A Counterrevolution in the Hands: The Console Controller as an Ergonomic Branding Mechanism

David Parisi

Abstract

In this article, the author examines the tactile materiality of the videogame controller, reading its stability across multiple generations of game consoles as a strategy simultaneously intended (1) to maintain the ergonomic identification between the player/consumer and the console/brand and (2) to continue the flow of information from game machine to player body. In spite of massive investments by both Sony and Microsoft in significant controller redesigns, the companies each opted for only slight modifications to the physical structures of their gamepads. Though new generations of game hardware are always accompanied by promises of "revolutionary" changes in the game experience, the material constancy of the PlayStation and Xbox controllers suggests that the hands, and the sensations communicated through them, serve to counter and constrain potential upheavals in the modalities of game interfacing. The haptic properties of these controllers, revealed through the player's active manipulation of the gamepad, cement a bond between player, console, and brand that engineers and marketers are reluctant to disrupt. What the author understands

---

Author Biography

David Parisi (PhD, NYU, Media, Culture, and Communication) is an Assistant Professor in Emerging Media at the College of Charleston, and previously held a postdoctoral fellowship in New Media Literacies at Rutgers University. He has published extensively on the relationship between games interfaces and player bodies, including "Reach In and feel Something: On the Strategic Reconstruction of Touch in Virtual Space" (*Animation*, 2014), "Shocking Grasps: An Archaeology of Electrotactile Game Mechanics" (*Game Studies*, 2013), "Game Interfaces as Bodily Techniques" (*Handbook of Effective Research on Electronic Games*, 2009), and "Fingerbombing, or 'Touching is Good': The Cultural Construction of Technologized Touch" (*Senses and Society*, 2008). His forthcoming book, *Touch Machines: An Archaeology of Haptic Interfacing*, provides a macro-historical grounding for the contemporary emergence of touch-based computer interfaces.

as an ergonomic branding strategy treats the controller as a material stand-in for the game company's identity.

Focusing critical attention specifically on the standard console controller, rather than on more recent gesture-based interaction mechanisms or audiovisual modes of information display, reveals a stable relationship underpinning the regular generational upheavals in game hardware, and by doing so, resists embracing the teleological and progressivist narratives around interfaces that understands them as pushing toward an increased folding of player bodies into game worlds.

Introduction

Each new generation of game consoles inspires hope, however fleeting, that steps forward in game hardware will bring increasing improvements in the quality of games and, correspondingly, in the gameplay experience. This technologically deterministic framing understands improvements in the computing hardware that enacts game texts as synonymous with improvements in games themselves; gamers wait hungrily for console manufactures to announce new hardware specifications, confident that game designers will capitalize on the potential for increased graphical detail, faster rendering speeds, lower input lag, greater processing power, and more accurate positional audio. These periodic advances, what we might understand following Apperley (2010) as part of gaming's "rhythms," establish a temporality grounded in regular breaks with the past and surges forward into the future—hardware advances are routinely celebrated as "revolutionary" for their capacity to unleash new sensate experiences with game worlds (***1***).

With the console controller, however, there is no universal standard for what constitutes a forward step; shifts in the physical design of the gamepad—changes, for example, in button placement, thumbstick length, and handle contours—interpreted as an advance by one player may be read as an alienating step backward by another. The concept of *fit* between the physical interface and the hands, deployed productively by Heidi Rae Cooley (2004) in her analysis of handheld mobile screenic devices, directs us to consider the way that industrial designers account for the particularities of and variations between human bodies, and the variety of uses human bodies will find for handheld devices, in selecting the button sizes, materials, surface texturing, weight, and shapes of handheld communication technologies. Fit emphasizes the importance of process over outcome: Necessarily-incomplete, the quest to find the correct fit depends on soliciting feedback from bodies with differently-sized hands as they physically engage media technologies. With considerations of fit, beauty—or pleasure derived from a device's tactile aesthetic—rests comfortably in the hands of the beholder (***2***).

In the process of designing and marketing new controllers, then, game companies face a competing set of imperatives as they strive to find a balance between the exotic and the familiar. The stakes in the design process are quite high; unlike with the audiovisual interface,

problems with controller design cannot be erased by simply pushing out a software update. Claire Gottschalk, an industrial designer who worked on Valve's forthcoming Steam Controller, framed this as a challenge of working with atoms, in the case of the console's controller, rather than bits, in the case of the console's software (Hamilton, 2014). New generations of consoles therefore bring a heightened interest on the part of hardware designers in the relationship between player hands and game machines, tacitly recognizing that the hands will be the primary points of contact between consumer and console—spaces where information vital to the game experience flows both from player to machine and from machine to player.

With this positioning in mind, I understand the hands as serving a counterrevolutionary function in console development cycles. The strategy of catering to what Microsoft's general manager for accessories Zulfi Alam referred to as "golden hands" (quoted in Hsu, 2013b)—shorthand for a core group of dedicated gamers with intricate knowledge of the controller's workings—helps ensure that controller designs will maintain a constancy from one console generation to the next. With the November 2013 release of the Playstation 4, Sony debuted the fourth generation of its successful DualShock controller; the design of the DS4, in 2013, does not feel or look significantly different from the DS1 Sony first sold in 1997. Similarly, Microsoft's Xbox One controller, also released in November 2013, does not deviate radically from the controller designed for the original Xbox in 2001. For an industry that traffics in the rhetoric of revolution, where each successive console lifecycle pushes toward the overarching end of purifying the game-as-medium, this stagnation of controller designs across consecutive generations of platforms indicates a desire for stability in the face of these periodic upheavals.

After briefly tracing the recent trajectory of game controllers and their theorizations by game scholars, I turn to the concept of "sensory marketing," recently popularized in marketing practice, to help explain this stagnation of controller design. Informed by comments from product designers for Microsoft, Sony, and Valve published in the gaming press, I argue that each company is engaged in a process of what can be conceptualized as *ergonomic branding*, where brands are maintained (or in Valve's case, established) through intentional and carefully-considered decisions about the material design of the controller intended to produce a signature feeling in the hands of players. Consistent references to the "iconic" layout of the dual analog sticks, for example, do not just refer to the controller's visuality, but also to its hapticality—a company's controller serves as a material and physical signifier of its brand, a haptic icon that is the tactile equivalent to the brand's logo. This keen awareness of the relationship between hand and brand, part of a broader trend in marketing toward considering the full range of senses involved in consumption, discouraged Microsoft and Sony from making radical and potentially disruptive changes to the configuration of game controllers.

To help further explain the controller's material stability, I then move to a discussion of the dual-motor vibrotactile feedback mechanism featured in console gamepads since Sony's first-generation DualShock in 1997 (**3**). Typically referred to as "rumble," the vibrotactile feedback system employed in PlayStation and Xbox controllers uses motors with different

weights in each handle (the lighter weight is located in the right handle; the heavier in the left) to produce tactile sensations that correspond to in-game events. In first-person shooters, differences in the pace and intensity of rumble indicate the firing of different weapon types; in fighting games, different rumble patterns indicate the intensity of strikes against the player's body. In spite of being denigrated as a "last-gen" feature by representatives of both Sony and Microsoft (Edge Staff, 2010; Kietzmann, 2007), both companies opted to continue to include rumble in their redesigned gamepads, with Microsoft enhancing the feature by adding vibrotactile feedback motors called "Rumble Triggers" to the device's triggers (Microsoft Corporation, 2014). Similar to fit, the efficacy of this feedback mechanism depends on the *grasp*—on a particular configuration of the hands as they squeeze the controller's two handles, thereby opening up the tactile channel to receive coded data from the game. Any drastic changes to the size and shape of the handles would prove disruptive to what has been perhaps the most widespread and stable deployment of haptics technology in its nearly century-long history. I close by suggesting that game critics, developers, and scholars alike can benefit from devoting increased attention to the controller's formal qualities, and their implications for game design, rather than waiting for the present, longstanding paradigm in controller design to be eclipsed by future technological advances.

Evolving Control: Celebrating the Body-as-Interface

The academics who study games are not immune to the aforementioned seductions of new hardware; as Brendon Keogh (2014) observed in the inaugural issue of *Journal of Games Criticism,* game scholars, signing onto "the commercial game industry's pervasive, progressivist coupling of "quality" videogames with technological advancements," seem to be waiting for game hardware to unleash the medium's true potential. Each successive generation of consoles places greater distance between video gaming's past reliance on the conventions of other media, and brings them closer to a future where they will conform to a "pure videogame form" (Keogh, 2014). For Keogh, this perpetual deferral proves problematic because it distracts attention away from what video games *are* by focusing on what they can, though perhaps may never, *be*; seduced by the allure of formal purity, game scholars participate in the privileging of a particular, universalized, and normative vision of videogames. Game scholars become too invested in realizing and articulating the potentiality of videogames' future formal evolution to recognize and appreciate the variances in the actuality of the medium's present forms. Following the more recent turn toward materiality and the related emphasis on embodiment in game studies (Apperley and Jayemane, 2012, p. 15–17), Keogh stresses the player's bodily relationship with the game text as the ground for this actuality and in doing so, attempts to press concerns over the phenomenology of game experience to the forefront of game criticism.

The Console Controller as Commodity

Before the emergence of gesture-based game interfaces, the controller had generally been excluded from these teleological narratives of videogaming's evolution, "bracketed," as Graeme

Kirkpatrick (2009) argued, "as a constant of hardware" (p. 131), seemingly immune from the fetishization of the new that has continually surrounded other types of game hardware. This constancy caused its presence to almost disappear, to the extent that Kirkpatrick (2009) claimed the gameplay experience depended on the player's capacity to forget and erase its presence—to fuse seamlessly with the game world requires the player to merge unconsciously with the device that provides access to it. In this paradoxical relationship, once the player acquired the basic syntactical movements necessary for navigating through the game world, the relationship between the hands and game slipped into neglect; the hands were central to the act of play, but peripheral to the experience of that act.

However, the controller's status as a "constant" in hardware, a device "antithetical to the game as commodity" (Kirkpatrick, 2009, p. 140), was gradually upended by the commercial success and cultural resonance of new, body-based controllers. The physical interfaces for rhythm games like *Dance Dance Revolution*, *Rock Band*, *Guitar Hero*, along with capture controllers like Sony's EyeToy, the Wiimote, the Wii Balance Board and, later, the Kinect and Move, each helped interrupt the controller's stability. Game interfaces were folded into the cycle of perpetually-hyped hardware turnover that they had previously been excluded from, as new audiences proved willing to pay a premium for devices that would alter their physical relationships with game worlds. Nintendo, in its initial codenaming of the Wii as "Revolution," explicitly announced and celebrated this paradigm shift in game interfacing, promising that its new console would provide a clean break with prior modes of interacting with game texts. The attempts by Microsoft and Sony at cloning Nintendo's success seemed to indicate that these "mimetic interfaces" (Juul, 2010, p. 18) were irrevocably altering the landscape of the game industry. The popular press, accustomed to bashing videogames for fostering sedentary and inactive lifestyles, began to praise the new devices for their ability to encourage bodily activity and exercise. What Jesper Juul (2010) termed the "casual revolution"—a "breakthrough moment in the history of video games" (2010, p. 2)—shifted away from the complexity of the traditional gamepad to market game hardware and software to new audiences. Rather than being *antithetical* to the game-as-commodity, the controller became instrumental in helping games penetrate new and previously unreachable demographics.

From hands to bodies

This wave of new controllers expanded the locus of control outward from the hands to encompass other body parts—each new game interface asked players to master an idiosyncratic combination of bodily movements, and by doing so, pleasurably disrupted the relationship between player and machine. The precise control over the fingers and thumbs required by gamepads quickly became displaced by the need to control and coordinate movements among the different limbs. These interfaces pushed player bodies into new configurations, asking that players assimilate to the "techniques of the body" (Mauss, 1972, p. 71) suggested by the controller's specific mode of reading and capturing bodily movements (Parisi, 2009). A symbiosis of technological innovation and marketing strategy (Simon, 2009; Jones &

Thiruthukal, 2012), this revolution in the mode of control suggested a new trajectory for game interfaces that would push, through refinements in both hardware and software, toward an increasingly-accurate physical realism, and by doing so, provide a refreshing reversal of the trend toward ever more abstract, arbitrary, and complex controller configurations. The paradigm shifted toward interfaces lauded as more natural, friendlier, frictionless, more intuitive, less challenging—*easier* interfacing that mobilized a preexisting storehouse of movements performed by the whole body instead of forcing players to assimilate their hands and fingers to the demands of 16-button, dual analog console gamepads. By capturing body movements, games interfaces seemed to be inching toward what has often been described teleologically as the "Holy Grail" of virtual reality: the feeling of being fully present in a computer-generated environment, achieved in this instance not by the enclosure of the player's audiovisual field, but instead by an increased envelopment of the body in various types of capture and feedback devices. Erasing the seams that serve as reminders of the gaps between our bodies and the virtual worlds they enter helps push, in this model, toward an embodied sense of immersion absent from previous interfacing schematics.

Writing the gaming body

Early videogame scholarship emphasized the medium's cinematic roots and visualist conventions of interfacing, what Behrenshausen (2007) described as a hegemonic ocularcentrism (the privileging of vision and visuality over and against the other senses) operating in game studies that "narrows thinking and theorizing about video games to cognitive, psychological, or quasi-cinematic concerns" (p. 335). Driven in part by a frustration with this ocularcentric tradition, a subset of game scholars turned their focus to players' embodied relationships with game texts and the machines through which they are encountered. Embracing a cyborgian perspective on gameplay that understands the act of playing a video game to involve a fusing of player and machine—a symbiotic union between two information-processing systems that meet at the point of contact known as the interface (for example Aarseth, 1997; Friedman, 1999; Huhtamo, 2005; Pias, 2011). In response to this purported overemphasis on the visual aspects of games and the corresponding genealogies of the medium that reductively position it as the offspring of cinema, game scholars stressed the ways in which videogames specify and depend on actions taken by players' bodies (for example, Apperley, 2010; Behrenshausen, 2007; Huhtamo, 2005; Kirkpatrick, 2009; Parisi, 2008).

This intensified focus on the videogame's invocation of and dependence on the body emerged, not by coincidence, in the wake of the commercial success of game interfaces that disrupted the gamepad's previous stability. Game scholars responded to this wave of interfaces by quickly developing nuanced theoretical frameworks capable of accounting for the body's newfound centrality in the play experience: concepts such as gesture, rhythm, kinesthesis, mimesis, sensory realism, and muscle memory increasingly took center stage in attempts at supplanting game studies' aforementioned ocularcentrism with more comprehensive, embodied accounts of play. The popularity of gesture controls provided an occasion to write the body *into* game studies, almost implying that, prior to gesture-based interface, the

body had been absent from games themselves. But even before gesture, players had bodies, and interfaces brought with them norms, expectations, and habits of bodily comportment essential to facilitating experiences of game worlds. Though gesture certainly altered relationships between bodies and games, it did not instantiate them, and further, those alterations have not proven irreversible.

A Return to the Hands

In the rush to celebrate these novel modes of interaction, in the push to understand the ramifications and significance of the revolution in game interfacing, game scholars may have underestimated the console controller's immense staying power. The November 2013 releases of new consoles from Sony and Microsoft, in spite of both companies devoting significant resources to reconceptualizing their controllers, brought no radical changes to either system's controllers. Microsoft invested over 100 million USD, and two and a half years of development time, in a redesign of the Xbox controller (Crossley, 2013); along the way, the engineering team built hundreds of prototypes with varying contours, button layouts, and embedded displays. One of the stranger iterations used olfactory display technology that would allow players to experience different smells (Hsu, 2013b) as they moved through game worlds. In plotting their strategy for transitioning from the DualShock 3 to the DualShock 4, Sony entertained similar fantasies of a complete design overhaul before ultimately, like Microsoft, opting for minor changes to the DS4's physical structure (Hsu, 2013a). Perhaps most importantly, Sony elected to retain the symmetrical, iconic locations of the controller's dual analog thumbsticks, ensuring that its central ergonomics would remain constant in spite of the new touch-sensitive surface added to just above the analog sticks. Valve, in their push to migrate the Steam distribution platform from the desktop to the living room, recognized that the keyboard/mouse control system PC Gamers have used for decades would need to be supplanted by a device friendlier to couch-based game session, and went to work designing a gamepad that the company understands as central to the success of its SteamBoxes. The Wii U Pro Controller, too, eschews the screen-centric design of Wii U GamePad in favor of what is frequently described as an "XBox-style" controller. Further, the media streaming devices released by both Amazon (the Fire TV) and Google (the Nexus Player) each feature game controllers as optional accessories, with the Fire TV's controller emulating the analog stick positioning and button layout of the Xbox controller, and the Nexus Player's controller mimicking the symmetrical analog stick design employed by Sony's DualShock controllers.

Rather than a move away from the hands to body-based control schemes, then, this most recent generation of gamepads expresses game companies' awareness that their "core" audience is concerned more with facilitating better finger- and thumb-based inputs than they are with novel modes of bodily engagement. I want to suggest that this conscious strategy of devoting resources to what are ultimately fairly conservative refinements in the design of game controllers can be read as part of an explicit strategy aimed at maintaining brand loyalty and cementing brand identity using the haptic channel. Such a strategy holds the design of gamepads within stable boundaries, keeping a range of potential futures of the body from

Figure 1: Xbox One Controller Prototype Shells. Image adapted from "The Xbox One controller: Projectors, smells(!), and other stuff that didn't make it in" by D. Hsu, November 18, 2013, *VentureBeat*. Copyright by GamesBeat.

manifesting.

Ergonomic Branding

In published interviews in the gaming press, representatives from Sony, Microsoft, and Valve each described the iterative design processes their teams went through in preparing new controllers for their consoles (Hsu, 2013b; Crossley, 2013; Hamilton, 2014). Microsoft in particular expressed a reluctance to significantly alter the design of what it trumpeted repeatedly as its "best-in-class" controller (Morris, quoted in Hsu, 2013b). The material stability of console controllers can be understood, then, as an attempt at *ergonomic branding*—impressing the brand's identity into the muscles, joints, fingers, and thumbs of the player/consumer through the design of controllers that manage to remain materially constant across successive generations while still pushing gains in both comfort and the efficient performance of game tasks (*4*). Such a positioning locates controller design as a competition between game

companies to arrive at an optimal arrangement between body, machine, and game text, a process aimed at unleashing the full potential of the gamer's hands through iterative design. This design process—a cocktail that mixes together research from disparate fields such as consumer psychology, biomechanics, psychophysics, industrial design, and human factors—produces an embodied experience of the company's brand, the fundamental locus of which rests in the player's hands. Through this process, controller designers express preferences for a particular demographic, body types, gender, and even genre. In a demo video published on the company's Youtube channel, which has received over 3 million views to date, Valve showcased its Steam Controller's capacity to accurately navigate the turn-based strategy game *Civilization V*, offering evidence to suggest that the genre could finally migrate successfully to what it refers to as the "big screen" after being confined by need for mouse/keyboard control to the smaller screens of desktops and laptops (Valve, 2013). The direction pad on the Xbox 360 controller had been designed with "Street Fighter-style maneuvers" in mind (Hsu, 2013c); in the reworked version, Microsoft senior industrial designer Quintin Morris specifically acknowledged making the d-pad friendlier to the uses of Call of Duty players (Morris, quoted in Hsu, 2013c). Alam reported interviewing "hundreds and hundreds of *core* gamers" (quoted in Crossley, 2013; emphasis added) in redesigning the XBox controller, signaling the company's aim to cater to what they understand as their most dedicated demographic, rather than attempting to pull in new audiences. Even the depth of the cups at the end of the dual analog sticks on the DualShock 4, altered in the new generation, express particular habits of manipulation and facilitate greater comfort when executing certain game actions. The styles of manual navigation do not, then, translate universally across game genres, but are idiosyncratic to the types of actions required by particular games.

Marketing (to and through) the Senses

Thinking about the console controller as a commercial product—the specific features and shape of which are the endpoint of a complex and arduous industrial design process informed by iterative prototyping, play testing, and market research—can help to explain its material stability by highlighting the ways the body and its senses are explicitly hailed by product designers. Recent research by scholars in the field of sensory studies has focused attention on the new trends in product design and marketing that take aim at consumers' sensory encounters with a company's brand identity. David Howes, one of the field's most prominent voices, proposed the term "hyperesthesia" to describe the state induced in consumers by the "multisensory marketing" strategies used to facilitate product purchases (2004, p. 288). The construction of spaces within which consumption occurs is informed by a set of technical practices aimed at "multiplying the sensory channels through which the 'buy me!' message is communicated" (Howes, 2004, p. 88). This process serves to link brand identity to carefully-crafted sense perceptions, forging a stable set of associations between sensory markers and the corporation's products—a literal imprinting of the brand on the consumer's sensorium. Although, as Howes (2013) pointed out, marketers have a long history of attending to sense experience, "it is only recently that the academic discipline of marketing has discovered the senses and the sensuality of products" (p. 23).

Sensory marketing practices invoke the senses both discursively and directly. At the discursive level, advertisements use sensory language to conjure either sensory experience as a whole or hail one of the five senses in particular. One ad for the Medieval Times restaurant chain, for example, promised "A Siege on the Senses," while 5 Gum's television commercials have used the tagline "Stimulate Your Senses." Nintendo used this discursive conjuring of a specific sensory modality extensively in its "Touching is Good" campaign, which employed both traditional and guerrilla marketing tactics to promote its DS console (Parisi, 2008). Direct appeals to the senses, by contrast, involve factoring sensory considerations into the process of designing consumer products and consumption experiences. The decisions Microsoft and Sony made in redesigning their console controllers illustrate an awareness of this recent move toward sensory marketing. Both discursive and direct appeals consciously hail the tactility and haptic experience of game interfaces, showing considerations of touch to be central to the branding of game consoles. Informed by specific case studies in the marketing and design literature, Howes (2004) shows this tactile modality to be a particularly appealing avenue for marketers, as it provided a pathway through "advertising clutter," an alternative route to the consumer that circumnavigated the "visual jungle of logos, billboards and neon signs" (p. 287). As recognition of touch's importance in consumer decision-making grows, the strategies for forging this pathway to touch acquire an increased complexity and technicity. In designing products capable of concretizing a set of haptic associations between brand and consumer, sensory marketers are encouraged to consider the "neurophysiological building blocks of touch" (Klatzky, 2010, p. 33) when selecting materials, deciding on the product's physical dimensions, surface textures, and weight. Taxonomies that cleave touch according to its "hedonic" and "instrumental" (Peck, 2010, p. 22) orientations provide a framework for the construction of consumer tactile experiences. Taken together, these efforts represent an attempt to provide touch with a new and formalized use-value in cultivating and securing brand loyalties, where the tactile materiality of the object is collapsed onto the set of stored memories associated with the imaginary of the brand.

A collective, cultivated sense of touch—that mass of gamers who possess the coveted "golden hands"—is mobilized to register, apprehend, and validate differences inaccessible to visual inspection alone. Generational differences between controllers may appear on sight to be slight, throwing gamers back on small differences in "feel" to notice the gains made in the latest offerings from Sony and Microsoft. Each controller mobilizes a haptic epistemology, apprehended through *fit* and *grasp*, not just of the game world, but of the product itself. The controller's contours, its weight, the texture of its surface, and the materials used in its construction each become essential considerations in the design process (an issue Swink discusses extensively in *Game Feel*); the responsiveness of the controller to player inputs, and the minute differences in the placement of buttons and the height of thumbsticks also each serve as crucial indicators of the brand's identity. From this perspective, controllers become not external to the logic of the game-as-commodity, but rather components crucial to a console's success in a competitive marketplace.

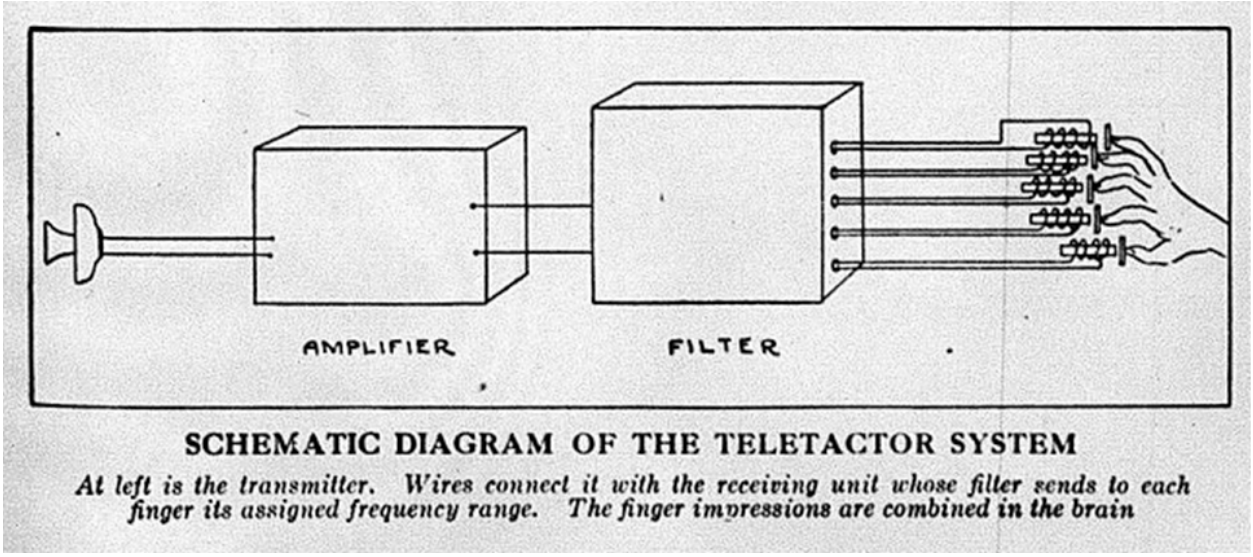

Figure 2: Robert Gault's Multiunit Teletactor. Image reproduced from "Learning Language by its Feel" by R. Gault, December 1927, *Scientific American*, pp. 524–525.

The Data Grasp

Microsoft and Sony's reluctance to drastically reconfigure the physical space of contact between player and game also underscores the importance of the *grasp* both to the construction of gamic experience in general, and to the hailing of touch as an informatic channel in particular. The grasp serves not just as a means of positioning the hands so that they can route commands to game machines, but also provides a way for information to move, via vibrotactile feedback generated by the rumble motors in the controller, from machine to player. This technique of using the grasp to route sensations into the player's body extends back to the 1880s, when the designers of arcade cabinets began using elaborately-crafted metal handles to send electricity into players' bodies (Huhtamo, 2005; Parisi, 2013). In those early shock games, the player, through contact between hand and handle, quite literally became part of an electrical circuit with the machine. Games like *Spear the Dragon* (1926) often tested the player's ability to maintain their grasp as gradually-increasing levels of electrical current inflicted pain that could be relieved simply by breaking the circuit—by releasing the handles. The handles provided a space of agonistic struggle against both the game machine and the quintessentially modern force of electricity, with the player's ability to maintain their grasp as the defining condition of victory.

In the 1920s, Robert Gault undertook a series of experiments intended to aid the deaf in "hearing with the sense of touch" (Knudsen, 1928, p. 320) using machine-generated vibrations. At his Vibro-Tactile Research Laboratory (5), Gault used a device called the Teletactor (see Figure 2, above) to pass speech sounds through five digits of a subject's hand (1936).

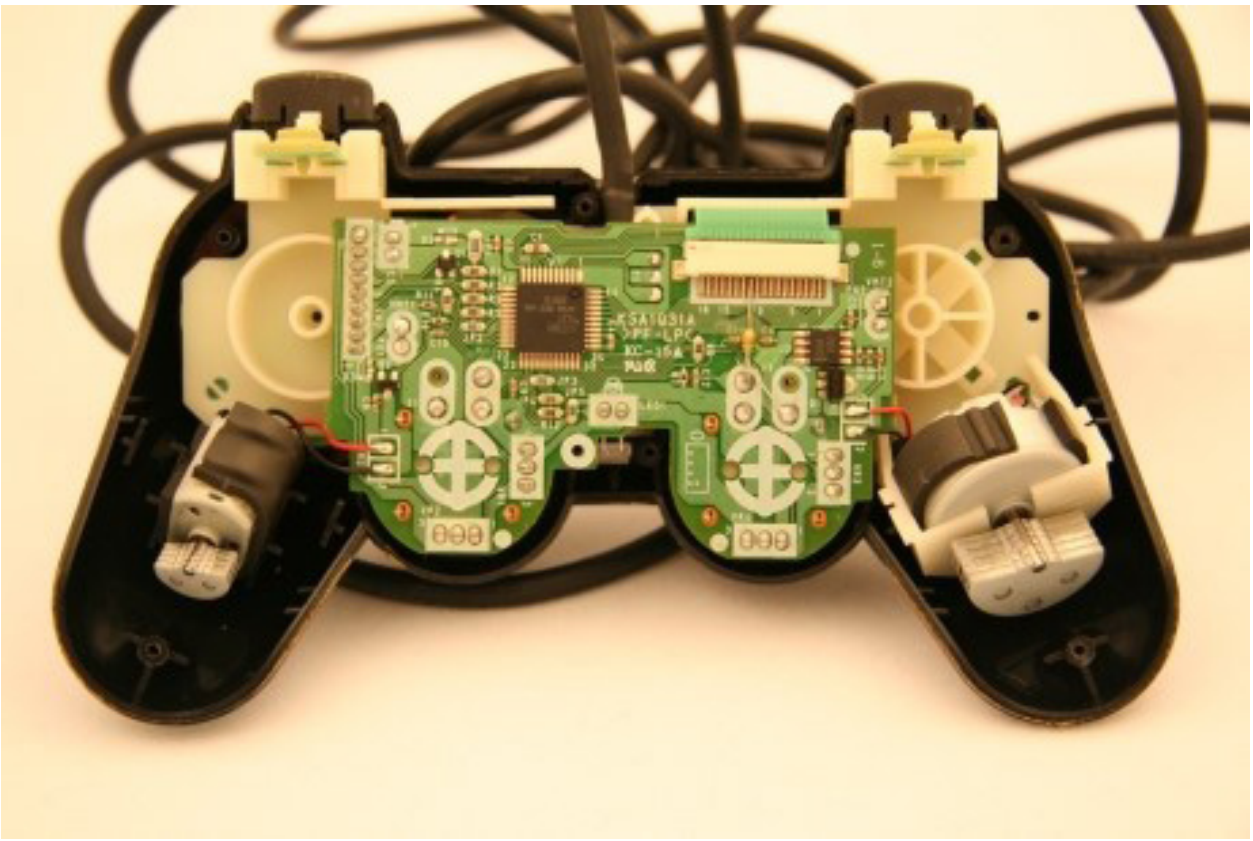

Figure 3: Rumble Motors in the DualShock 2. The differences in the weights on each motor allows the controller to produce a greater range of sensations than would be possible with matched weights. Image reproduced from "Playstation 3 SIXAXIS dissection and Dual Shock comparison" by G. Block, December 1, 2006, *IGN*. Copyright 2015 by Ziff Davis.

Here too the grasp proved essential to allowing sensations to pass from machine to human—the Teletactor's rods, vibrating against the tips of the subject's digits, depended on a firm and uninterrupted grasp of the device. Gault's research involved specifying the fingers' capacities to discriminate between machine-generated sensations, and by doing so, helped further the construction of an extensive body of knowledge about the vibrotactile channel's data-processing capacities. In addition to engineering sensations, Gault was faced with the task of engineering subjects: Participants in his trials had to be *trained* to associate the rods' vibrations with speech patterns, and this training process proved to present an insurmountable challenge for some of his subjects. Attending to these minute differences in vibratory fluctuations, what would later be called "vibrotactile learning" (Furner & Diespecker, 1969, p. 167), demanded the devotion of vast attentive resources to the points of contact between skin and device. Later devices that followed in this tradition used vibrating motors distributed across the body to convey coded information to their wearers (see Geldard, 1940) and by

doing so, displaced the hands as the loci for tactile information transmission. As engineers moved the vibrotactile motors about the body, attempting to find the most efficient configuration for circulating coded messages through touch, what remained constant was the requirement that information-processing subjects assimilate themselves to new touch-based languages; these subjects had to learn to interpret vibrations that would otherwise be read as noise instead as signal.

Grasped firmly in the player's hands, with its two motors spinning at carefully-modulated frequencies, the console controller embodies a merging of these two traditions—one where the grasp materially implicates the player in the game world, and the other where the grasp is hailed as a space with particular capacities for receiving coded information. Since Sony's 1997 release of a dual-motor rumble feedback system in its first-generation DualShock controller (*6*), console gamers have gradually learned to read by touch; like the experimental subjects acclimating themselves to early tactile language systems, console gamers' acquisition of a "tactile literacy" (Geldard, 1957, p. 115) is specific to the mechanism employed in the production of tactile sensations. Any drastic transformation in the mechanism—a shift in the modality of tactile feedback from vibrotactile to pneumatic, a movement of the stimulus away from the hands to other parts of the body, or even the move from a single-motor to a dual-motor system—requires the player to acquire literacy in a new language of touch.

Denigrating and Transcending Rumble

Though both a comprehensive genealogy of rumble in videogames and a detailed analysis of its formal conventions are beyond the scope of this article, the continued absence of such analyses from game studies indicates the extent to which rumble appears, like the controller prior to the advent of mimetic interfaces, as a sort of taken-for granted constant of game hardware. Discussions of game feedback mechanisms make obligatory and passing references to rumble, but stop short of meditating on the specific techniques used to forge semiotic links between images, sounds, and tactile cues (for one exception, see Lipkin, 2013, p. 36–37). Even Swink's (2009) *Game Feel*, which would seem to present a fitting space for such a discussion, devotes only a single paragraph of what is already a truncated single-page discussion on "tactile effects" (p. 162) to vibrotactile feedback (*7*).

Some in the commercial game industry have gone beyond passive neglecting rumble to actively denigrating it, crafting a narrative where dual-motor vibrotactile feedback will be inevitably eclipsed as part of game interfaces' teleological march forward toward full sensory immersion. In 2007, after the initial launch of the PlayStation 3 console and its rumble-less SIXAXIS controller, Sony's Phil Harrison declared rumble a "last-generation" feature that would be rendered obsolete by motion control (Kietzmann, 2007). Kudo Tsunoda, general manager for Microsoft Game Studios, referred to rumble as a "rudimentary form of haptic feedback" and indicated that Microsoft's engineers by 2010 had "gone so far past anything that can be done with rumble" (quoted in Edge Staff, 2010). Arguing for the superiority of the contact-less Kinect, Tsunoda characterized as "laughable [...]the way people hold on to

rumble as the holy grail of haptic feedback" (quoted in Edge Staff, 2010). For Tsunoda, future generations of game interfaces will inevitably liberate players from the need to maintain the grasp of the hands on the controller. Even some engineers and researchers in the field of haptic interface design read the dual-motor feedback technology used in gamepads as a sign that "haptic technology is still in its infancy" (Bicchi, Buss, Ernst & Peer, 2008, p. 2), rather than an indicator of haptics' successful and widespread deployment.

The promotional materials for third-party, non-rumble haptic feedback mechanisms also participate in this generationalist narrative, appropriating the rhetoric of revolution in trumpeting the features of their products. Novint Corporation, which had previously attempted to transform game interfaces with its Falcon 3D touch controller (released in 2007), has recently turned its attention toward a controller called the Xio, essentially an exoskeleton for the whole arm that added "the sense of touch to motion control" by providing force feedback through the device. Like the Falcon before it, which used force feedback to simulate the weight, texture, and impact of objects in a three-dimensional workspace, the Xio has promised to instantiate "a revolution in gaming" (Novint, 2014). The 3rd Space Vest, a PC peripheral made by TN Games, has used eight inflatable air pockets (four each on the chest and back) to create what the company describes as "physical 3D": carefully-controlled inflations and deflations produce "spatially accurate physical cues for the virtual environment" (TN Games, 2014). Physical 3D allows the players to "feel what [they've] been missing," providing "the ultimate intersection between *Reality* and *Virtual Reality*." (TN Games, 2014; emphasis original). Tactical Haptics touted its Reactive Grip interface as "more compelling than vibration feedback" and "touch feedback for the next generation of human interfaces" (Tactical Haptics, 2014). ViviTouch CEO Dirk Schapeler explicitly framed his company's haptic feedback technology with reference to the stagnation of vibrotactile feedback vis-a-vis advances in audiovisual display: "Since 1997, the audio has evolved, the video has evolved, the screens, everything, but the rumble is still the same, and we are trying to do something about it" (What's the Big Deal, 2013, July 4).

To this point, however, the demand for and interest in these devices has been slim and fleeting: The Falcon failed to garner enough commercial success to justify porting the device from the PC to consoles, and quickly vanished from retailers' shelves; though Novint announced the product in 2011, the Xio remains vaporware as of mid-2014; and the 3rd Space Vest, released in 2008, did not feature driver support for games released after 2011. In each example, it is not only previous generations of control that the new interface promises to leave behind, but also previous instantiations of physical feedback mechanisms. In light of the aforementioned research into "tactile literacy" that provides the genealogical and technical grounding for rumble feedback, we can think of each new feedback mechanism as requiring the assimilation to a new tactile vocabulary, a vocabulary idiosyncratic to the technical features of the mechanism it uses to produce tactile stimuli. The commercial failure or stagnation of new haptic feedback mechanisms suggests that gamers have been unwilling to learn to read by touch all over again—by moving the location of haptic inputs and by changing the mechanisms used to produce tactile stimuli, these new interfaces between player and

gameworld demand a retraining and re-education of the senses.

Rumble's Unshakable Persistence

In 2006, after Sony's announcement that rumble would not be included in the SIXAXIS controller for its forthcoming Playstation 3, Immersion Corporation (the company that owns key patents for vibrotactile feedback technology currently licensed to Microsoft and Sony) sponsored an extensive market research survey intended to quantify the priority console gamers placed on vibrotactile feedback (Ipsos-Insight, 2006). Of the survey's 1075 respondents, 72% identified rumble as a feature important to their gameplay experience (Ipsos-Insight, 2006, p.4). In the survey's sole open-ended question, respondents were also asked to identify the "best use of rumble/vibration feedback in a specific game," and to describe what they liked about it (Ipsos-Insight, 2006, p.4). Their answers not only helped pressure Sony to add rumble back into the PlayStation 3, via the release of an updated SIXAXIS controller that kept the original's motion-sensing capabilities and added the dual spinning motors present in DualShocks 1 and 2, but also provided Immersion with a storehouse of knowledge about the uses of vibrotactile feedback that gamers found pleasing, useful, and engaging. It helped map the genres where gamers valued rumble most (shooters, racing, action/adventure, and fighting games) and those where they found it to be superfluous (strategy and puzzle games). Informed by the results of this survey and another it conducted independently, this one of over 10,000 respondents from gaming websites, Immersion Corporation (2010) released a "Best Practices for Use of Vibration Feedback in Video Console Games" intended to both provide a useful taxonomy for game programmers while simultaneously touting rumble's "value and universal appeal" (p. 2). The 20-page report concluded with a "top 10" of rumble design and coding tips (coming it at #6: "Don't be annoying") and a genre-specific guide to creating and using haptic effects.

Immersion Corporation's findings suggest that the specific language of touch that rumble makes possible is only achieving coherence and formalization in gradual and piecemeal fashion; tactile literacies are not advancing with the rapidity of literacies in the crafting and reception of aural and visual signification schemes. At an informal level, however, designers have learned to use vibrotactile feedback as a means of signification, and players have come to expect game worlds to communicate to them using touch. The inclusion of rumble in the most recent generation of console controllers was not accompanied by any radical steps forward; controller designers instead attempted to push existing vibrotactile mechanisms to new limits while still retaining the basic functionality and ergonomics of the previous, time-tested designs. The rumble motors in the triggers of the Xbox One controller, according to Microsoft's Quintin Morris, offered haptic feedback "right at your fingertips, which is the most sensitive part of your hand." (Morris, quoted in Hsu, 2013d). The addition of the motors in these "Impulse Triggers" allows the controller to provide "richer haptic effects that have directionality to them" (Xbox, 2013) by coordinating their revolutions with those of the motors in the handles. In this instance, players are not so much asked to learn a new language of touch, as in the more experimental examples discussed above, but are instead

taught new words that they can add to their extant vibrotactile vocabularies. The next generation of tactile feedback technologies is not, then, one severed from those that came before it, but is characterized instead by an intensified recognition of the grasp as a space where increasingly-codified sensations flow from machine/brand to player/consumer.

Game developers, critics, and scholars interested in understanding how tactile literacies operate can familiarize themselves with the logic of haptic signification using some easily accessible tools and documents released by Immersion Corporation. Immersion Corporation's (2010) "Best Practices" white paper details strategies for effectively using dual-motor rumble feedback in console games, and its *Haptic Effect Preview* and *Haptic Muse* apps for the Android operating system show how touchscreen vibrations can be used to signify onscreen events for the sense of touch. Gaining an appreciation of how such systems operate at the practical level can make game critics more astutely aware of the logics at play in gamic touch, allowing them to make this aspect of gameplay a recurring part of their critical analyses. Incorporating this awareness into game criticism—praising unconventional or especially engaging uses of rumble in a given game—can help push for more creative and innovative uses of existing haptic feedback hardware.

Grasping Counterrevolution

The recent resurgence of interest in head-mounted, motion-sensitive displays suggests that we may be on the verge of another upheaval in game interface technologies. The Oculus Rift—acquired by Facebook in March of 2014 for approximately 2 billion USD—and Sony's "Project Morpheus" both promise to allow new modes of interacting with and inhabiting game worlds. Anxious for something to hype, the popular technology press has, even with the release of a consumer version of the Oculus Rift still on the distant horizon and no release date fixed for Morpheus, declared the promised new devices giant first steps toward "the coming virtual reality revolution" (Ohannessian, 2014, March 19). Since the Rift first caught the attention of industry luminaries and lay gamers alike, the imaginary of what videogames can be has exploded, and there is a distinct possibility that games are posed to move in bold new directions, with VR making good on every check written on its behalf in the 1990s.

This might, then, seem an inappropriate time to mount what could easily be read as a rearguard defense of the controller's entrenchment in game culture. The position I am staking here, however, is intended to be more descriptive than predictive—considering the economic, cultural, and technical forces at work in maintaining the constancy of the physical interface highlights the tensions faced by interface designers as they try to maintain a stable haptic brand identity in a marketplace that constantly demands and celebrates innovation. Rather than placing game interfaces on a long arc of teleological progress toward ever more faithful modes of haptic simulation, attentiveness to the design process represents interfaces as shaped by a complex matrix of competing forces—contingent outcomes of negotiations between bodies, economies, and technologies, instead of inevitable expressions of funda-

mental logics that steer technological progress. Grasp and fit should be understood not as absolute and static qualities, but rather, as *processes*—decisions about whose hands the controller's contours should conform to, or about what functions the grasp ought to enable and constrain, depend on soliciting data about player bodies, filtering that data through design teams and market researchers, and then submitting it to corporate executives. As Friedrich Kittler suggested in an analysis of audiovisual technologies, human sense experience in consumer society exists in a dependent relationship with agreements between technicians and marketers, or, in Kittler's words, a "compromise between engineers and salespeople" regulates the sensations emanating from media technologies (1999, p. 2).

With sensory studies and the technical practice of sensory marketing turning a renewed attention toward the tactility and ergonomics of products and the strategies used to market them, we can extend Kittler's thesis to encompass the materiality of the game controller and the sensations it generates. Brand identities are not merely seen and heard; they are actively constructed through touching and being touched by the controller; functioning as a haptic icon for the brand itself, the controller works to imprint itself onto memory of the player through repeated, embodied experiences of gameplay. Brand loyalty is maintained by remaining faithful, by achieving a degree of fidelity, not to a haptic realism, but to the embodied memories of controllers past, imprinted on the player's mind through hundreds of hours of manipulating analog sticks, pressing shoulder buttons, and precisely measuring the time it takes for the thumbs to travel between buttons.

Game studies, by shifting emphasis onto the body's role in enacting game texts, has already worked to counter the ocularcentrism operating in early games research. Treating the controller as a negotiated space that sits at the intersection of player bodies, game worlds, and corporate marketing strategies allows game scholars, developers, and critics alike to productively investigate both the controller design processes and its outcomes. Attending to the gaming body and gaming hands as a sites of commercial investment shows how seemingly minute design decisions, such as how much distance to place between buttons and how deep to make the cups at the ends of thumbsticks, embody preferences for particular types of game players and player bodies. In the iterative process of prototyping controller designs, for example, Microsoft's insistence that prototypes be "tested with golden hands" (Alam, quoted in Hsu, 2013b) ensured that the golden hands' preferences would be embedded in the materiality of the end product. Game controllers, in short, participate in forging and cementing the contested, gendered, normative, and hegemonic "gamer" identity, bringing with them particular notions of what constitutes the ideal, and non-ideal, gaming body. Considered from this perspective, innovative game developers can trouble hegemonic controller designs by building games conducive to being played on modified controllers built to make games accessible to players with motion impairments (see, for example Benjamin Heckendorn's modded controllers for one-handed players, and the many discussions of accessible controllers design at Game Accessibility). Controller design, with its attention to the physiology of touch and the materiality of buttons, triggers, and sticks, invokes an aesthetic lineage with its own unique conventions and assumptions; tugging at these threads can establish fascinating

new connections between the controller design process and other practices of engineering human-machine interfaces.

Finally, treating game controllers as counterrevolutionary, stabilizing forces encourages game critics to resist the knee-jerk valorization of the new that perpetually accompanies iterative updates to game hardware. The controller's relative stability, in this framework, becomes generative: with vibrotactile feedback, as demonstrated above, it facilitated the gradual emergence of a new signification system that players were only able to acquire because of the sensory channel opened up through their tight grasping of the controller's handles. In short, if changes in media technologies are registered materially at the level of the body, so too are their regularities. Such a perspective is not intended to foreclose the possibility that new game interfaces will radically alter the relationship between player bodies and machines—it makes no predictions about the interface schematics of the XBox Next or PlayStation 5. Rather, it takes the body to be simultaneously a multichannel sensory system that exchanges information with game worlds and the object of a highly technical, commercially-driven engineering process underpinned by normative assumptions about how to best establish a haptic bond between players and corporate brands.

Endnotes

1. Though, as Langdon Winner (1986) pointed out in his noted essay "Mythinformation," the common practice of using the term "revolutionary" to describe alterations in information-circulation technology is problematic for both its deterministic connotations and its assumption of an alignment between media change and social change, the rhetoric of revolution nevertheless continues to provide conceptual and temporal frame for understanding iterations in game hardware.

2. In her analysis of sculpture reception practices, Johnson (2002) frames beholding as a tactile, rather than visualist, orientation toward aesthetic objects.

3. The naming of the controller provides a direct reference to the motors contained in each handle, with shock being a reference to the effect produced by vibrotactile feedback.

4. Pushing the body to the center of branding practice recalls the materiality of branding's origins, where symbolic markers of ownership were burned into the skin of livestock.

5. Gault's hyphenation of the term "vibro-tactile" embodies the debate among his contemporaries about the nature of the vibration sense; beginning in the late 19th century, some psychologists and physiologists argued that vibration possessed its own unique mechanisms and proclivities, and as such, should be treated as a sense separate from touch. See Geldard (1940) for a summary of the various positions staked in the controversy.

6. The first use of rumble in a console controller came earlier in 1997, when Nintendo released the single-motor Rumble Pak as an add-on for its Nintendo64 controller.

7. Later in the book, Swink provides an excellent discussion (2009, p. 324–328) of the future possibilities for haptic feeedback devices in which rumble gets a bit more detailed articulation.

References

Aarseth, E. (1997). *Cybertext: Perspectives on ergodic literature*. Baltimore, MD: Johns Hopkins University Press.

Apperley, T. (2010). *Gaming rhythms: Play and counterplay from the situated to the global*. Amsterdam: Institute of Network Cultures.

Apperley, T. H., & Jayemanne, D. (2012). Game studies' material turn. *Westminister Papers in Communication and Culture, 9*(1), 5–26.

Behrenshausen, B. (2007). Toward a (kin)Aesthetic of Video Gaming: The Case of Dance Dance Revolution. *Games and Culture, 2*(4), 335–354.

Bicchi, A., Buss, M., Ernst, M. O., & Peer, A. (2008). *Sense of touch and its rendering: Progress in haptics research*. Berlin: Springer.

Block, G. (2006, December 1). Playstation 3 SIXAXIS dissection and Dual Shock comparison. *IGN*. Retrieved from http://www.ign.com/articles/2006/12/01/playstation-3-sixaxis-dissection-and-dual-shock-comparison

Cooley, H. (2004). It's all about the fit: The hand, the mobile screenic device and tactile vision. *Journal of Visual Culture, 3*(2), 133–155.

Crossley, R. (2013, August 12). The $100M story behind the Xbox One controller. *Computers and Videogames*. Retrieved from http://www.computerandvideogames.com/423871/features/the-100m-story-behind-the-xbox-one-controller/

Edge Staff. (2010). Kudo Tsunoda: Rumble is rudimentary. *Edge Online*. Retrieved from http://www.edge-online.com/features/kudo-tsunoda-rumble-rudimentary/

Friedman, T. (1999). *Civilization* and Its Discontents: Simulation, Subjectivity, and Space. In G. Smith (Ed.), *On a silver platter: CD-Roms and the promises of a new technology*. New York: New York University Press.

Furner, A. H., & Diespecker, D. D. (1969). A note on vibrotactile learning. *Australian Journal of Psychology, 21*(2), 167–168. doi:10.1080/00049536908257780

Galloway, A. (2006). *Gaming: Essays on algorithmic culture*. Minneapolis: University of Minnesota Press.

Gaming with a physical disability. Retrieved from: http://www.game-accessibility.com/index.php?pagefile=motoric

Gazzard, A. (2013). Standing in the way of control: Relationships between gestural interfaces and game spaces. In M. Wysocki (Ed.), *Ctrl-alt-play: Essays on control in video games* (pp. 121–132). Jefferson, NC: McFarland & Company.

Gault, R. (1927, December). Learning language by its feel. *Scientific American*. 524–525.

Gault, R. (1936, June). Recent developments in vibro-tactile research. *Journal of The Franklin Institute, 221*(6), 703–719.

Geldard, F. A. (1940). The perception of mechanical vibration: IV. Is there a separate "vibratory sense"? *The Journal of General Psychology, 22*(2), 291–308. doi:10.1080/00221309.1940.9710036

Geldard, F. A. (1957). Adventures in tactile literacy. *American Psychologist, 12*(3), 115–124.

Graft, K. (2013, October 30). Chasing the 'holy grail' of the video game holodeck. *Gamasutra*. Retrieved from http://www.gamasutra.com/view/news/203147/Chasing_the_holy_grail_of_the_video_game_holodeck.php

Gregersen, A. and Grodal, T. (2009). Embodiment and interface. In B. Perron & M. J. P. Wolf (Eds.), *The video game theory reader 2* (pp. 65–83). New York: Routledge.

Hamilton, K. (2014, January 8). How Valve is building a new way to play games. *Kotaku*. Retrieved from http://kotaku.com/how-valve-is-building-a-new-way-to-play-games-1497334223

Howes, D. (2004). Hyperaesthesia, or The sensual logic of late capitalism. In D. Howes (Ed.), *Empire of the senses* (pp. 281–303). Oxford: Berg.

Howes, D. (2013). The race to embrace the senses in marketing: An ethnographic perspective. Paper presented at the Ethnography Praxis in Industry Conference, London. Retrieved from http://onlinelibrary.wiley.com/doi/10.1111/j.1559-8918.2013.00002.x/pdf

Huhtamo, E. (2005). Slots of fun, slots of trouble: An archaeology of arcade gaming. In J. Raessens & J. Goldstein (Eds.), *Handbook of computer game studies* (pp. 3–21). Cambridge: MIT Press.

Hsu, D. (2013a, October 21). The Playstation 4 controller: The weird stuff that could've been (part 1, exclusive). *VentureBeat*. Retrieved from http://venturebeat.com/2013/10/21/the-playstation-4-controller-what-couldve-been-part-1-exclusive/

Hsu, D. (2013b, November 18). The Xbox One controller: Projectors, smells(!) and other stuff that didn't make it in. *VentureBeat*. Retrieved from http://venturebeat.com/2013/11/18/the-

xbox-one-controller-projectors-smells-and-other-stuff-that-didnt-make-it-in-part-1-exclusive/

Hsu, D. (2013c, November 19). The Xbox One controller: What's new with the analog sticks and D-pad. *VentureBeat*. Retrieved from http://venturebeat.com/2013/11/19/the-xbox-one-controller-whats-new-with-the-analog-sticks-and-d-pad-part-2-exclusive/

Hsu, D. (2013d, November 21). The Xbox One controller: A close look at the new rumble, faster speed, design, and everything else. *VentureBeat*. Retrieved from http://venturebeat.com/2013/11/21/the-xbox-one-controller-a-look-at-the-new-rumble-faster-speed-design-and-everything-else-part-4-exclusive/view-all/

Immersion Corporation. (2010). *Best practices for use of vibration feedback in console games* [White paper]. Retrieved from: http://www.immersion.com/resources/haptic-whitepapers/#tab=rumble-best-practices

Ipsos-Insight. (2006, September 22). *Current and next generation game console feature study* [White paper]. Retrieved from http://www.immersion.com/resources/haptic-whitepapers/#tab=-console-study

Johnson, G. (2002). Touch, tactility, and the reception of sculpture in Early Modern Italy. In P. Smith & C. Wilde (Eds.), *A companion to art theory*. Oxford: Blackwell.

Jones, S., & Thiruvathukal, G. (2012). *Codename revolution: The Nintendo Wii platform*. Cambridge: MIT Press.

Juul, J. (2010). *A casual revolution: Reinventing video games and their players*. Cambridge: MIT Press.

Keogh, B. (2014). Across worlds and bodies: Criticism in the age of video games. *Journal of Games Criticism, 1*(1).

Kietzmann, L. (2007). Sony' Phil Harrison: No pressure to drop PS3 price. *Joystiq*. Retrieved from http://www.joystiq.com/2007/02/26/sonys-phil-harrison-no-pressure-to-drop-ps3-price

Kirkpatrick, G. (2009) Controller, hand, screen: Aesthetic form in the computer game. *Games and Culture, 4*(2), 127–143.

Klatzky, R. (2010). Touch: A gentle tutorial with implications for marketing. In A. Krishna (Ed.), *Sensory marketing: Research on the sensuality of products* (pp. 33–48). New York: Routledge.

Lipkin, N. (2013). Controller controls: Haptics, ergon, teloi and the production of affect in the video game text. In M. Wysocki (Ed.), *Ctrl-alt-play: Essays on control in video gaming*. Jefferson, NC: McFarland.

Mauss, M. (1973). Techniques of the body. *Economy and Society, 2*(1), 70–88.

McDonald, P. (2013). On couches and controllers: Identification in the video game apparatus. In M. Wysocki (Ed.), *Ctrl-alt-play: Essays on control in video gaming* (pp. 108–120). Jefferson, NC: McFarland.

Mills, M. (2011). On Disability and Cybernetics: Helen Keller, Norbert Wiener, and the Hearing Glove. *Differences*, 22(2-3), 74–111.

Minsky, M. (1995). *Computational haptics: The sandpaper system for synthesizing texture for a force-feedback display* (Doctoral dissertation). MIT.

Novint Corporation. (2012). Adding the sense of touch to motion control. Retrieved from http://home.novint.com/index.php/products/novintxio

Ohannessian, K. (2014, March 19). Oculus Rift, Sony, and the coming virtual reality revolution. *Fast Company*. Retrieved from http://www.fastcompany.com/3027790/oculus-rift-sony-and-the-coming-virtual-reality-revolution

Parisi, D. (2008). Fingerbombing, or "touching is good": The cultural construction of technologized touch. *Senses and Society, 3*(3), 307–327.

Parisi, D. (2009). Game interfaces as bodily techniques. In R. Ferdig (Ed.), *Handbook of effective research on electronic games* (pp. 111-126). New York: IGI Global.

Parisi, D. (2013). Shocking grasps: An archaeology of electrotactile game mechanics. *Game Studies, 13*(2). Retrieved from http://gamestudies.org/1302/articles/parisi

Paterson, M. (2007). *The senses of touch: Haptics, affects, and technologies*. Oxford: Berg.

Peck, J. (2010). Does touch matter? Insights from haptic research in marketing. In A. Krishna (Ed.), *Sensory marketing: Research in the sensuality of products* (pp. 63–74). New York: Routledge.

Pias, C. (2011). The game player's duty: The user as the gestalt of the ports. In E. Huhtamo & J. Parikka, *Media archaeology: Approaches, applications, implications* (pp. 164–183). Berkeley: University of California Press.

Plotnick, R. (2012). At the interface: The case of the electric push button, 1880–1923. *Technology and Culture, 53*(4), 815–845.

Simon, Bart. (2009). Wii are out of control: Bodies, game screens, and the production of gestural excess. *Loading..., 3*(4). Retrieved from http://journals.sfu.ca/loading/index.php/loading/article/viewfile/65/59

Sony Computer Entertainment. (2014, March 18). Sony Computer Entertainment Announces "Project Morpheus". Retrieved from http://www.sony.com/SCA/company-news/press-releases/sony-computer-entertainment-america-inc/2014/sony-computer-entertainment-announces-project-morp.shtml

Swink, S. (2009). *Game feel: A game designer's introduction to virtual sensation*. New York: Morgan Kaufman.

Tactical Haptics. (2014). Tactical haptics: Touch feedback for the next generation of human interfaces. Retrieved from http://tacticalhaptics.com/

TN Games. (2014). 3rd Space: Where virtual becomes reality! Retrieved from http://tngames.com/products

Valve. (2013, October 11). Steam controller demonstration [Video]. *Youtube*. Retrieved from https://www.youtube.com/watch?v=eeAjkbNq4xI

Warren, S. and Chang, S. (2010). Real-world patent issues for a virtual world. In R. Dannenberg (Ed.), *Computer games and virtual worlds: A new frontier in intellectual property law*. Chicago: American Bar Association Publishing.

What's the Big Deal. (2013, July 4). Hands on: ViviTouch Haptic Feedback Controllers at E3 [Video]. *Youtube*. Retrieved from https://www.youtube.com/watch?v=YYZ8_exnCPQ

Wilson, D. (2009). How haptics will change the way we interact with machines. *Popular Mechanics*. Retrieved from http://www.popularmechanics.com/technology/gadgets/news/4253368

Winner, L. (1986). *The whale and the reactor: A search for limits in an age of high technology*. Chicago: University of Chicago Press.

Xbox. (2013, August 13). Hands on with the new Xbox One controller [Video]. *Youtube*. Retrieved from https://www.youtube.com/watch?v=sG0L_xJfFro#t=200