, where '*phenomena' are the ontological inseparability of objects and apparatuses* [sic]."[128] The apparatus is both the potentiality of and inseparable from phenomenal intra-actions. The boundaries of an object are inseparable from the apparatus responsible for its cut.

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[122] Barad, *Meeting the Universe Halfway*, 33.

[123] Barad, *Meeting the Universe Halfway,* 270.

[124] Barad, *Meeting the Universe Halfway*, 152.

[125] Barad, *Meeting the Universe Halfway,* 170.

[126] Barad, *Meeting the Universe Halfway*, 170.

[127] Barad, *Meeting the Universe Halfway*, 170.

[128] Barad, *Meeting the Universe Halfway*, 128.

The domain of possibility for the reality of objectness is not determinate for Barad, as her theory reconfigures entirely the common understanding of causality. Where OOO requires an account of occasionalism to account for the incapacity of objects to be causal actors based on their autonomous definition, Barad enacts objectivity and causality through the agentive intra-actions. Previously held conceptions of the boundaries of objects are enmeshed in substantiation via extension; Barad's causality allows for phenomenal entities as bounded in themselves. It is not a specific entity that marks an "effect" on an object; rather, the marks are "said to constitute a measurement of specific features of the object (the cause)."[129] Again, measurements are intra-active mark-making actants; "either way, what is important about causal intra-actions is that 'marks are left on bodies.'"[130] In the next section, I will introduce the argument for assessing these bodies as sensual.

IV. B. The Sensible Object

A guiding research objective for this thesis led me to assemble the ways in which contemporary theory produced sensible qualities in digital objects. I assert that practical sensation is different from the sensible objects proposed here after that I am attempting to illuminate. Theorist Elizabeth Grosz[131] in *Chaos, Territory, Art: Deleuze and the Framing of the Earth*, draws from philosophers

[129] Barad, *Meeting the Universe Halfway*, 176.

[130] Barad, *Meeting the Universe Halfway*, 176.

[131] Duke University. Women's Studies.

Gilles Deleuze and Felix Guattari, outlining important distinctions between the aesthetics and affective and phenomenological uses for our productions of art. What is proposed is an account of sensation as a body of artwork, arguing that sensation is not in the receiver; rather, that "sensation draws us, living beings of all kinds, into the artwork in a strange becoming in which the living being emptied itself of its interior to be filled with the sensation of that work alone."[132] Here, the relation of practical sensation is still implied; however, I would like to consider this relation of sensual becoming posited by Grosz to include all bodies, specifically digital object bodies, whose interior is emptied and becomes a body in becoming sensation.

Perception is defined as a "bodily relation between states of things and subjects."[133] Affect for Grosz is tied to the materiality of the human body, and that affect is the calling or coming to know the animal urgency of sensation. Yet, Claire Colebrook[134] expounded Deleuze's conception of sensation in *Deleuze: A Guide for the Perplexed* (2006) by stating that

> percepts and affects are *not* continuous with life and are not effects of a synthetic activity of consciousness. Affects and percepts stand alone and bear an autonomy that undoes any supposed independence of self-constituting consciousness: "we attain to the percept and the affect only as to autonomous and sufficient beings that no longer owe anything to those who experience them or who have experienced them."[3][135]

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[132] E. A. Grosz, *Chaos, Territory, Art: Deleuze and the Framing of the Earth* (New York: Columbia University Press, 2008), 74.

[133] Grosz, *Chaos, Territory, Art*, 78.

[134] PennState College of the Liberal Arts. Contemporary Literature. Theory and Cultural Studies. Visual Culture.

[135] Colebrook, *Deleuze: A Guide for the Perplexed,* 94. Citing Deleuze and Guattari from *What Is Philosophy?* (1994).

Grosz describes sensation as "the zone of indeterminacy between subject and object, the bloc that erupts from the encounter of the one with the other."[136] Thus, sensation is separate from the bodily experience of affect and percepts and "requires no mediation or translation. It is not representation, sign, symbol, but force, energy, rhythm, resonance."[137] This description of sensation is useful in my attempt to define sensation as being something that is autonomous and outside of the relationality of human perception. The definition of sensation I have provided takes it a step further by distancing itself from understanding as a representational process. The next section specifically describes the sensible object as something more than representing a real object.

There is rapidly growing literature on object-oriented ontology, which indicates a revival of interest of metaphysical object ontologies. Graham Harman composes complexity in (2011) on the ontology of objects when he uncovers, with polarizing clarity, the tensions of real and sensual objects: "What formal ontology is concerned in is not so much the bare existence of certain individuals, but rather the rigorous description of their *forms*."[138] Real objects endure "having an objective existence; actually existing physically as a thing, substantial; not

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[136] Colebrook, *Deleuze: A Guide for the Perplexed,* 73.

[137] Colebrook, *Deleuze: A Guide for the Perplexed,* 73.

[138] Nicola Guarino, "Formal Ontology, Conceptual Analysis and Knowledge Representation," *Int. J. Human-Computer Studies,* 43, (1995): 628.

imaginary."[139] The substantial qualifier of extension in turn will be refuted, as objects are made composite through Harman's ontology. Real objects are said to withdraw from access—Heidegger calls this "veiled," Husserl calls this "hidden"—whereas sensual objects are available for presence, appearance, and experience, Harman's sensual objects are considerably more than phenomenal appearance. Appearances can be removed from sensual objects, indicating that they are more than the sum of their parts, and thus uncovering a real sensual object as different from its sensual qualities. Harman's central argument is premised on the assumption that "objects [exist] in their own right, as autonomous from their relations with other things."[140] As such, the definition of an object is not a bundle of descriptions situated by way of relations; "objects need not be natural, simple, or indestructible. Instead, objects will be defined only by their autonomous reality."[141] This is a striking contrast from the historical understanding of the indivisibility of substances by way of Aristotle.

I am hypothesizing the separation of sensual and intentional objects. "In all phenomenal experience, there is a tension between sensual objects and their sensual qualities."[142] The sensual object is modeled after Husserl's intentional object—with notable exceptions. An intentional object "pertain[s] to the

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[139] "real, adj.2, n.2, and adv.". *OED Online*. http://www.oed.com/view/Entry/158926?rskey=VbNNAB&result=3 (Accessed February 18, 2016).

[140] Graham Harman, *The Quadruple Object* (Winchester, U.K.: Zero Books, 2011), 69.

[141] Harman, *The Quadruple Object,* 19.

[142] Harman, *The Quadruple Object,* 26.

operations of the mind; mental; existing in or for the mind."[143] The intentional object is a form of thought whose attributes or phenomenal expression exist without coherence of the natural/real world. Yet, these "intentional species, appearances or images [are] supposed to be emitted by material objects so as to strike the senses and produce sensation."[144] These representations are presentations of something.

I am calling upon the theories of Graham Harman and his analysis of Heidegger's objects to develop evidence for the sensual digital object theory. Heidegger's real objects are expounded in Harman's analysis, the central claim is that "entities withdraw into a silent underground while also exposing themselves to presence"[145]—here, the significance is indicating that a real object cannot be known empirically, rather only the phenomenal appearance or 'presence' of an object is revealed. This quotation articulates the polarizing of real qualities and sensual qualities in order to separate an object from its phenomenal properties. Sensual objects are available to consciousness, but with a caveat: they are not dependently known by consciousness. The system by which the object is constructed operates on the notion that objects are autonomous. The object that is proposed by Heidegger is a sensual object which upon Harman expands.

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[143] "intentional, adj. and n.". *OED Online*. http://www.oed.com/view/Entry/97494?redirectedFrom=intentional+ (Accessed February 18, 2016).

[144] "intentional, adj. and n.". *OED Online*. http://www.oed.com/view/Entry/97494?redirectedFrom=intentional+ (Accessed February 18, 2016).

[145] Harman, *The Quadruple Object,* 39.

The relationship between objects is sensual because, although it is not entirely mind-independent, it requires other relationality for its presence to be known. How I've altered this conception is to include Barad's notion that phenomena are objects. Objectivity relates to a phenomenal object. Sensual objects are objectivity, because of their impartiality, and to reiterate Quine's claim that empirical evidence—scientific evidence—is sensual. It is precisely the case that the determination and requirement of an observer is not necessary for a sensual object. According to Harman, the sensual object doesn't retreat from—rather, it presents or announces. It is in the unveiling, in its presence of exteriority that an object can be said to be sensual. Real objects' exteriority cannot be known regardless of the type of knower it is, independent of that relationship—in this place, one can question if internal/external discussion pertains to real objects.

The method that Harman uses to differentiate a sensual object from an intentional object is reductive reasoning; he recognizes sensual objects as being more (or less, but other) than the sum of their qualities. This skeptical reduction alerts his focus to tensions that exist in the sensual object between their sensual or accidental and real or essential qualities.[146] The divergence is that accidental qualities lie directly before an observer, and essential qualities do not.[147] These sensual and accidental qualities "shift . . . nearly at will without affecting the character of the object."[148] However, essential qualities are *eidetic* qualities, and

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[146] Harman, *The Quadruple Object,* 26.

[147] Harman, *The Quadruple Object,* 27.

[148] Harman, *The Quadruple Object,* 26.

they do not lie "before us in experience."[149] These *eidetic* features cannot be made present via intuition or intellect. Eidetic features are the real qualities of sensual objects. These real qualities, like objects veiled within Heidegger's philosophy, can only be "inferred indirectly rather than witnessed."[150] This means that objects by this reading require a human cognizer for their reality. These tensions surpass the substantial materialization and the antiquated notion of object singularity; here we can realize the phenomenal existence of objects without reliance on causally.

This section introduced the tangential cut of agential separability by Karen Barad as a methodology for this discourse. It is a mode or a performance that is the metaphysical operant for "exteriority with-in phenomena." The apparatus is characterized as a practice empowered with causation. The objects for which these tools will be employed are products of Graham Harman's Q*uadruple Object*—a speculative realist project that polarizes real objects adjacent sensual objects—it is by way of praxis that these real objects are made objects of presence. These working definitions of objects, tensions, and qualities will be mapped upon digital objects in an effort to discover and diagram areas of cohesion and dissonance. Through out this analysis, I will argue for the presence of sensual boundaries of digital objects. This thesis employs the method of agential separability coupled with the analyses of digital objects as neither within nor without the digital

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[149] Harman, *The Quadruple Object,* 27.

[150] Harman, *The Quadruple Object,* 29.

environment, but differentiated from it, in order to argue that agential separability creates sensual boundaries within the simulation.

IV. C. Epistemological Intervention

In order to exemplify phenomenal boundaries in simulation systems, I answer the call of writer and philosopher Brian Massumi[151] to contort scientific experimentation. While there may be dissenters to this view among the digital humanities discipline, for discussion, I contend that the humanities' adoption of the scientific systems is of a "piece-meal" approach.[152] This scientific piece-meal is leveraged against the humanities by Brian Massumi in *Parables for the Virtual* (2002) suggesting:

> they will isolate an attractive scientific or mathematical concept and add it to the repertoire of their own disciplinary system like an exotic pet. Scientists might rightly object that the concept has ceased to have anything remotely scientific about it and is just functioning as a metaphor . . . where it suffers an exemplary kind of creative violence.[153]

Simulation environments allow theorists to examine, predict, and dramatize their hypotheses and subsequent consequences outside of the "real world." When modeling for an exploratory use, there is purpose and creation—it is the model for the future. The model represents a likeness, or rather, it provides a mode for interpretation. Simulation as a method of intervention and theory construction,

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[151] Université de Montréal. Department of Communication.

[152] Brian Massumi, *Parables for the Virtual: Movement, Affect, Sensation (*Durham, NC: Duke University Press, 2002), 19.

[153] Massumi, *Parables for the Virtual*, 19-20.

becomes a fiction—"we may come to see a pattern in the facts through the lens that a fiction supplies."[154] Epistemologist Catherine Elgin[155], examines the models of truth in epistemological inquires, concluding that "felicitous falsehoods configure a domain, enabling us to characterize the phenomena in what that would otherwise be unavailable."[156] That is to say that simulation, as previously defined, pertains to a falsity or appearance, but these phenomena would otherwise be unavailable. The manner in which the phenomenon of simulation experimentation is not impervious to its innovative history, namely, in the use of simulation in the scientific modeling of biological molecules and nuclear energy; some environments are too precious—and most are too complex—to construct experiments in.

I will use simulation to map theory to its particular features and assumptions of observable phenomena. Jason P. Davis[157], Kathleen M. Eisenhardt[158], and Christopher B. Bingham[159] outline how one can define the logic and assumptions of theories and alter variables in *Developing Theory through Simulation Methods* (2007). Davis et al has argued that one could take a simple theory, define its constructs, and link it throughout the simulation while ensuring

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[154] Catherine Z. Elgin, "True Enough," in *Epistemology: An Anthology,* eds. Ernest Sosa, Jaegwon Kim, Jeremy Fantl, and Metthew McGrath (Malden; Oxford; Victoria: Blackwell Publishing, 2000), 513.

[155] Harvard University. Graduate School of Education.

[156] Catherine Z. Elgin, *True Enough*, 517.

[157] Massachusetts Institute of Technology. Sloan School of Management.

[158] Stanford. Management Science and Engineering.

[159] UNC Kenan-Flagler Business School. Strategy and Entrepreneurship.

to meaningfully represent the descriptions of objects inherent in the simulation; in other words, creating computational representations is how one utilizes simulation in theory development.

This thesis takes aforementioned considerations of the theory of objects and links them in a straightforward way, using the constructs and descriptions of objects upon their simulated twins: digital objects. It is based on Lucy Suchman's view of self-explanatory artifacts. As she argues, "the degree to which an artifact is self-explanatory is just the extent to which someone examining the artifact is able to reconstruct the *designer's intentions* regarding its use,"[160] the "intentions" being that the digital object is modeled from a physical object. Davis et al (2007) provides a roadmap for theoretical development by defining activities used to create computational representation that "operationalize[s] theoretical constructs" and to conduct "robustness checks of computational representation."[161] In other words, "the software code should embody the theoretical logic,"[162] and this lens is applied to *breve*. Davis et al argues that "overall, the key point of verification is to ensure that the computational representation accurately represents the underlying theoretical logic."[163] In the section, "Digital Object Architecture," I provide a description of the digital object as an enumerative effort to confirm the accuracy

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[160] Lucille Alice Suchman, *Human-Machine Reconfigurations: Plans and Situated Actions.* (Cambridge ; New York: Cambridge University Press, 2007), 43.

[161] Davis, Jason P., Kathleen M. Eisenhardt and Christopher B. Bingham. "Developing Theory through Simulation Methods." *Academy of Management Review* 32, no. 2 (2007): 482

[162] Davis et al., *Developing Theory through Simulation Methods,* 491.

[163] Davis et al., *Developing Theory through Simulation Methods,* 492.

and internal validity of the theories herewith chosen to fit the simulation environment and approach that is broadly embodied in *breve*.

The research questions proposed in the case studies were intended to analyze the simple processes, performances, or phenomena according to the systems modeled in the simulation.[164] This thesis simulation approach explores case studies that operate through "NK fitness landscapes," "genetic algorithms," and in one instance, "cellular automata."[165] Each of these processes will be unpacked in the case studies section of the thesis. Experimentation in simulation through theory occurs in four ways according to Davis et al: first they suggest "varying the value of constructs that were held constant in the initial simple theory";[166] secondly, "*unpacking* key theoretical constructs . . . breaking a single construct into constituent component constructs";[167] thirdly, "*varying assumptions*";[168] and finally, *"adding new features* to the computational representation."[169] "Experimentation is closely associated with building theory using "disciplined imagination."[170]

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[164] Davis et al., *Developing Theory through Simulation Methods,* 485.

[165] Davis et al., *Developing Theory through Simulation Methods,* 487-488.

[166] Davis et al., *Developing Theory through Simulation Methods,* 493.

[167] Davis et al., *Developing Theory through Simulation Methods,* 493.

[168] Davis et al., *Developing Theory through Simulation Methods,* 493.

[169] Davis et al., *Developing Theory through Simulation Methods,* 493.

[170] Davis et al., *Developing Theory through Simulation Methods,* 494. Citing Weick from *Theory Construction as Disciplined Imagination,* 1989.

From here, I appease Massumi's call for action: I attempt to poach from science, while betraying its system of design.[171] The most routine access to simulation is through the graphical events on the computer screen. Nevertheless, rational access is available through a variety of data outputs. I will address select back-end ontological components of digital objects such as the role of code; however, mostly I access *breve* demonstrations via the screen.

IV. D. Simulation as Apparatus

I will look at the precession of models and optical consistency within simulation as a demonstration of the apparatus. A simulation provides the reconstruction of target objects into a simulated or virtual space. In *Simulacra and Simulation* (1981), postmodern thinker Jean Baudrillard outlines the quest for the real as a fallout of representationalism. Baudrillard identifies that "simulation is characterized by a *precession of the model*."[172] What Baudrillard is suggesting in his characterization is that the model supplants reality. Simulation requires two models: the target object and the world frame. Both validity and justification principles are applied to the ways that these models are said to refer. Just the same, simulation implements a world frame that is a structured domain in which digital objects are enframed.

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[171] Massumi, *Parables for the Virtual*, 20.

[172] Jean Baudrillard, *Simulacra and Simulation* (Ann Arbor: University of Michigan Press, 1994), 16.

In order to emphasize the powerful perspective simulation affords us, I refer to Bruno Latour (1986) who generalizes that powerful explanations of science are efficient. The instruments, literature, and all scholastic achievements have end results in common: inscriptions, i.e., graphs or diagrams. An attribute of inscriptions is the "keeping in place" of both "scientific methods" and "world views."[173] A key issue in Latour's description of inscription is the role of optical consistency. Optical consistency allows for accounts of variance in perspective and changes in spatial location while not changing the model. For simulation, the access point for observation requires a different perspective from the world frame being modeled. Importantly, this transition in perspective for it to be successful must ensure that the rotation and accession through different positions does not change the properties of the object. If this were to occur, the transmission of knowledge would be unobtainable. Optical consistency sustained by inscription is a component apparatus for objectivity, and it's why we privilege sight.

This notion of optical constancy could possibly clarify how the observational entry point is static (screen) and different from the way the object is framed within the simulation. That is to say the orientation of the world frame, the object frame, and the frame of access are all different. Simulation accommodates the sought-after Archimedean point sought after by viewers by leveraging their access outside of the world frame. Using Barad's terms, we can imagine this line to be a cut that is employed by the apparatus, that illustrates the "inseparability of

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[173] Bruno Latour, "Visualisation and Cognition: Drawing Things Together," *Knowledge and Society Studies in the Sociology of Culture Past and Present* 6 (1986): 3

observer and observed."[174] This unique observational viewpoint allows observers to step out of their inescapable world frame. ""Give me a place to stand," Archimedes is said to have promised, "and I will move the world."" [175]

[174] Barad, *Meeting the Universe Halfway*, 139.

[175] Judson Knight, "Archimedes and the Simple Machines That Moved the World," *Gale Virtual Reference Library.* Science and Its Times, Ed. Neil Schlager and Josh Lauer. Vol. 1: 2,000 B.C. to A.D. 699. Detroit: Gale, 2001, 363-365. Web. http://ezproxy-library.ocad.ca/login?URL=http://go.galegroup.com/ps/i.do?id=GALE%7CCX3408500380&sid=summon&v=2.1&u=toro37158&it=r&p=GVRL&sw=w&asid=ae8081ac9b791f2e40e1d0ca4ec109bb (Accessed February 22 2016).

V. Biography of Breve

I will be examining the simulation software called *breve* because of its behaviour-rich simulation and focus on object oriented collaboration. While researching foundational computer aesthetics, I looked to artists who wrote programs and designed utilities for graphic representations that contributed significantly to the ways algorithms build images; two key figures were digital art pioneer Manfred Mohr and computer graphics artist and researcher Karl Sims. *Breve* replicates the walking behaviours of the multi-body creatures first executed by Karl Sims in his seminal release *Evolved Virtual Creatures* (1994). *Breve* is one of six or so popular agent-based modeling systems of its time (StarLogo, Repast, MASON, Swarm, Digital Spaces, and Framsticks) and is no longer being debugged or maintained by its makers.[176] In fact, one is hard-pressed to find a downloadable and executable file, and most of the support documentation for *breve* is no longer searchable. While the question is outside of the scope of this work, one can wonder which of these lost software are preserved and why, and with what value are computational objects chosen to be resurrected?

Artificial intelligence researcher Jon Klein designed *breve* at MIT in 2002, as an open-source, multi-agent simulation software for decentralized systems and artificial life. To introduce *breve*, I will be performing a cognitive walkthrough by running demonstrations to provide a user-focused descriptive analysis of some of the simulation's capabilities and the interfaces. Given that my computer

[176] Jon Klein and Lee Spector, "3D Multi-Agent Simulations in the Breve Simulation Environment," *Artificial Life Models in Software*, edited by Maciej Komosinski and Andrew Adamatzky (2009): 84.

programming skills are still growing, I view the environmental affordances as key components that help me understand how *breve* invites users to make objects and how on can understand objets made as sensual.

breve's underlying programming language operates with Python, C++, and Steve. Despite the complexity of these languages, *breve*'s design mandate created the application to be approachable for those whom do not possess programming literacy. Such affordances allow the interface to be user-friendly yet also transparent for those who code by allowing access to the command screen. *breve,* like many computer programs, transposes and adopts English vocabulary for descriptions and functions. For example, when describing a virtual stage, or hyperplane, the program uses theatre terminology, including "actors," "scripts," and "scenes." This is significant, demonstrating the platform's reliance on metaphor for the development of programs and visualizations.

The software's desktop environment opens three windows: a graphics window, text terminal, and dialogue box. The main menu bar hosts the usual suspects: file, edit, demos, font, window, tools, speed, simulation, and help. The graphic window is black and displays a toolbar; rotate, zoom, move, and select are buttons for altering the cursor mode. To the right, users find a stop and play button, and finally, a scroll bar listing the text terminal names of programs available to run. The text terminal window's title bar displays the title of the programmed demonstration to be ran, and users have the option of choosing a portion of code according to a "go to line" or to select via method. The third and

final screen appears when a program is selected to run, and here an output log is recorded. This window is where error messages inform the user of problems with the simulation code. In some manner, this interface responds to the nature of the simulation being developed for programmers—it is still available as a back-end as opposed to the black box intuitive interfaces of today.

This thesis draws on the analysis of syntheses between the graphical event of the digital object and construction of digital objects in juxtaposition with the object ontologies of contemporary and traditional philosophies. The thesis explores demonstration files available in *breve* by illustrating areas in which the computational representation embodies the theoretical logic of sensual exteriority.

The demonstrations are ready-made simulations that will act by giving explanation and fostering understanding by way of example.[177] In the course of this study, I will examine a variety of programming examples in the section on "Sensual Alterity." One demo explores object construction through a static simulation of joint-type demonstrations, exemplifying how objects are composited. Additionally, *creatures* is a multi-body simulation demonstration illustrating emergent walking behaviours. These digital objects are class described as multi-bodies and are constructed of multiple objects. Plus, there are two swarming demonstrations that emphasize complex behaviours appearing as a gestalt gesture of individual particles. The swarming demonstrations will be specifically useful in describing important collisions and neighbour detection

[177] "demonstration, n.," *OED Online*. http://www.oed.com/view/Entry/49841?redirectedFrom=demonstration (Accessed February 18, 2016).

methods. Each of these demonstrations has a yellow star marked with the word "start"—perhaps at the centre of the simulation—which situates the place in which users or digital objects begin their competitions.

Stable conceptual space is useful for the user's acquisition of knowledge, which is a simulation's ultimate purpose. The containment provided by this space is necessary for the digital object to persist. The simulation environment is constructed with representations of the physicalities that occur in our natural world. Natural laws like gravity and viscosity exist as ready-mades in the simulation environment, however, these 'laws' can be violated. The base of the visualization of the simulation has a ground whose rigidity can be challenged by users—objects can be pulled through, indicating the malleability of these simulated, environmental laws. Under the simulations menu, one can select alterations for many demonstrations; for example, "gravity" has four selections: soft, hard, double, or no gravity. Amusingly, the "no gravity" environment is not exclusive to viscosity, and as such, the walking multi-bodies of *creatures* learn to swim. The coordinates of this space are finite, much like an aquarium, and in the distance a horizon line is met by flat mirages of distant mountains.

Dirk Helbing[178] and Stefano Balietti[179] argue (2011) that agent-based simulations are suitable for detailed hypothesis testing. This work identifies agent-based modeling as suited to modeling social mechanisms of humans. Behaviours

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[178] ETH Zurich. Department of Humanities, Social and Political Sciences.

[179] Postdoc at Northeastern Network Science Institute.

and properties are represented in an agent via rules, and these are not limited to: "birth, eating and reproduction, individual needs of resources, competition and fighting ability, perception, curiosity, exploration behaviour, ability for innovation, emotions . . . communication . . . [and] the tendency to have relationships with other agents."[180] *breve* is used to simulate complex social systems, particle systems, 3D imports, and evolved fitness creatures. This simulation software has additional uses, "including physically simulated evolving creatures [11], evolving ecologies [10], swarm robotics [6, 42], artificial intelligence applied to homeland security applications [43], simulations of sorting behaviours in ants [5], cognitive science research [4], and self-assembly in physical systems [2].[181]

V. A. Digital Object Architecture

I am interested in whether the ontological requirements of physical objects can be exhibited in the architectural forms of digital objects? Through my inquiry of *breve*s' apparatus of simulation, as explicated, I will illustrate the boundaries it constructs as properties of digital objects.

The issue of whether or not contemporary theory can produce sensual boundaries in simulation is clouded by our mainstream understanding of the ontology of digital objects and their epistemological frameworks in which we come to understand them. Ontology is "the science or study of being; that branch

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[180] Dirk Helbing and Stefano Balietti. *How To Do Agent-Based Simulations in the Future: From Modeling Social Mechanisms to Emergent Phenomena and Interactive Systems Design* (Santa Fe: Santa Fe Institute, 2011), 2.

[181] Klein and Spector, *3D Multi-Agent Simulations,* 96. [11] Lassabe, [10] Kriplean, [6] Hamann, [42] Szymansko, [43] Veeraswamy, [5] Don, [4] Cohen, [2] Bhalla.

of metaphysics concerned with the nature or essence of being or existence."[182] In an effort to establish a more robust understanding of digital objects in this section, I will describe the composition and design of these objects.

"Object" is the name of a computational data in object-oriented programming. Digital objects are vertices and attributes encapsulated within code and enframed in bounding boxes which enframe the digital object in a simulated environment. These digital objects are visual representations made via a process known as rasterization. Through the description of these objects, I consider the ontological assumptions of these descriptions. I employ a demonstration of joint construction as a means of exploring the basic cube and its functional relations to other objects within the simulation in order to offer a functional understanding of the digital object at hand.

The ontological distinctions of single predicates (statements about the subject) are "*countability, temporal stability*, and *ontological rigidity*."[183] A predicate is countable if "whenever it holds for an object x, it does not hold for a *connected* part of x"; temporally stable if what holds for an object at time1 holds at time2; and ontologically rigid if what is predicated holds in any possible worlds.[184] I apply three requirements as described by computer scientist Nicola

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[182] "ontology, n.," *OED Online*. http://www.oed.com/view/Entry/131551?redirectedFrom=ontology+ (Accessed February 18, 2016).

[183] Guarino, *Formal Ontology*, 635.

[184] Guarino, *Formal Ontology*, 635.

Guarino[185] (1995), who focuses on knowledge modeling methodologies, to the object as demonstrated in *breve* to understand the ontological assumptions ascribed to the object. The tensions and polarizations that arise from this investigation will be addressed throughout this introduction to digital objects and to the case studies following.

The description of digital space within the simulation is defined as coordinates and frames. Object frames are a literal example of the boundary-producing practice of the simulation apparatus. Objects are placed in object frame coordinates, and these frames operate within a world coordinate frame system.[186] There is also the eye frame, or clip coordinate, which is aligned for an observer through the screen to look down the z-axis into the world frame. When an object is moved, what is being rotated is the framing of the object, and not the object's vertices. All vertices of the object are housed within subject frames, which is called the bounding box.[187]

"Objects" is also the name of the top level of computational code in *breve*. These objects are constructed through a hierarchy; at the top level, objects are either *real* in that they are coordinated with a physical entity in the simulated world, or *abstract* and used to control objects. Object attributes are data elements and methods are program elements, and both are encapsulated in an object. Methods as program elements, "provide[] the only interfaces between the object

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[185] Institute of Cognitive Sciences and Technologies.

[186] Steven J. Gortler, *Foundations of 3D Computer Graphics* (Cambridge, MA: MIT Press, 2012), 35.

[187] Gortler, *Foundations of 3D Computer Graphics*, 41.

and other parts of the program."[188] A class is similar to a template of object construction, participates in inheritances and hierarchy, each "class with it own methods."[189] Objects have an age, a type, and can announce and observe notifications. Class methods provide descriptions of controls, including the position and rotation of objects.

Digital bodies are vertices and attributes; this is an ontologically stable or rigid quality of digital objects in the environment. As a component requirement of ontological distinctions, all digital objects in any possible world will be made of vertices. Vertices are the "junction of two or more lines in a network or graph."[190] These vertices are the limits of the object. The vertex of each triangle makes up a geometric 3D image. 3D graphics are a constellation of coordinates whose vertices are associated with a numerical data called an "attribute"—attributes assign properties. This attribute determines the appearance for the vertices; for example, what the colour is, or what defines reflection.[191] These vertices are assembled by x, y, and z coordinates. Rasterization is a compression process that is comparable to materialization in matter, wherein the pixel-by-pixel expression of a form is rasterized. During rasterization, processed vertices are drawn on the

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[188] Donald M. McLver, "Object-Oriented Languages." *Encyclopedia.com.* Computer Sciences. 2002. http://www.encyclopedia.com/doc/1G2-3401200244.html (Accessed March 23, 2016).

[189] Donald M. McLver, *Encyclopedia.com.* http://www.encyclopedia.com/doc/1G2-3401200244.html (Accessed March 23, 2016).

[190] "vertice, n.". OED Online. December 2015. Oxford University Press. http://www.oed.com/view/Entry/203876?rskey=Kg6qT0&result=1 (Accessed February 18, 2016).

[191] Gortler, *Foundations of 3D Computer Graphics*, 5.

screen via an assembler.[192] This process interpolates—or blends—the value of the three vertices in order to apply attributes to the area within the triangle. This process will be discussed extensively in the next section, which focuses on the notion of sensual boundaries as developed by rasterization.

I would argue that many of the apparent qualities of digital objects are not considered a property of the object. For example, the data value for some geometric properties can be stored in the scene and not on or in the object itself. Light and reflection, for example, alter the appearance of the graphic, however; the data is not stored within the object itself. Texture is mapped onto an object.[193] Data that is not stored in the object can be constructed and assumed. This process provides visual complexity and it is used to smooth the triangular vectors. On the basis of this evidence, there is support for a way in which an apparatus divides the object from the environment.

In the present section, the issue under scrutiny is to consider which qualities of digital objects are the definitions of such an object. As a component requirement of ontological distinctions, I provide an example of countability: joint types indicate what type of object is divisible and in what ways it can be considered multiple, or countable. These functional joints illustrate how multi-bodies are formed, and subsequently how they can be torn apart.

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[192] Gortler, *Foundations of 3D Computer Graphics*, 6.

[193] Gortler, *Foundations of 3D Computer Graphics*, 7.

To demonstrate how objects connect to other objects, I will employ a demonstration that illustrates how "joint types" are constructed to provide a clearer picture of how multi-cuboid-bodies are formed. The simulation opens with two red cubes framed tightly within a wire frame masking with the y and x axes labelled. The cubes hover and cast a shadow upon a pink-chequered ground. "Use the simulation menu to select a joint type" is written across the bottom of the screen. The simulation menu lists five joint types: fixed, prismatic, revolute, universal, and ball. The type on the screen changes with each selected option. "Fixedjoints do not move," "PrismaticJoints slide along one axis"; the two red cubes are now animated, with the lower rising to fit like a piston within the top cube, and then falling to completely remove and disconnect. "RevoluteJoints rotate around one axis"; the bottom red cube lifts, tracing an invisible circle around and through the top cube, and at some point the cubes fit and transfer through one another seamlessly. "UniversalJoints rotate on two axes" illustrating the bottom cube cutting though the top with a range of motion, limited to one or another circular path. "BallJoints rotate on all axes"; the bottom cube spins below as if affixed by a spherical ball. These five joints are the manner in which multi-bodies can be constructed. The cubes, through user input, can be separated and the fragmentation of the graphical event occurs. Knocked off the joint, the program prints an error report and the illustration turns grey.

For the temporal stability component of the ontological requirements, users require a working conceptualization of the space in which these objects

experience time steps. Many of the demonstrations in *breve* have formulated time measures, both in the constant redrawing of the code, and in the evolutionary processes of the program. The graphical event of a digital object is a constellation of coordinates, and this constellation of coordinates exhibits temporal stability. The modeling environment provides a world frame, allowing for coordinates and depth, while the digital object is localized in a fixed space. In this way, the simulation environment is itself a digital object, with its internal space defined by vertices. Digital objects' "substance" of extension in space is one and the same. What the digital object is made of and the environment it exists in are not differentiated by kind. I am arguing that the digital object and the environment appears to be a unity, in that the digital objects' vertex definition necessarily requires the environment to be tangible and to appear as *other.*

The polarization of real and sensual qualities in physical objects is also in digital objects, expounded by the definition of data through the graphic event and in code. Code is a system of rules that expresses and instructs computers and is the method by which all processing, display, and transmission of information occurs.[194] N. Katherine Hayles (2010) unpacks the performativity of code, saying:

> Code running in a digital computer causes changes in machine behaviour and, through networked ports and other interfaces, may initiate other changes, all implemented through transmission and execution of code. Although code originates with human writers and readers, once entered into the machine it has as its primary reader the machine itself.[195]

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[194] "code, n.1". OED Online. December 2015. Oxford University Press. http://www.oed.com/view/Entry/35578?rskey=JOAoiT&result=1 (Accessed February 18, 2016).

[195] N. Katherine Hayles, *My Mother Was a Computer : Digital Subjects and Literary Texts* (Chicago, IL, USA: University of Chicago Press, 2010) (Accessed March 23, 2016) ProQuest ebrary. 50.

Alexander Galloway (2004) reiterates:

> code draws a line between what is material and what is active, in essence saying that writing (hardware) can not *do* anything, but must be transformed into code (software) to be effective…*code is the only language that is executable*. [sic][196]

It is paramount to note that the environment in which these digital objects operate and engage in is a rule-based environment, and as such, they are monitored by governing standards and code. These digital objects are situated objects, which is "the view that every course of action depends in essential ways on its material and social circumstances."[197] Galloway defines protocol as the principle of the distributed management of networks, outlining rules and standards, and thus, code unpacks the ways information is partitioned and shared.[198] "These regulations always operate at the level of coding—they encode packets of information so they may be transported . . . they encapsulate information inside a technically defined wrapper, while remaining relatively indifferent to the content of the information contained within."[199] Code is machine behaviour, transforming objects in the rule based environment; the object is encoded yet remains relativity indifferent from the environment it was constructed from.

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[196] Alexander R. Galloway, *Protocol: How Control Exists after Decentralization* (Cambridge, MA: MIT Press, 2004), 165.

[197] Suchman, *Human-Machine Reconfigurations: Plans and Situated Actions,* 70.

[198] Galloway, *Protocol,* 7.

[199] Galloway, *Protocol,* 8.

The consequence—given the evolution, multiplication, and encapsulation of code—makes it so that its source (the computational origin) is untraceable and unrecoverable. The object-oriented principles of programming clarify what it is for a computational object to be encapsulated. A computation object is a series of actions and descriptions that are encapsulated. Encapsulation in programming, is the language construct that facilitates the bundling of data and attributes with the methods operating on that data. A digital object that is encapsulated can be said to be bimodal—that is, to have both have an exteriority and operate via an internal principle logic. Encapsulation is interesting in its resemblance to Matryoshka dolls—there are parent classes, and child class, nesting within one another. Classes are constructed of methods and variables, these are developed by creating subclasses of parent classes. Some classes of *breve* include, but are not limited to: joint types, shape and custom shape, floor, mobile, multi body, real (interestingly enough, "a class which is never instantiated.")[200] User programmers can alter or construct from empty classes, yet the software parent class list is expansive.

Galloway defines objects as "inheritable, extendible, procreative. Objects are not archived, they are autosaved. Objects are not read, they are scanned, parsed, concatenated, and split."[201] These digital objects produced by code are objects of computer language; they are self-contained or encapsulated units of properties, tasks, actions, etc. All actions and processes in object-oriented

[200] "The Breve Simulation Environment Documentation | Breve." 2015. Accessed May 7. http://www.spiderland.org/breve/documentation.php.

[201] Galloway, *Protocol,* 74.

programs are encapsulated as interiors. Given that the apparatuses always produce the subject, interiority, and alterity, this investigation asks in what manner do digital objects possess an interiority? By identifying the process of encapsulation as an internalizing action, processes of the digital object necessitates the interiority of a computational object.

I have described an apparatus according to Barad's definition of the apparatus as it defines/marks boundaries of the digital objects. These are outlined using the illustration of the digital object's ontological qualities as they are present in breve. This apparatus, I want to suggest is dependent on the observer as it provides access to the construction of the computational object in terms of language, and access in terms of language. Our access to digital objects beyond phenomenal and sensory access, is through language and code, and as such, there is a limit to what types of observers have access to the objects that I am discussing. Interestingly, this restriction doesn't pertain to the ability of digital objects themselves being able to participate in communicative states through announcement and subscription.

Digital bodies are vertices and attributes that have a rigid or ontologically stable quality, as do the framing devices assembled in the simulated space. These framing devices are spelled out in clearer detail in the forthcoming section, "The Apparatus of Touch." Digital objects' countability was discussed in terms of the linking force of joints, demonstrating that what can be fragmented from an object is not considered the object in itself, but rather, as something countable and *other*.

VI. Sensual Facets

This thesis endeavours to describe ways in which agential separability performs and marks sensual boundaries upon and within digital objects that in turn, allow for intra-activity of sensual phenomena as exteriority. Here, I argue for the construction of sensual boundaries of digital objects through the discursive practice of rasterization. The lens I apply is Karen Barad's agential separability, which offers a tangential cut to separate subject and object, interior from exterior. Agential separability is a performative mode that renders "exteriority with-in phenomena."[202] This performance as agency is not an attribute or a property of the exteriority; rather, the performative cut itself is agentive. The apparatus of simulation provides the potential for marking boundaries allowing for intra-activity.

I will argue that rasterization is an agency, and that it is a knowing process that enacts meaning through phenomenal reconfiguration of *virtual* matter—again, where *"'phenomena' are the ontologically inseparability of objects and apparatuses*. [sic]"[203] This is a sensual analysis, within which the presence or exteriority of the phenomenal cut or boundary is explored—where we recognize the exterior of a digital object. I interrogate the manner in which objective phenomenal cuts can be said to represent a sensual body, or more specifically, the way that normals intervene with the computational object to provide an exteriority

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[202] Barad, *Meeting the Universe Halfway*, 140.

[203] Barad, *Meeting the Universe Halfway*, 128.

considered as skin. “Two cardinal tenets of empiricism remained unassailable, however, and so remain to this day. One is that whatever evidence there *is* for science *is* sensory evidence.”[204] The second is that the “meaning of words must rest ultimately on sensory evidence.”[205]

Rasterization is the process that converts an algebraic formula into a computer-generated image, pixel-by-pixel, unto a screen. Barad’s phenomenal cuts as means of materialization is mirrored in the process of rasterization. The phenomenal cuts that occur during the procedure of rasterization are events mirrored by agential separability. Rasterization separates the object from the subject, and in its agential separability it can be said to performs as a boundary-making apparatus. Rasterization converts a computational equation into a set of points or pixels on screen.[206] I’ll argue how meaning is constructed on the virtual screen, asking the question: in what ways can the objective phenomenal cut be said to represent a body—a sensual body?

Current research by new media artist Vibeke Sorenson[207] and social architect Mark Beam[208] seems to validate the view that digital objects can be outfitted with a host of sensible properties and experiences; to this end, a host of anthropomorphized sensibilities can be assumed. Sorensen and Beam (2001)

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[204] Quine, *Epistemology Naturalized*, 530.

[205] Quine, *Epistemology Naturalized*, 530.

[206] "rasterize, v.". *OED Online*. http://www.oed.com/view/Entry/247452 (Accessed February 18, 2016).

[207] Nanyang Technological University. School of Art, Design and Media.

[208] http://www.beaming.com

compile hardware developed as technological extensions of human senses, but senses are not the only requirement for sensuality or sensual objects. These object descriptions include the sensible outfitting or hybrid physical-digital interfaces, which lead to proposed sensibilities.

Sensible objectness is it not what potential sensibilities an object could experience; rather, what this section aims to discuss is which sensual boundaries are observed, and in what manner is that phenomenon a sensibility. The boundary of a sensual object is a product of the apparatus, and boundaries indicate the point between presence (presentation) and apprehension (preceptive understanding), as well as between the real qualities and the sensual qualities of sensual objects. The phenomenon described is a distinct process of boundary production that separates a digital object from its environment. The other method of boundary production in terms of separating digital objects from their environment is encapsulation, discussed more shortly. For now, I limit the scope of this discussion to the specific phenomenal production of rasterization.

The digital phenomena I am talking about are a direct product of the rasterization process; we are discussing digital objects' exteriority. Its skin—which comprises a textural pattern or colour that is draped over the digital objects' vertices—allows for volume and form and is in some manner, opaque. This phenomenon of form, volume, and colour are pragmatically reliant on a human observer, yet the sensual objects of presence have both real and sensual qualities —real qualities that retreat from apprehension and exist autonomously.

Phenomena is said by representationalists to be a property that is separate from the thing observed; rather, it is considered a sensation within the observer. On this account, the apparatus—here, the rasterization process—becomes the observation or observer that marks (causes) phenomenal expression. Through the empiricist tradition, the objects' sensual properties conclude that the sensing property is a product solely of the observer.

We will be operating with a different version of phenomena, one that addresses phenomenal materialization through Barad, and the objectivity of this phenomenon through Harman. A phenomenon is what separates an object from its real and sensual qualities, as described in Harman (2010). Harman puts forward the view that sensual objects are not entirely reliant on an observer; in fact, they are independent with both real and sensual qualities. The phenomenal experience then is not wholly human, but rather an expression of objects whose causal impression is not unilateral.

To portray the issue in Karen Barad's terms, "phenomena do not merely mark the epistemological inseparability of observe and observed, or the results of measurements; rather, phenomena are the ontologically inseparability/ entanglement of intra-acting 'agencies.'"[209] The issue is not simply to note the requirement of an observer, but to say that in simulation there is a unique observer, being that the domain is itself embedded with intelligence and agencies. Further, these simulation environments were designed to model the rationality of

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[209] Barad, *Meeting the Universe Halfway*, 139.

humans. The separations that are pronounced through phenomenal cuts are further made boundary*less* when we consider the acts of rasterization as defining a boundary that is itself reliant on the material configurations of the screen.

The definition and precision that is accounted for operate in two realms, both on screen and in virtual space. One consideration is the material limitation of pixels, and inherent to these limitations is the indivisibility of the square light. In virtual space we have easy access to scale manipulability; when an image is zoomed in or enlarged it is clear that the division of the rasterization process is not clear-cut in a throughly penetrative and definite way, as the boundaries are blurred. There are washes of objects sharing boundaries. In a different domain, off the screen yet still pertaining to the virtuality, visualization becomes a relational notion that infinite magnification that can occur with lines.

Each point is a point in between and in a long succession of other points. The serial nature of points is described by art historian George Kubler (1962). Kubler describes at length open-ended sequences and closed series; a closed series is a duration with a finite number of possible positions it has within each position. Consider here that each position is a pixel, and each has a limited potential to commit in correspondence when taking the said position. Once committed, the potentiality ceases to be limiting to other potential possible positions.[210] It is

[210] George Kubler, "Serial Position, Age, and Change," in *The Shape of Time* (New Haven: Yale University Press, 1962), 54

important and not redundant to say that the taking of one's position in a series "limits the succeeding innovations."[211]

The simple task of enlarging a low-resolution image indicates what happens to boundaries as the scalability changes: the crisp boundary becomes jagged, blurred, and broken. The question of the role of the domain is apparent in these two analogies. The scope of the domain changes drastically after the phenomenal cut, and it changes the apparatus of measurement.

Normals is a mathematical calculation that allows one to gain the gradient of the curve. On the screen, the first methods of visualization are the boundary formation of the "normals" skin on the digital object. In many graphic editors—for example, Photoshop—"normals" is a filter function to see the gradient and curves of a 3D object. The lines drawn through the normals function are the vertices of the graphical digital object. The "normals" filter is the skin. Digital skin is the computational descriptions intercepted by the limitations of the objects' vertices—upon which the primary property, being the boundary of the object, textures can be applied. These textures that are applied—and further at its root, normals (even though they are a mathematical equation)—are a phenomenal quality of digital objects. If it is phenomenal, it is sensible.

I am not attempting to describe digital objects as material, but it's important to reiterate that they are models of physical materiality that operate with many similar descriptions as their target source. It is important to note—as

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[211] Kubler, *Serial Position, Age, and Change*, 54.

previously discussed in both the modeling of digital objects, and the means of representation—that some of the ontological object-ness of materiality is necessarily modeled into the simulation.

What I argue to be modeled are the phenomenal qualities; in turn, these can be quantifiably measured and duplicated in *breve*'s simulation environment. The case of this thesis is not to argue for the reality of digital objects, in neither their objectivity nor their supposed substantivity, but rather for the transference of materiality by way of the apparatus, which is used to define and build objects and environments in hand.

The idea of discursive practice will be elaborated on further in the next part, but here it is important to note that the methods in which the objects themselves are constructed is through definition. As I described in the previous section, digital objects are objects of definition. Here, we are discussing ways these objects are visible, and we unpack what process made them visible. It is not to discuss the miraculous lens of the eye, but rather, something *other* has made these objects demonstrate exteriority. The objects that are being modeled are being modeled in such a way that their visibility is necessary so, by the apparatus that is chosen to measure them.

VI. A. Discursive Practice of Rasterization

If rasterization is considered a discursive practice, then how does it model the intra-actions of agential separability? On the basis of this analysis, the

simulation frame hosting the body is a discursive practice. The discursive practice of the frame is performative. In addition, the virtual environment and its transposition into a visual landscape hosts an interesting eye frame apparatus. The role of camera projection coordinates (user screen perspective) simulates the gaze's capacity to apply cuts. The clip coordinates of the rasterization process probes the exterior veil of the digital object, and the object coordinates are turned into eye coordinates.[212] The camera projection matrix gets the clip coordinates and these clip coordinates determine how the image is presented on the screen, including its colour and distance from the screen.[213] It is the case that although the object in virtuality exists in a 3D space, each item needs to be transposed upon the screen, "pixel by pixel."[214] The frame as a discursive practice is a "specific material (re)configuring of the world through which the determination of boundaries, properties, and meanings is differentially enacted."[215] Points are places that are described by the frame. Vectors are motions that move the frame within a master frame system. The movement is a performance of the digital object.

The boundary is defined, such that the precipice of truth and representation, as well as that of space and movement, is described in the vector motions and coordinates of the digital object's exteriority. Barad argues, "matter

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[212] Gortler, *Foundations of 3D Computer Graphics*, 51.

[213] Gortler, *Foundations of 3D Computer Graphics*, 52.

[214] Gortler, *Foundations of 3D Computer Graphics*, 52.

[215] Barad, *Meeting the Universe Halfway*, 148.

does not refer to a fixed substance; rather, matter is substance in its intra-active becoming—not a thing but a doing, a congealing of agency. Matter is stabilizing and destabilizing process of iterative intra-activity."[216] The doing in the case of *breve* is a constant running of the simulation program, whereas the vector and the visualization of it are being written throughout the rasterization process. Although this rasterization appears seamless, it is a process and not static.

The way Harman sets up his phenomenal tension also supports the transference of digital objects ontological structures without relying on intentionality. That is to say, the phenomenal tensions are the intra-actions of mattering. The sensual and real qualities are not bundled or encapsulated into one object; rather, they are extended in a multi-relational suspension allowing for a variety of sensual or phenomenal understandings on the object—objects are multiple. The phenomenal cut can be necessarily reproduced given the use of the apparatus. The separation of the digital object from its digital environment sets up a way to illustrate the discursive practice of cutting and defining boundaries in these objects as they are rasterized.

Mattering, according to Barad, is a doing. A common idea of matter is to consider matter as a particle whose key attributes are extension and passively awaiting form. This atomistic view is mirrored in the virtual space, for example in *breve*, with each point or pixel being localized and awaiting word from a causal force. Barad's agential separation expands the notion of matter as a process of

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[216] Barad, *Meeting the Universe Halfway*, 151.

intra-active becoming. It is in this way that mattering is a doing—it is not a fixed substance: "*Matter(ing) is a dynamic articulation/configuration of the world*. [sic]"[217]

Agency is prominent in the literature on phenomenal mattering. According to Barad, agency is the "ongoing dynamics of intra-activity." [218] On these grounds, I argue for the performance of digital objects and their cuts of rasterization as apparatuses of discursive practice. This rasterization exemplifies the individuation of phenomenal cuts; it is a means of choosing one line of the apparatus in which to cut through the simulation, allowing slices of insight into the ontology of a digital object. The cuts that occur with this process provide an unrivalled exteriority.

Barad describes "according to Foucault, discursive practices are the local sociohistorical material conditions that enable and constrain disciplinary knowledge practices such as speaking, writing, thinking, calculation, measuring, filtering, and concentrating."[219] Rasterization exemplifies the apparatus as a boundary-making practice—it marks the digital body by ascribing properties and meanings by differentiating the digital object from its environment. "In an agential realist account, *discursive practices are specific material (re)configurings of the world through which the determination of boundaries, properties, and*

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[217] Barad, *Meeting the Universe Halfway*, 151.

[218] Barad, *Meeting the Universe Halfway*, 170.

[219] Barad, *Meeting the Universe Halfway*, 147.

meanings is differentially enacted. [sic]"[220] Rasterization then is agentive; it is a knowing process that enacts meaning for the object through phenomenal reconfiguration. Rasterization is a process that specifically articulates differentiation; it is "a generative factor in the formation of bodies."[221] Barad reframes causality by defining *"discursive practice*[s] [as] *causal intra-actions*"—they enact causal structures through which some components (the "effects") of the phenomenon are marked by other components (the "causes") in their differential articulation.[222]

In what ways is rasterization a means of mattering? Rasterization is a process of mattering; it is the agential cut that renders virtual space with an exteriority that presents like a face. This analysis posits that a multiplicity of sensations occurs between and within a single or multiple-bodied system through the sensual object of exteriority. These digital objects perform toward experienced individuation from a coalescent environmental body, and/or from *other* digital bodies.

VI. B. Object as Face

In understanding the object as face, I look to the sensual boundaries that are developed through rasterization and consider the manner in which this exteriority can be considered a face. These sensual boundaries are products of the

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[220] Barad, *Meeting the Universe Halfway*, 148.

[221] Barad, *Meeting the Universe Halfway*, 152.

[222] Barad, *Meeting the Universe Halfway*, 149.

rasterization apparatus. Here, the apparatus defines the exteriority and leads one then to inquire into the nature of its interiority. Typically, objects are considered to have both interiority and exteriority. The manner in which a digital object is said to have an interiority will be explored further in these case studies. I provide an analysis of digital objects-as-face and object-as-other. The graphic event of individuation as indicative of an interiority, yet, the interiority of a digital object is not available in its representation, that is to say—not available via the screen. I would suggest that the visual face is indicative of interiority and allows for its individuation. The way this contributes to the sensual analysis, relates to the way the phenomenal exteriority is necessarily stranger to others and by encapsulation stranger within its environment. In object-as-other, I explore touch as a means of individuation as it is exemplified in collision and neighbour detection methods through the *Swarm* demonstration. Touch is considered sensual in practical ways. I establish how individuation occurs outside of sensual visualization by clarifying the process of encapsulation to arrive at the place where computational objects dwell.

The sensual boundary, considered a "face," engages the user to consider responsibility towards digital objects. Philosopher Emmanuel Lévinas, in *Totality and Infinity: An Essay on Exteriority* (1961), indicates ways in which the face provokes responsibility. In this manner, the face confronts. Confrontation is a mode of engagement that the face participates in. Confrontation is also the term Harman uses to describe the relationship an object has with other objects.

Confrontation is a way to illicit movement for sensual qualities. It can then be said that the sensual boundary of a face elicits both notions of interiority and ethical responsibility or its confrontational mode of engagement.

VI. B. 1. Exteriority of Sensual Facets

In this paper, I have addressed rasterization in terms of introducing the bounding box as being the frame that is presented to the screen. The skin of the object is spoken about in terms of its normals, meaning the intersecting vertices and subsequent to rasterization, its opacity which is its exteriority. The digital object—that is, any sensual object that expresses digital vertices—has a rasterized face. The face is both the "principle feature in recognition" and the "bounding planes of a regular geometric solid."[223] A face is an exteriority that insinuates an interiority, due both to its potentiality and its responsibility. The face indicates that there is something behind. The aim of this section is to explore the interiority that is provided by the notion of the face. Alterity provides a face—a face that meets other faces. Lévinas discusses the nakedness of the face, illustrating that it is beyond one's eyes and perceptions. The face "*is* by itself and not by reference to a system."[224] The alterity or otherness of the face is exaggerated in its nudity. Lévinas introduces "the relation with the face is not an object-cognition. The transcendence of the face is at the same time its absence from this world into

[223] "face, n.," *OED Online,* http://www.oed.com/view/Entry/67425?rskey=jm0PDn&result=1 (Accessed February 18, 2016).

[224] Emmanuel Lévinas, *Totality and Infinity: An Essay on Exteriority* (Pittsburgh, PA: Duquesne Univ. Press [u.a.], 2011), 75.

which it enters, the exiling [dépaysement] of a being, his condition of being stranger, destitute, or proletarian."[225] Here, the focus is that the exteriority is pronounced by the otherness in its condition of being a stranger; the face requires an other to confront. There is a realm of responsibility that is birthed in this theory. In this section, I ask: what is the sensual object of exteriority?

A keen difference between the apparatus cut in matter and the cut in simulated matter is the multiplicity of the intra-actions available within the simulation. It would seem that the specificity of the rasterization task—although complacent in its own historicity—is less complex. The cut, however, is still sensual in its capacity to mark bodies, and as such, is ontic—recalling the sensual object has both sensual and real qualities. The cut produced penetrates the simulation but not the graphical event, for what is revealed to this sensual analysis is that rasterization operates at a level of phenomenon that excludes interiority. The interior of the cube is not rendered visible; only interceptions veiled in sensual texture are visible as such; the inexhaustibility of computational description is not visible. The boundaries of the digital objects exterior vertices that are produced are not transparent, nor is its skin. Nevertheless, the boundary, which is indicated by its skin has sensuality. I maintain that the texture skin or colour red has the same sensual foothold, although potentially more nuanced given the restrictive conditions in simulation—a red cut is still red.

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[225] Lévinas, *Totality and Infinity*, 75.

The sensual object's real qualities of interiority are hidden. It is awkward to talk about ways in which the interiority of an object is not available in the representation of the object. Both Harman and Barad would say, in different ways, that the phenomenon or sensual object of the object *is* the object. Harms sensual object and Barad's phenomenon in exteriority are the base of my sensual description. The act of searching for an interiority is a product of the human cognizer's subject/object dualism, a remnant of Descartes.

Can the tensions between real and sensual qualities be exhibited in the confrontation of a face? The face is a mode of confrontation. Harman suggest that confrontation "turns the unspoken duel of sensual object and quality found in time into an open dispute between its two constituents."[226] Where some objects require the recognition of one another, others merely need an exteriority to maintain alterity. Confrontation that requires recognition is an intentionality. Digital objects participate in "interiority" yet continue to inherit, collide, and mediate with situated others, thereby building an in-between alterity.

VI. B. 2. Intentional Descriptions

Is the apparatus inexhaustible in its penetration? Interiority is the intentionality of an object. Computation objects are objects of thought that have been filled with content—that is, descriptions and actions by programmers. In *breve*, users are the programmers. The intention of an object is the meaning or

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[226] Harman, *The Quadruple Object,* 126.

content of an object. Here, intentionality is considered to be epistemically available because of encapsulation. Encapsulation is the coded composition of computational attributes and methods that make up the computational object. The descriptions of objects are encoded on the inside, whereas phenomenal theory speaks of descriptions being encrusted upon the outside of an object.

First, there is no access to the object's interiority by way of the screen. The screen does not offer access to the interiority of an object. As mentioned previously, the exteriority of the digital vertices are inexhaustible, and as such, so is skin, which is why we cannot touch the body. Harman argues that only the intellect can access particular kinds of objects, namely those considered real. Objects considered to be real are those that hide or retreat from the sensual object-ness, and as such make no presentation and lack exteriority. In a similar manner, the way in which a human cognizer understands objects through intentionality is mapped upon the way computational objects witness their own intentionality and the intentionality of other computational objects. Where observation may be required to discuss the interiority of the object, I would suggest it is not a requirement of that observer to be a human cognizer.

The face that appears is not different from the environment in most ways, as it is still an image on the screen. Further differentiation is articulated by other phenomena, such as collision because it activates a method for response. Rasterization, as an apparatus lacks interiority, this is indicative of the product of an apparatus' function. It is anthropocentric that I yearn for organs and bone and

in virtual environments similarly like breve, users yearn for the interiority of digital objects. Yet, the opaque intra-actions of rasterization is a function of the penetrative and encompassing force of that description.

Lévinas has suggested that alterity requires an absolute other; I would suggest that individuation in virtual environments occurs from within, not without. Lévinas motivates "to have meaning is to be situated relative to an absolute, that is, to come from that alterity that is not absorbed in its being perceived."[227] The aim of simulation, is to assume a position of control in the environment, yet this virtual environment cannot be considered absolute as its' domain is naturally restricted by autopoiesis. Again, this speaks of the other's capacity not to be neutralized by possession. Providing the object is not made property by other objects, the alterity of the computational object persists in differentiation from its environment and other rasterized objects persist.

[227] Lévinas, *Totality and Infinity*, 97.

VII. Sensual Alterity

VII. A. Object as Other

In object-as-other, the intra-action that is discussed is the boundary production of touch. Users touch objects in their construction and mutability through programming. Here, I discuss the ways that digital objects 'touch' others in their simulated environments. The third party collision handler of *breve* operates as the apparatus that measures the embodied object, as well as differentiates the body from others and from the environment. Through the discussion of the touch apparatus, collision, and neighbour behaviours, sensual boundaries of the bounding box—sensational areas that frame the object's vertices—we see how the apparatus operates to enframe the digital object through touch or collision. This enframement is then discussed as a form of dwelling, a concept introduced in Lévinas' alterity theory. Alterity is an internalizing principle that arises from the state of "being other or different; diversity, difference, otherness" are examples of this relational position.[228] The apparatus internalizes digital objects through encapsulation. Encapsulation is the manner by which objects in object-oriented programming come to be operable as a unit or composite object.

VII. A. 1. The Apparatus of Touch

Touch is understood through the tactility of experiencing rigid pressure, typically through materialism and extension. I ask in what ways can a digital

[228] "alterity, n.," *OED Online,* http://www.oed.com/view/Entry/5788?redirectedFrom=alterity+ (Accessed February 18, 2016).

objects experience touch? In object-as-other, I explore touch as a means of individuation. Cultural theorist Erin Manning's[229] "Engendering: Gender, Politics, Individuation" in *Politics of Touch: Sense, Movement, Sovereignty* (2007) begins by describing the way skin develops and is stimulated by the environment to produce, for humans, "the most alert of the organs."[230] Touch in this expository is considered an opportunity to move beyond "fixing bodies as simple objects of thought."[231] Touch is more than things being brought into contact with each other; touch is "to leave its mark."[232] I want to move beyond touch as being the point of recognition for the causal chain, and consider how touch imparts participation in self-individuation.

In this present section, the issue under analysis is how objects can experience touch and therefore experience an *other* or the relation of alterity. Barad unpacked ways that touch identifies an otherness: "so much happens in a touch: an infinity of others—other beings, other spaces, other times—are aroused."[233]

Collision is the way *breve* touches, and a closer examination on the collision interaction follows. Collision occurs in two ways: when digital objects

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[229] Concordia University. Fine Arts.

[230] Erin Manning, "Engendering: Gender, Politics, Individuation," in *Politics of Touch: Sense, Movement, Sovereignty* (Minneapolis: University of Minnesota Press, 2007), 110.

[231] Manning, *Engendering,* 110.

[232] "touch, n.," *OED Online,* http://www.oed.com/view/Entry/203876?rskey=Kg6qT0&result=1 (Accessed February 18, 2016).

[233] Karen Barad, "On Touching—The Inhuman That Therefore I Am," in *Differences: A Journal Of Feminist Cultural Studies* 23, no. 3 (Fall 2012): 206.

collide into other digital objects, and when objects are able to determine the intersecting objects, be it themselves or others. A digital object requires the knowledge of collision when interacting with its body, as expounded here: "all touching entails an infinite alterity, so that touching the Other is touching all Others, including the 'self,' and touching the 'self' entails touching the strangers within."[234] Applying this idea of self-touch, digital objects require collision handlers to define the boundaries of their bodies. A collision handler is a third party that indicates the moment a boundary has been breached. Touch is exemplified in *breve* through collision and neighbour detection methods.

The moment of individuation occurs at the moment of touch, and this is where sensual othering occurs. For the digital object, touch is a unique phenomenon, and digital skin is different. The thing that is touched in simulation software is neither skin nor a body proper; rather, it is a bounding box that surrounds a digital object. The visualization of the digital object requires this bounding box for its situatedness in the simulated environment, but it also is a method used to allow digital bodies to recognize the boundaries and limitation of their body. The bounding box performs the task of skin, and it is how digital objects come to recognize their body.

Manning illustrates that "identity is exposed by individuation as a moment in a process that expands far beyond the bounds of a strict category one might call

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[234] Barad, *On Touching,* 214.

the 'self.'"[235] This quote illustrates the way that the bounding box—in excess of the digital body, and through a process of individuation, or touch—reveals through the collision handler the digital object as bounded, and it is qualitatively *one*. Now, I hesitate to use "self," and I have argued against the categorical oneness of substance, so to claim individuation from the perspective of the object is challenging. Touch in the digital environment doesn't indicate *one* in composite wholeness; rather, it indicates one point or measurement of relation to the said point within the digital coordinates. The way that touch individuates is by activating the collision handler, forcing the digital body to respond to touch.

The analysis of individuating human bodies and digital bodies is non-equivocal in a multitude of ways; namely, the individual digital body is pre-organized, pre-constituted, and pre-defined, whereas the human body in this analysis is considered "in-formation," becoming and metamorphosing form and matter.[236] Yet, "the body is mechanic in the sense that it is plural and unpredictable, evoking always through movements that are contingent on environment and (re)combinations."[237] The body is described as "a network of imminent trajectories with longitudinal and latitudinal lines intersecting," an assemblage as described by the vectorization of the body. I want to motivate an understanding of the digital object as in-formation with the digital body.[238]

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[235] Manning, *Engendering,* 115.

[236] Manning, *Engendering,* 116.

[237] Manning, *Engendering,* 118.

[238] Manning, *Engendering,* 132.

The notion that an architectural building is a host for a body, or that architecture is a bounding box of a body, is interpreted by cultural theorist Mark Hanson[239] in *Wearable Space* (2003). This paper describes "wearable space" as a balance between the "affective basis for interface" and correlated sensory capacities, as the interface between humans and computing. Hanson's main claim is that the human body is "a *source* for and *activator* of a rich affective constitution of space."[240] Hanson introduces "landing sites" as perceptual situatedness; a requirement for being a subject is to participate in these relational claims, and a landing site allows one to say "here or there."[241] Imaging landing sites are not considered perceptual; rather, in "…imbuing [space] with a sensory richness that yields bodily meaning," they are active and allow for the "embodying of space."[242] Hanson mirrors Barad's always already "agentive" matter in identifying the world as "always already endowed with the 'kinaesthetic context and feel of [the] sensoria' of embodied perceivers. [18]"[243]

The origins of the architectural landing sites are instrumentally constructed from the performance of the body.[244] In *breve,* the architectural landing site is a bounding box, and as such, is instrumentally created from the performance of the

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[239] Duke University. Program in Literature.

[240] Mark Hansen, "Wearable Space," *Configurations* 10.2 (2002): 322.

[241] Hansen, *Wearable Space*, 331.

[242] Hansen, *Wearable Space*, 332.

[243] Hansen, *Wearable Space*, 332. Citing Arakawa and Gins from [18].

[244] Hansen, *Wearable Space,* 339.

digital body. Hanson introduces Peter Eisenman[245], a contemporary figure in architecture whose struggle with embodied constraints in architecture are discussed in terms of interiority:[246] "For Eisenman, . . . *the* crucial element of a new conception of architecture's interiority corresponds to a digitally facilitated metamorphosis of the diagram."[247]

The metamorphose of the transcended digital diagram produces a new interiority based on the pushing and pulling of shape and volume as it is digitally inserted into the architecture's interior. This dismisses the previous claim by Peirce (1955) that in architecture the sign and the signifier possess a real compositional coherency. This premise supports the claim that the digital diagram is a "vehicle for the transformation of interiority itself."[248] The diagram is motivated as an apparatus whose product is always a subject. In *breve*, the interior space by which users construct is a ready-made, though the environmental variables are open to alteration. Simulation environments at a carte blanche state allow for dynamic spatialization as environments are constructed from empty classes. What follows from this discussion is a new configuration of space—or space as void—as a functional affect or property of the architectural space as *not-presence*.[249] This new concept is a digital interiority. "As a kind of recipe for

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[245] http://www.eisenmanarchitects.com

[246] Hansen, *Wearable Space,* 342.

[247] Hansen, *Wearable Space,* 345.

[248] Hansen, *Wearable Space,* 345.

[249] Hansen, *Wearable Space,* 345.

reconfiguring architectural interiority, spacing functions precisely by soliciting an affective embodiment *that exceeds the spatial bounds of the organic body."*[250] The affect is that the digital body is in excess of itself.

VII. A. 2. Bounding Box and Neighbour Response-Ability

The bounding volume is a geometric-shaped frame that houses an internalized digital object. This digital object does not parrot the bounding box's shape; the landing site exceeds the digital body, and as such, there is excessive volume of actionable space in the bounding box where there is no digital object. This excessive volume is included in penetration monitoring. *breve'*s object-to-object interaction or reciprocal action is limited; objects can collide with one another—they can touch. They have neighbour detection methods that can find the closest object within a preordained environment known as a "neighbourhood." Other interactions involve triggering events by the use of notifications or announce methods, and they can search for a given type of object and respond to a method call.

Touch is the monitored penetration of the body's bounding box and its excess. This excess within the bounding box allows for some otherworldly causal and visual effects; namely, objects will be triggered in response when the object appears, as if no collision or touch has occurred. The digital objects will respond to a method call that will generate a response of rigidity and potential bounce,

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[250] Hansen, *Wearable Space*, 348.

while simultaneously experiencing the boundary call. Manning demonstrates that "touch is performative in the sense that it exposes the challenges the excessive body (the body in excess of its-self) calls forth within the domain of cultural intelligibility."[251] Manning describes a "force field" that through and at the act of reaching towards engenders a force that alters space and time. Touch as a relation reaches towards not a situated body, but a body that becomes engendered by that touch. The point of contact, the mark, is what defines and causes the exteriority, and not the volume nor the space it occupies itself. Bodies are defined by their in-forming boundaries.

Collision modeling is the modeling of the rigidity of physical objects. It is the modeling of the causal chain that is prevalent in mechanistic world modeling. Digital objects experience rigidness in multiple ways; it is both written into their property assessment, and is a by-product of interacting with the environment. Rigidity is an operational definition for the ontological predication of an object. Rigidity is a quality of collision that is replicated by the drawing of boundary boxes. The way that rigidness is simulated in *breve* is as a ready-made object quality. Rigidness then, is not a quality of substance; it is a boundary that is developed through touch. One is individuated in as much as it has been touched.

Collision modeling is an interesting form of knowledge production. On the one hand, collision is the confrontation of others, on the other, it is a sensual coming to know. The way that collision is modeled in a simulated environment is

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[251] Manning, *Engendering,* 112.

prolonged from the manner collision occurs in the physical world, and collision here requires a third party. The digital object responds to collision information through a collision handler. The collision handler puts forth the appropriate action and a preordained trigger behaviour in response; namely, retreat or progress—cowardice or aggression. The manner in which collision and confrontation is treated requires a moment that causal qualities appear to transverse their commonsensical notions of causality, where action appears to flow backwards in time. This becoming is the notion that individuation occurs after the privation of body boundaries. The boundary is defined in its being breached. This phenomenal confrontation requires a mediating force, power, space, something to coalesce that allows for affect of phenomenal qualities to retroactivity be caused by the real object.

In *breve,* touch is the penetration of a bounding box that alerts the digital object that it has collided with something. The bounding box is hollow and its exteriority is transparent, and the relation of touch existing in the simulated environment transcends the supposed tactile requirements of objectness. All that is required is a point, a situatedness to experience touch. The velocity in which an object experiences touch is measured according to the depth of the penetration, in relation to the centre of its bounding box. Sybren Stüvel et al notes that "collision is usually only detected after two objects have some measure of interpenetration,

and the penetration depth is then used as a measure of the collision force [5]."[252] Bounding boxes simplify shapes of digital objects, leading one to consider that in collision, the contour of an object, its polyhedral mesh, and the volume of the bounding box are disparate. "We represent characters by their boundaries and do not see them as solids; we consider two objects as colliding when their boundaries intersect. This means that we will not be able to detect the case where one character completely envelops another."[253] The measurement of force allows to the calculated response to behave as a physical object would in the causal chain of contact being the cause, and displacement its effect. One is entangled with the other.

Interestingly, the centre point of an object has the possibility of being completely absorbed within or entirely co-located with another object. This notion of co-location supports the claim for the "dwelling" as a requirement for alterity or the radical otherness or differentness from other digital objects. Dwelling is to "live" in a permanent residence as one's abode.[254] Lévinas (1961) has stated that "dwelling is the very mode of *maintaining oneself [se tenor]* . . . The 'at home' is not a container but a site."[255] This dwelling is a requirement for actions as an "I." Lévinas however asks, "but how can the same, produced as egoism, enter into

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[252] Sybren A. Stüvel, Nadia Maagnenat-Thalmann, Daniel Thalmann, Arjan Egges, and A. Frank can der Stappen, "Hierarchical Structures for Collision Checking between Virtual Characters," *Computer Animation and Virtual Worlds*, CASA 2014, 24, 3-4 (2014): 331.

[253] Stüvel, et al., *Hierarchical Structures for Collision,* 331.

[254] "dwell, v.," *OED Online,* http://www.oed.com/view/Entry/58765?rskey=n0DNCu&result=1 (Accessed February 18, 2016).

[255] Lévinas, *Totality and Infinity*, 37.

relationship with an other without immediately divesting it of its alterity? What is the nature of this relationship?"[256] This is precisely the tension posed when querying the sensual alterity and the apparatus of touch in the *breve* environment; two objects are others in that they are not assumed by the possession of one or another, then, maintain their alterity while participating in a phenomenal relation. The site of individuation becomes necessary to maintain alterity. Lévinas contests this, stating that alterity is prior to the world we inhabit: "He is not wholly in my site."[257]

Both collision and the concept of others are based on the assumption that digital objects have neighbours. Neighbours are, quite simply, "a person or thing in close proximity to another."[258] A neighbour is an other. *breve* has ready-at-hand neighbour behaviours. The process by which to recognize others is through environmental knowledge; neighbour behaviours are neighbour detection, crowding radius observation, neighbourhood size definition, and monitoring. These behaviours rely on location knowledge and communication. Guillaume observes, "it is classic aporia: the aim of communication is the very thing that renders it unnecessary. In other words, all communication relies on its opposite and on the separation of beings."[259] Neighbour behaviours are more complex than

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[256] Lévinas, *Totality and Infinity*, 38.

[257] Lévinas, *Totality and Infinity*, 39.

[258] "neighbour | neighbor, n. and adj.," *OED Online,* http://www.oed.com/view/Entry/125923?rskey=VBnwh4&result=1 (Accessed February 18, 2016).

[259] Jean Baudrillard and Marc Guillaume, *Radical Alterity* (Semiotext(e) Foreign Agents Series. Los Angeles, CA: Cambridge, MA.; London: Semiotext(e); Distributed by the MIT Press, 2008), 31.

collision handling, and there can be multiple variables by the user programmer and via the interactions of objects, controlling the interactions and responses. What is key in these interactions are ways that they relate to each other regardless of observation. One can see flocking and gestural relations outside of their observational framework given that they are products of a few specific calls to action from the code.

One can better understand the practice of neighbour detection through the demonstration of *Vision Swarm*. The demonstration divides the graphic window to include a first-person view, illustrating triangular bodies and their bounding box. The main graphical window hosts approximately sixty multi-coloured triangle pyramids that signify boids (or "birds") all engaging in apparently aimless flight. There is no goal or energy source to motivate the movement. The floor and blue-coloured sky are dotted by birds that follow, land, and take flight, following commands.

This demonstration illustrates the neighbour detection required for swarming behaviour. The relations of those triangular objects to others in the neighbourhood are clearly marked; the code reads "showNeighborLines." From the code, one can understand in relatively plain language that swarm variables alter the object centre, velocity, spacing, max velocity, and max acceleration. Variables are capable of variation, and these variables are exaggerated into three classes of swarming: normal, obediently, and wackily. If the variables are changed, then the gestural movements are dramatically different. The gestalt of

the gesture is desperate and therefore viewed as disjunctive behaviour. "Vectors are determined from the state of the world," and the vectors move away from neighbours within a "crowding" radius and move towards the centre of the world with the acceleration of an average agent's velocity.[260]

In a similar demonstration, called *SwarmEvolve-2.0,* the neighbouring and swarming gestures operate upon the same logic as the demonstration *Vision Swarm*. The tensions between the objects are the same. What is unique in this demonstration is that the avoiding crowding radius has an included variable to the vector, in order to move away from *other species*. Species are indicated by the colour of the agent bird. In the previous demonstration, the colour was self-chosen, and here it is the facticity of description. Also added was a goal motivator, a vector to move the agent bird towards a randomly shifting energy source, indicated in the visualization as a floating, yellow, pentagram-shaped coin. These digital agents receive an energy boost when they collide with an energy source. They bear energy costs in time step if they collide with another agent, or by being in a neighbourhood predominately composed of different species, and when giving birth.[261]

Rich evolutionary behaviour is exhibited in this swarming demonstration, and some species outperform others by tracking energy sources. Static clouds of

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[260] L. Spector, J. Klein, C. Perry, and M. Feinstein, "Emergence of Collective Behavior in Evolving Populations of Flying Agents," in eds. E. Cantu-Paz, J.A. Foster, K. Deb, L.D. Davis, R. Roy, U.-M. O'Reilly, H.-G. Beyer, R. Standish, G. Kendall, S. Wilson, M. Harman, J. Wegener, D. Dasgupta. M.A. Potter, A.C. Schultz, K.A. Dowsland, N. Jonoska, and J. Miller, *Proceedings of the Genetic and Evolutionary Computation Conference (GECCO-2003)*, (Berlin: Springer-Verlag), 3.

[261] Spector, et al., *Emergence of Collective Behaviour,* 3.

feeders maintain equal distribution amongst the neighbourhood while many feed on the energy source. There is a fitness function to these agent birds that allows for evolution. The digital agents die and are reborn, receiving a new genotype from the "best" agent bird as calculated by energy and age.[262] As agent birds die when they are not receiving an energy source, the multitude of agents born originate from those in the pentagonal coin. "The entire feeding cloud can therefore be thought of as a genetically coupled collective, or even as a multicellular organism in which the peripheral agents act as defensive organs and the central agents act as a digestive and reproductive organs."[263] Here the analogy of the simulation as body is overt.

VII. A. 3. Internalizing Alterity

The apparatus always produces the subject, producing both an interiority and alterity of the digital object. Encapsulation is a means for digital objects to possess an interiority that is indicative for their capacity to demonstrate alterity. I will discuss Lévinas' (1961) notion of alterity, incorporated with some insight from Jean Baudrillard and Marc Guillaume's[264] *Radical Alterity* (1994) will help me in an effort to motivate an interiority of digital objects. I argue that the object's alterity develops an external and internal divide. Encapsulation then becomes a

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[262] Spector, et al., *Emergence of Collective Behaviour,* 4.

[263] Spector, et al., *Emergence of Collective Behaviour,* 4.

[264] Université de Paris-Dauphine.

method of individuating an object from the domain and others—it is an internalizing project of the apparatus.

Alterity is the relationship one experiences to otherness. Otherness is required for objects to interact with one another and in separation from their digital environment. The notion of alterity is a by-product of the agent's separability cut that defines the boundary or the exteriority of the digital body. Alterity provides an intentionality, or an interiority, within these digital objects whose interiority we normally, but mistakenly, understand to be code. The graphic event is, as simulation theory eludes, incomplete and incomprehensibly penetrative. Exteriority is never-ending in the graphical event; however, there is a negation of this exteriority, and that occurs through encapsulation. This object otherness occurs when we have established that the representation of the object and the environment is indistinguishable, from language/code—like cultures and individuals. Alterity, then, is a method of producing the subject, and subsequently, alterity describes an interiority.

The description of object-as-other can be understood via the *Swarm* demonstration which indicates opportunities of otherness within the simulation. A unique distinction in this demonstration is the use of colour to formulate groupings amongst the swarming triangles. I want to motivate otherness as an experience for computation objects as necessary for the resemblance of objectivity. It is another phenomenal cut that renders digital objects different from their environment.

The modularity of agents in *breve* arises from encapsulation; all data required for modifying the agent is internal to the computational object. In *Object Oriented Simulations*, Diane Bischak[265] and Stephen Roberts[266] identify encapsulation as a key potentiality of object-oriented simulation: "Objects encapsulate their functionality and that functional list could include 'intelligence'."[267] A property within an encapsulated object agent may include a parallel processor that learns and evolves.

I have used Barad's agential theory and apparatus to cite phenomenal cuts as a product of rasterization; the exteriority developed, then, is an ontological exteriority—an exteriority that exists as an object in its own right. What Lévinas' exteriority develops is the concept of a face. This agential separability of objects as in-differentiated from others and their environment is but one way to consider these digital objects, be they devices or beings, as individuals or becoming things. The object's separability from the environment is drawn further into question when rasterization occurs. As Lévinas reiterates, "to have meaning is to be situated relative to an absolute, that is, to come from that alterity that is not absorbed in its being perceived."[268] Meaning is a relation, and if phenomenal expression is the quality that is being perceived and is absorbed completely, then

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[266] North Carolina State University. Edward P. Fitts Department of Industrial and Systems Engineering.

[267] Diane P. Bischak and Stephen D. Roberts, *Object-oriented Simulation*. In Proceedings of the 23rd conference on Winter simulation (WSC '91). (IEEE Computer Society, Washington, DC, USA, 1991): 202.

[268] Lévinas, *Totality and Infinity*, 97.

there is no objectivity for sensual objects—this I refute. This quote can be spoken of to represent the sensual object and sensual quality.

In understanding, the other's capacity not to be neutralized by possession so long as the object is not made property, the alterity of the digital object persists. Self-collision is required for the multi-body to not completely possess or self penetrate. The face of the digital object is its frame to its world. Sensual boundaries are considered as the body is developed through multiple configurations. In this demonstration, the apparatus (or the computational method) is a linking force that establishes boundaries of unity that allow for an embodied performance.

VII. A. 4. Intelligibility of the Multitude

The *breve* demonstration titled *creatures* is an iteration of walking behaviours first executed by Karl Sims in *Evolved Virtual Creatures* (1994). The cuboid assemblage of multiple textural colours and patterns form a body held together by various joint configurations, as mentioned previously. Each multi-body contains a variety of attributes and can be spoken of colloquially as the description of physical objects. The multi-body can be evaluated in terms of joints and vectors.

Creatures begins with a scene in which, after abruptly falling from the sky, various configurations of bodies land on their edges and begin to move autonomously, and any joining cubes act as limbs. The ground is a repeating

texture of light green that alternates in hue, providing the illusion of grass density and appearing rigid as it stops the falling blocks of various volumes in place. In the background, high brown mountain range circles the simulation environment, seemingly unreachable, faded to almost transparent in the distance. This demonstration has text on the bottom right-hand side of the screen indicating the objects' generation, previous best distance, and current distance travelled. Each body that falls from the sky increases the generation number by one. The movement is so jarring that the multi-bodies often fragment and re-join without experiencing damage to the joints and the body as a whole.

Multi-bodies are constructed in *breve* as a subclass of mobile. "Mobile objects are objects in the simulated world which move around and interact with other objects."[269] Multi-body is a group of objects connected as a single body that commands a group of objects into one articulate body. A multi-body requires a root link object; all links directly and indirectly attached become the multi-body. Appearances, like other objects, are set with texture, reflection, and shadow methods. Multi-bodies are unique and require additional collision-handling calls, where they can penetrate and collide with themselves. Multi-bodies are articulated as one body.

In the *creatures* demonstration, digital objects interact as performative agents constructed of multiple cubes to illustrate the intelligibility of the

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[269] "The Breve Simulation Environment Documentation | Breve." 2015. Accessed May 7. http://www.spiderland.org/breve/documentation.php.

multitude. These digital objects operate on the method of multi-body, which have groups of objects interacting in a logical whole. An interesting departure from Lévinas' notion of the face, the face here has become spectral, meaning a mode of being and exchanging that is due to multiple networks of communication.[270] Guillaume expresses that "spectrality is the dispersion of the subject."[271] Further, Guillaume restates "spectral exchanges with a multitude of others are no direct encounters with their alterity . . . they contribute to sculpting the multiple facets of the self; they give rise to effects of alteration and alterity within the subject."[272] The inclusion of a multiplicity of faces in the multi-body's digital object helps to "modernize" Lévinas' theory that is premised on subject/object relationships and extending the notion of response-ability to a variety of others. The intelligibility of the multitude is for the world, not a specific observer.

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[270] Baudrillard and Guillaume, *Radical Alterity*, 30.

[271] Baudrillard and Guillaume, *Radical Alterity*, 39.

[272] Baudrillard and Guillaume, *Radical Alterity*, 40.

VII. Conclusion

This thesis set out to research ways in which contemporary theory has the potentiality to describe sensual objects in a simulated/virtual environment. In "Representation and Mediating Structure of the Apparatus," I interrogated how representationalism was responsible for dissonance in referent modelling. This allowed me to introduce the apparatus as a mediating structure. I proposed that fiction and metaphor are powerful components to simulations capacity for demonstration.

In this thesis, I put forward the claim that the sensual bodies of digital objects has cause little debate in contemporary theory. In an effort to communicate digital objects autonomy, I examine the apparatus as it fills the role of the observer, and as such instantiates marks upon the digital body. I establish the digital object as a object which ought to be considered in popular object oriented ontologies. I backed away from the reflexive perspective of the user, in an attempt to differentiate perception from sensation however, this excluded the agency of the maker.

For that reason, in "Applied Assemblage," I construct a definition of sensation that is approximately distant from a representationalist approach. The sensible object is defined to be something more than representing a real object. Further, I question how the transformation of digital objects in their sensuality are made objects 'appropriate' for scientific inquiry. Again, I try to advocate for the inclusion of digital objects as objects of value.

These objects are discussed at length in "Biography of Breve," where I suggest that computational representations embody the theoretical logic of sensual exteriority, namely through visualization. I negotiate digital bodies as vertices and attributes to be ontologically stable. I consider how the linking force of joints demonstrate what can be fragmented from an object, is not considered the object in itself, rather something countable and *other* holds. I explore the apparatus as always producing the subject—interiority and alterity—and illustrate how encapsulation is the interiority of the computational object.

As has been stated in "Sensual Facets," I formulate that rasterization is an agency working upon objects, arguing that it is a knowing process that enacts meaning through digital reconfiguration. The rasterization process becomes an observer that marks (causes) phenomenal expression of exteriority. The cuts that occur with the rasterization apparatus provide an unrivalled, and inexhaustible digital exteriority. This exteriority is pronounced by otherness in its condition of being a face to a stranger of other digital objects. I exemplify rasterization as the apparatus being a boundary-making practice, marking the digital body by ascribing properties and meanings by differentiating the digital object from its environment. I defend that digital objects perform an experienced individuation from a coalescent environmental body and from other digital bodies.

To advocate for Barad's infinite universals and as a way to introduce the absolute otherness of Levinas theory, the role of 'domain' is paramount; the scope

of the domain changes drastically the phenomenal cut, as it changes the apparatus of measurement.

In brief, “Sensual Alterity” introduced the architectural landing site as a bounding box and as such, it is instrumentally created from the performance of the digital body. I defend that the site of individuation becomes necessary to maintain alterity. I defend that rigidness is not a quality of substance, rather a boundary that is developed through touch, expounding on the idea that alterity is the apparatus of otherness. I defend that the face as spectral, and illustrates the intelligibility of the multitude.

The contribution of this work endeavours to define what constitutes a sensual alterity between digital objects. The exterior of a digital object is argued sensual in the framework provided. I defend a call to action for the metaphysical exploration of digital objects and their sensual proprieties.

Moving forward, I am interested in the relationship between sensible digital objects and responsibility. Recognizing screen essentialism as a criticism to the limitations of the scope of my thesis, I see an opportunity to explore the materiality of touch gestures not simply considering how the image is entangled with its hardware, but what can occur as gestures are interfaced in a simulated environment? In what manner does the potential of digital sensuality change the way media is constructed or experienced?

I argue that the potentiality of sensual boundaries in digital objects excites an empathic transfer of morality in users. What is permissible to code is called

into question now that intentionality and sensibility are exhibited between digital objects. This thesis urges the consideration of the digital object as a stakeholder in technological design, that would include but not be limited to imaging technologies, intelligent personal assistants, software, holograms and animation. The outcome of this analysis forecasts a future new aesthetics of the object, that can be said to participate in the ethical.

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