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# 3-D cinema: immersive media technology

**Anna Hamilton Jackman**

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**Abstract** 3-D cinema is a largely overlooked media within geographical critique. This omission is notable given both the sustained academic consideration afforded to other popular media, the medium's significant commercial and popular success, and its status as an 'affective' and captivating storytelling medium. With reference to film industry advertisements, the experiential dimensions of the 3-D cinematic encounter and its (popular) framing as an 'immersive' consumer experience are explored. In particular, the notion of 'immersion' is unpacked with reference to the medium's engineering and production techniques. In so doing, the intertwinement of the industrial desire for ever more 'immersive' and 'realistic' consumer experience is explored in relation to the engineering techniques exhibiting perceptual mimicry, or what could be termed 'mimetic engineering'. The association between 3-D cinema and 'tactile' images is then explored with reference to geographic literatures on 'haptics' and technologies of touch. A number of recent 'innovations' in these fields are drawn upon in order to complicate 3-D cinema's association with 'tactility'. In so doing, a technological shift towards the increasingly pervasive and sophisticated engagement of the wider multi-sensory palette is explored. Drawing upon recent media technology 'innovations', this persistent and relentless desire for ever more 'immersive' and perceptually-convincing media technology is explored in light of developing media geographies.

**Keywords** 3-D cinema · Media · Immersion · Technology · Haptics

## Introduction

> "Going to the Feelies this evening, Henry?" enquired the Assistant Predestinator. "I hear the new one at the Alhambra is first-rate. There's a love scene on a bearskin rug; they say it's marvellous. Every hair of the bear reproduced. The most amazing tactual effects" (Aldous Huxley 1984 in Paterson 2006: 691)

3-D cinema is a largely overlooked media within geographical critique. This paucity is notable given the sustained academic consideration afforded to other popular media, including, for example: newspaper cartoons (Dodds 1998, 2010a; Falah et al. 2006), videogames (Ash 2009, 2010a, 2010b, 2012; Ash and Gallacher 2011; Hughes 2010; Power 2007; Shaw 2010; Shaw and Sharp 2013; Shaw and Warf 2009; Stahl 2006), graphic novels (Holland 2012), comic books (Dittmer 2005, 2007), radio (Pinkerton and

A. H. Jackman (✉)
Geography, College of Life and Environmental Sciences, University of Exeter, Amory Building, Rennes Drive, Exeter, Devon EX4 4RJ, UK
e-mail: ahj203@exeter.ac.uk

Dodds 2009), magazines (Sharp 2000), journalism (Pinkerton 2013), and film (Aitken and Dixon 2006; Carter and Dodds 2011; Carter and McCormack 2006; Dittmer 2011; Dittmer and Dodds 2013; Dodds 2010b; Lukinbeal and Zimmermann 2006, 2008; Pile 2011; Power and Crampton 2005; Shapiro 2009; Sharp 1998).

In making the case for a sustained consideration of 3-D cinema, this paper turns first to the medium's notable box office success and commercial popularity which show no signs of abating. As a medium premised and marketed precisely around its appeals to the non-representational, sensory experience, this paper then critically considers the 'affective' dimensions of this captivating storytelling medium. By exploring 3-D advertisements within the film industry, the paper then illustrates how the medium is framed in terms of its capacity to offer an 'immersive' consumer experience. This discussion of 'immersion' is then brought into conversation with the medium's underpinning engineering and production techniques. In so doing, the medium's engineering techniques are found to mimic human stereopsis processes in order to technologically construct a 'realistic' or depth-rich image. This process could be termed 'mimetic engineering'. A number of recent cinematographic developments, including 'higher frame rate' and 'screen x', are then explored and are found to reflect the industrial goal of engineering ever more 'realistic' or perceptually-convincing cinematic experience.

In the paper's final substantive section, the coupling between (3-D) cinematic immersion and notions of 'tactility' are unpacked. In so doing, a dialogue is developed with geographic literatures exploring the technological realm of 'haptics', the development of technologies of touch. In working through a number of examples of each, it is found that both 3-D cinema and 'haptics' share a concern for the 'tactile' and employ 'mimetic engineering' in the quest for ever more 'immersive' and 'realistic' consumer experience. A number of recent 'innovations' in both fields, namely '4-D'/'5-D' cinema and augmented reality, are then drawn upon in order to complicate this association with the 'tactile'. In so doing, a notable shift from a focus on the 'tactile' to the industrial engagement of the wider multi-sensory palette is explored. Lastly, the case is made for the increasing import and applicability of such discussions across the wider technological media landscape.

## Why 3-D cinema?

Many of us are familiar with 3-D cinema due to its sustained presence and domination of the contemporary box office. For example, in 2012 alone, 3-D cinema grossed $1.8 bn in US and Canadian box offices, accounting for 17 % of total box office revenues (Motion Picture Association of America 2013: 9). In the same period 3-D cinema grossed £215.7 mn in the UK and Republic of Ireland, accounting for 18 % of total box office revenues (British Film Institute 2013: 14). Whilst the number of 3-D titles released in 2012 declined when compared with 2011, the 3-D format continues to draw in both substantial revenue and continued global investment in screen fittings, with such aforementioned cinematic bodies attributing this decline to an increasing discernment of when 3-D capabilities should be employed, rather than a consumption lull or consumer disinterest. Such sentiments are reflected by both the continued high revenues and the extensive media coverage and consumer "hype" around 3-D films. 'Avatar' (2009), for example, remains the highest grossing film ever to date, taking a record-breaking "$1 bn (£620 mn) at [global] cinema box offices" in its first three weekends alone (Guardian 2010: n.p.), whilst 'Gravity' (2013), another film popularly acknowledged as a show-case for refined 3-D cinematography, grossed $55.5 mn in US and Canadian box offices on its opening weekend and £6.2 mn in its first four days at UK and Ireland box offices (of which around 90 % of ticket sales were attributed to the 3-D format) (BBC News 2013: n.p.).

This picture of a commercially notable popular medium views 3-D cinema in its contemporary format only, however. It should be noted that 3-D cinema is not a new technology, rather one originating from a series of experiments with stereoscopic photography in the nineteenth century (see Crary 1992; Freeland 2012; Walters 2009; Zone 2007). The subsequent evolution and development of the technology was not a neat, linear and progressive one. Rather, a number of narratives of various iterations of the technology exist, due to its cyclical and periodic development, popularity and decline (see Elsaesser 2013; Gurevitch 2012; Hawkins 1953; Ross 2012; Walters 2009). Whilst not seeking to valorise 3-D cinema as a 'new' technology, this paper does wish to illustrate the value of exploring the medium in its contemporary format.

## Immersive 3-D cinema

> 3D definitely adds something to the experience. You get the depth of field you need to truly experience the movie and feel as though you're right there with Sandra (Consumer Review, Gravity, IMDB 2013a)
>
> There are a bevy of 3D parlor tricks in the movie. They look great in 3D but are just silly. I am not gonna get into the stuff flying, floating, drifting into the third person camera. You know what they are and just what sort of cheap showmanship they are (Consumer Review, Gravity, IMDB 2013b)
>
> So for 3-D film images that pop out of the screen, grab a seat and enjoy 3-D cinema like never before. Immerse yourself in an experience that cannot be replicated at home (Reel Cinema advertisement 2014)
>
> When you watch a film in RealD 3D, you feel as though you've stepped inside it. Superb image quality – crisp, bright and ultra-realistic…the story's unfolding around you…. It's immersive: the film surrounds you (Odeon Cinema advertisement 2014)

Despite this box office status 3-D cinema remains a largely overlooked popular medium within geographical scholarship. An exception to this relative paucity is Jason Dittmer's (2011) discussion of special and visual effects when considering 'American Exceptionalism' and the post 9/11 superhero film 'boom'. Dittmer's (2011) discussion of such cinematography is conducted through the lens of audience testimony. As Dittmer (2011) identifies, consumer vignettes and reviews akin to those opening this section can be evocative in pointing to the role of special and visual effects in audience appreciation and interpretation of film. Whilst the integration of such testimony certainly provides valuable methodological insight for (popular geopolitical) scholarship more widely, Dittmer (2011: 127) notably refers to the affective and "visceral thrills" left "outside [this] frame" of analysis. I therefore wish to build upon Dittmer's piece, further unpacking the experiential dimensions of 3-D cinematography specifically, an integral facet of the wider contemporary special and visual effects 'revolution'. Given the recent wave of discussions around the affective and experiential qualities of popular media (see Carter and McCormack 2010; Dittmer 2010, 2011; Hughes 2010, 2013; Pile 2011; Pinkerton and Dodds 2009), such a discussion of 3-D cinema, a medium premised precisely around appeals to the sensory, appears fitting. In critically considering the 'affective' dimensions of this captivating storytelling medium, this section reflects upon how the medium is framed, both by film industry rhetoric, consumer testimonies, and scholarly discourse, in terms of its capacity to offer an 'immersive' consumer experience.

When sat in the cinema, glasses poised, with a 3-D film flickering ahead, it is not uncommon to see an audience member bring forth their hands to try and 'grasp' an image, or to "flinch…in response to objects thrown from the screen" (Ross 2012: 391). As will be expounded upon in the next section, 3-D cinematography strives to fashion such enchanting or mesmerising illusions via the technological creation of the impression of depth. This illusion of 'depth' is registered or 'felt' via our inbuilt 'proprioceptive' spatial sense. Proprioception refers to the bodily sense perceiving of "position, states and movement of the body" (Paterson 2007: ix), or the body's "recursive response" to "weight, dimension, gravity and movement in the world" (Crang 2002: 22; Sobchack 2004: 60). Through the creation of various depth planes, 3-D cinema thus stimulates perceptive responses via our 'proprioceptive' reflexes (Ash 2009; Paterson 2006, 2007). When the images 'pop out of the screen', as the opening advertisement proclaims, they spill and burst forth, appearing "more imma-nent" to the viewer (Shaw and Warf 2009: 1136). When coupled with advancements in surround and multi-channel sound (Prince 2012), the 3-D cinematic encounter can thus be understood as aiming to engage these 'somatic senses' as a unit acting in concert (Paterson 2007).

Across such descriptions 3-D cinema is presented as a medium that evokes and appeals to "kinesthetic sensation, haptic engagement, and an emphatic sense of wonder" (Bukatman 2003 in Dittmer 2011: 120). Such affective and sensory appeals function as an advertising hallmark for the film industry's 3-D cinema enterprise. Consider, for example, the advertisements opening this section. Such experiential qualities are showcased in the industry realm and across advertising vernacular with reference to a particular motif, that of 'immersion'. This can be exemplified more broadly by the standardised announcement acting a precursor to many 3-D films,

stating: "Put on your 3-D glasses now. Prepare to be immersed". The Oxford English Dictionary (2014: n.p.) defines 'immersion' as a "deep *mental involvement* in something" (emphasis added). As the aforementioned discussions of 3-D cinema illustrate, however, the sensory and embodied dimensions of experience are central in this deployment of the term. When considered anew in terms of experiential (rather than solely 'mental') 'involvement', it is not difficult to see why 3-D cinema, a medium premised on sensory engagement and proprioceptive involvement, is often associated with 'immersion' in the industry and popular vernacular.

Whilst 'immersion' may constitute a notable component of 3-D cinematic experience, it must too be critically unpacked. For example, it is important to note that consumer experience of such popular media is of course not uniform, but plural, negotiated and contested (see Dittmer 2010; Glynn and Cupples 2014). Rather than "assuming a hypodermic model of media power, ascribing to "the media" the ability to inject their preferred messages into the minds of their audiences" (Dittmer 2010: 98, see also Barnett 2008: 193), we must appreciate 'immersion' as one of many possible experiences of 3-D cinema. For some, such as the consumer reviewer opening this section, 3-D cinematography adds to the experience. For others, however, it does not. For example, a recent MIT Technology Review (2010) details research conducted with viewers having just watched a 3-D film. The report notes that a number of viewers declared eyestrain and headaches. These strains were attributed to what is known as 'vergence-accommodation conflict' (MIT Technology Review 2010). This arises due to the slight difference in 'parallax conditions' when artificial 3-D images are viewed, and the resultant difference in the way the eyes must 'verge' or "rotate slightly inward or outward so that the projection of an image" remains "in the center of both retinas" (MIT Technology Review 2010: n.p.). Other discussions in this area mention additional forms of eyestrain such as 'binocular rivalry', 'diplopia' (aka 'double vision') and 'suppression' (Mendiburu 2012; Yang et al. 2012). Such research illustrates the importance of attending to the plurality of experiences of such technological media consumption, perception and reception. In addition, a number of commentators have noted that the very illusion of depth facilitating 3-D cinema's status as an 'immersive' medium is an "excessive" one, and that the "existence of 'flat' versions, along with promotional materials….that demonstrate content in 2D, makes it apparent that the story can be told without" 3-D cinematography (Ross 2013: 413). As such, the medium has (historically) been conceived of as a money-making enterprise or gimmick courtesy of the film industry (Hawkins 1953; Ross 2012, 2013). Whether conceived of as an artistic medium or an industrial gimmick, 3-D cinema shows no sign of abating and is thus worthy of sustained consideration.

Lastly, the notion of being 'immersed' is somewhat of a go-to word in our vernacular regarding popular media consumption more widely. Consider phrases such as 'getting lost' in a book, or being 'drawn into' a film. Whilst these instances and their connotations are notable, through the lens of 3-D cinema this paper aims to explore and unpack specifically the increasing technological sophistication of that advertised as ever more 'immersive' (cinematic) experience.

In briefly exploring the experiential aspects of 3-D cinema, this paper has thus far sought to critically unpack and 'flesh out' the (framing of the) 'immersive' 3-D cinematic encounter. In so doing, it has sought to supplement textual explorations and conceptions of film as a narrative fiction with an appreciation of 3-D cinema's distinctive affective, experiential and 'immersive' appeals. The next section seeks to move from responding to the 'rhetorical' framing and experiential dimensions of immersion within 3-D film to, instead, a critical reflection on the production processes underpinning the medium. In so doing, the intertwinement of this 'immersion' motif and discussions of 'realism' and perceptually-convincing engineering techniques will be explored.

## Mimetic engineering and naturalism

> Much of the effort of directors, designers, and draftspersons working in 3-D goes towards naturalizing this type of technologically produced spatial vision, making it increasingly indiscernible (Elsaesser 2013: 221)
>
> We are born seeing in three dimensions. Most animals have two eyes, not one. There is a reason (Film Director in Ross 2012: 381)
>
> The higher the frame rate, the more realistic the image, and even more so with 3D…The result is

> more like live performance…The viewer is in the movie, on the adventure (Film Director in COW 2012: n.p.)

Having fostered an appreciation of the experiential affective dimensions of 3-D cinema and filmic immersion, this paper wishes to bring into conversation the medium's underpinning engineering and production techniques. It proposes that 3-D cinematic production relies upon the 'reproduction' or mimicry of certain kinds of perception which it achieves via particular forms of what could be termed 'mimetic engineering'. Drawing upon discussions of 'biomimicry', described as "reverse-engineer[ing] animal life to develop technologies and tactics that solve social and environmental problems" (Johnson 2010: 177; see also Johnson 2011; Kovac 2014), this paper considers 'mimetic engineering' as that which 'reverse-engineers' or mimics human sensory faculties. Paterson (2006: 700) employs a similar conception of sensory mimicry in technological development via what he terms 'retro-engineering' in a discussion of 'haptic' engineering (see below). This differential consideration of mimesis is not to overlook the important scholarly dialogue around the established representational 'reel'/'real' binary, with its own politics of the mimetic (see Crampton and Power 2007; Dixon and Grimes 2004; Lukinbeal 2004; Lukinbeal and Zimmermann 2006; Marks 2000), but rather to consider mimesis through a different analytic frame. By bringing into conversation experiential discussions of 'immersive' 3-D cinema with the engineering that underpins the medium I hope to illustrate how increasing demands for techno-realistic experience, both in the case of 3-D cinema and across the media technology landscape more widely, intersect with and rely upon biological, embodied and naturalistic knowledges.

Having moved on from the days of red-green anaglyph glasses, the current popular format of 3-D cinema functions via a method known as 'polarisation'. Consumers wear polarised stereoscopic glasses which pick up separate projections from two synchronised projectors, each operating from a different perspective (Ross 2012). Crucially there is a horizontal disparity, known as a 'parallax', between these perspectives. 3-D cinematography utilises negative, positive and zero parallax techniques in order to manipulate the resultant 'stereopsis' (3-D rendition) (Ross 2012). For example, negative parallax techniques or 'emergence effects' are utilised to visually foreground an image (Klinger 2013; Reeve and Flock 2010; Ross 2013), at once creating the illusion of an 'ultra-realistic' depth-rich scene, and "destabilising" the audience's "traditional" relationship with the screen (Odeon 2014; Ross 2013: 407). This 'parallax' is also what accounts for the appearance of blurriness or 'double vision' if the polarised glasses are removed. If the projection streams and glasses are seen in conjunction however, the harmonious impression of a third dimension is created (Lipton 2010). This technological creation and manipulation of dimensionality is the cornerstone and signature of the medium's popularity and success.

If we consider such mechanics anew, clear design similarities to human binocular vision emerge. Binocular vision refers to the 'stereopsis' we experience due to the distance between our eyes ('interocular distance') causing an image to be seen from two slightly different angles, which when combined in the brain form a three-dimensional image (Howard and Rogers 1995; Reeve and Flock 2010). Understood through the lens of 'mimetic engineering', we see clear parallels between our sensibilities and the design and engineering of this mechanised process. Through this process of 'mimetic engineering' 3-D cinema thus seeks to (re)create or mimic our 'natural' experience. In so doing, it produces an experience distinguishable from the photo-realistic, instead achieving a more depth-rich topography, exuding a "sense of 'tele-presence': an extended spatiality through the screen" (Ash et al. 2009: 467).

This mimetically engineered "spatial verisimilitude" (Elsaesser 2013: 239) continues to be refined through various technological ventures, leaps and forays. Consider, for example, recent cinematographic advancements in *Higher Frame Rate 3D* (HFR 3D). Trialled in the two 3-D hit films thus far released in '*The Hobbit*' trilogy (2012, 2013), HFR 3D is a production technique showcasing, in its latest iteration, 48 frames per second (fps) rather than the standard cinematic 24 fps. This essentially means that the camera shutter is closed less, and more frames and motion data are produced in between (Tech Radar 2012: n.p.). By increasing the

number of frames shown per second, this technique boasts the reduction of both "motion blur", "the strobing of fast-moving images" and "flickering" in order that scene changes may appear more seamless and movement thus more 'realistic' (Tested 2014: n.p.; PopSci 2013: n.p.). The higher number of frames thus aims to decrease such side-effects or 'unnatural' interruptions to the image stream. A number of film directors have labelled such developments as rendering 3-D film more "immersive" (Gizmodo 2012: n.p.). As in this section's opening quotations, here we see an emergent coupling between the advertisement and discussion of 3-D cinematography as increasingly 'immersive' and its underpinning engineering striving for a more 'realistic' or 'natural' consumer experience whereby "the human eye [sees] a much smoother movement" (Tech Radar 2012: n.p.) in order for the medium to become ever more "perceptually convincing" (Prince 2012: 183).

Interestingly, this coupling is one that extends across the wider cinematic landscape. Consider for example the recent unveiling of a new cinematic experience dubbed *'Screen X'* in South Korea. Described as presenting the viewer with a wider "270-degree field of vision that creates an immersive experience without the need to wear 3-D glasses" (Independent 2013: n.p.), the medium 'constructs' depth via the placing of three large screens to produce a "hyper-wide panorama", aiming to simulate and stimulate "peripheral vision" (The Verge 2013; DVICE 2013). Such an experience can be seen as a technological extension of the established IMAX cinema format that has a 146-degree view (DVICE 2013: n.p.), and illustrate (3-D) cinema's continuously refined desire for the creation of an immersive and perceptually-mimicking encounter. Such developments have also been mirrored and domesticated with technological advancements in 3-D televisions, specifically those that now boast 'curved' screens such as LG's recent range bringing you "an eye-popping world of immersive detail…at home" (Currys 2014: n.p.). This section has thus aimed to explore a dialogue between 3-D cinema as an 'immersive' medium and one designed and engineered around the (re)creation or approximation of 'natural' human visual perception.

## 3-D cinema and beyond

> The New Dimension of Entertainment. 3-D: Touch the film (Odeon Cinema advertisement 2014)
>
> [D-Box seating] enables the moviegoer to live the action that is taking place onscreen, providing an unmatched, realistic, immersive experience (D-Box advertisement 2014)
>
> With intuitive touch control and exciting features for the whole family, the Microsoft Surface…is the ideal tablet (Tablet advertisement, PC World 2014)
>
> Embedded S Pen: Real Pen-like feeling for natural writing experience (Tablet advertisement Samsung 2014)
>
> Touching is knowing (Tablet advertisement Currys 2013)

## Tactility

In this section the coupling of 3-D cinematic immersion with notions of 'tactility' is unpacked. The paper then explores the utility of consulting 'haptics' literatures in order to develop and make the case for a consideration of 'mimetic engineering' across the wider media technology landscape. In so doing, it explores developmental similarities in recent innovations in both fields, seeking to complicate a focus upon 'tactility'.

As has been established, whether via an audience 'grasp' or involuntary flinch at created illusions, 3-D cinema is often said to exemplify a kind of 'tangibility' or 'tactility' (Loew 2013; Ross 2012, 2013). As the opening advertisement from cinema chain 'The Odeon' demonstrates, this 'tactility' is an integral component of 3-D cinema's industrial immersive status. Scholarly discussions around 2-D cinema commonly also refer to the 'tactile' appeal of cinema, evoking and foregrounding the sensory and more-than-visual dimensions of cinematic experience. Accounts such as Marks' (2000: 162) discussion of "haptic perception" and "haptic visuality" propose that "the eyes themselves function like organs of touch". Marks (2000: 163) notably discusses the distinction between "optical perception" and "haptic perception", with the former "privileging the representational power of

the image" and the latter instead "privilege[ing] the material presence of the image". Such approaches thus valuably move towards "considering the ways cinema appeals to the whole body" (Marks 2000: 163). Similarly, Sobchack's (2004: 67) elaboration of the 'cinesthetic subject' denotes both "the complexity and richness of the…bodily experience of cinema, and….also….[the] ways in which the cinema uses our dominant senses of vision and hearing to speak comprehensively to our other senses". In discussing the film 'The Piano', Sobchack (2004: 62) wonderfully illustrates the sensuous resonances and reverberations of film, evoking a notable sense of tactility in the 2-D format. Ross (2013), however, has reconsidered such engagements with regard to 3-D cinema specifically. In particular, Ross (2013: 408) draws upon Bruno's (2002) discussion of the 'field screen'. The 'field screen' refers to a "habitable geographic space" in which a tactile and haptic apprehension of space occurs (Bruno 2002: 250), comprised of a "tactile eye and visual touch" (Bruno 2002: 253). In her reworking, Ross (2013: 408) considers the 3-D field screen as "constituted by… an embodied viewer who is encouraged to be cognisant of sensory perception that extends beyond optical observation", developing discussions of "haptic affects" and a "hyperhaptic visuality" (Ross 2012: 383, 384). Clearly there is an established association between (3-D) cinema and notions of 'tactility'. In order to further unpack this coupling, I turn now to geographic literature exploring the technological field of 'haptics' which directly engages with the engineering of 'tactility'. Whilst 3-D cinema and the field of 'haptics' engage differently with the tactile, both utilise forms of 'mimetic engineering' in order to create ever more 'immersive' and 'realistic' consumer experiences. 'Haptics' is also a commonplace component of many devices across the wider media technology landscape, and is thus a valuable resource to draw upon and demonstrate the wider applicability of these discussions.

'Haptics', stemming from the Greek "haptethai", can be defined as "of, pertaining to, or relating to the sense of touch or tactile sensations" (Paterson 2007: 4). In the technology sphere this translates to the development of interfaces and 'technologies of touch' (Paterson 2006). A familiar product of 'haptics' is the touch-screen found in many media devices, including smartphones and tablet computers. This manifestation of 'haptics' is becoming increasingly pervasive with smartphone and tablet device ownership at 51 % of all adults in the UK (Ofcom 2013: 3), and similarly 56 % of adults in the U.S own smartphones (Pew Research Center 2013a: 1) and 34 % own tablets (Pew Research Center 2013b: 2). Like 3-D cinema, 'haptics' is also underpinned by the engineering goals of 'realism', 'intuition' and perceptual-mimicry, but in this case via gestures and touch specifically (Dourish 2001 in Kitchin and Dodge 2011: 218). In addition, akin to 3-D cinema, 'haptics' has experienced many 'innovations' and technological iterations. Paterson (2006, 2007) provides an invaluable history of a series of such iterations. In so doing he works through the example of the PHANToM™, a robotic 'desktop' 'haptic' interface famously facilitating the first "virtual handshake". Seeking to build upon such scholarship, this paper considers recent 'haptics' innovations functioning instead in the domestic and popular spheres.

A notable innovation leading to the mainstream uptake of a now pervasive component of 'haptics', 'multi-touch', occurred in 2007 when 'Apple' launched the 'iPhone'. 'Multi-touch' refers to a device's ability to "recognize and respond to touch inputs at multiple locations simultaneously" (AIS 2013: 2). Apple popularised a form of 'multi-touch' with the 'pinch-to-zoom' capability whereby users are able to expand and contract content "by sliding [their] thumb and forefinger apart and pinching them together to restore the original size" (PC Mag 2013: n.p.). This capability has since become synonymous with Apple's wider product-lines, as well as being integrated across the Android and technological device landscape more widely. 'Multi-touch' has been continually refined in a bid to make it ever more sensorily responsive or perceptually 'natural'. Consider, for example, the recent surge of increasingly sophisticated handwriting capabilities in the tablet computing sphere. As the opening advertisements illustrate, the value of the 'touch' capabilities feeling 'natural' or 'intuitive' is commonly emphasised. Fierce competition around the development of an ever more "precise stylus'" or the "best-note-taking" ability and "writing experience" (Digital Trends 2013: n.p.) illustrates, as in the case of 3-D cinema, both the role of mimetic engineering and the industry rhetoric surrounding the value placed on the emulation of 'realistic' and 'natural' sensory experience.

A similar pervasive, popular and commercially notable manifestation of 'haptics' can be seen through the case of 'force-feedback' in the videogames sector.

Within this context 'force feedback' refers to a tactile sensation, vibration, or reverberation sent back through the controller when particular gaming scenarios arise—for example upon experiencing gunfire (Hughes 2010; Paterson 2006, 2007). Such capabilities are increasingly marketed as key components in the wider "immersive" gaming experience. For example, the widely anticipated and reported Playstation 4 'Dualshock' controller boasted both a 'sensitive' touch panel and sophisticated force-feedback capacity with "enhanced vibration" (Playstation 2014: n.p.), each labelled as integral to the wider "immersive" gaming experience. Additional features also included motion-sensing gyroscopes and a speaker, marketed as facilitating a "more personal and intimate" gameplay experience (Youtube 2013). Such features reflect precisely the industry focus upon "exploiting and manipulating…sensory experience" (Shaw and Warf 2009: 1332), and the centrality of 'tactility' or 'hapticality' in this endeavour. Through advertising discourse such as "even the subtlest movements can be turned into precise controls" (Playstation 2014: n.p.) the goal of a tactile-inflected perceptual mimicry or 'mimetic engineering' is again industrially foregrounded.

## Recent innovations: beyond tactility

Thus far it is evident that 3-D cinema and 'haptic' technologies share both a concern with the 'tactile' dimensions of popular media experience and the employment of 'mimetic engineering' in order to (re)create forms of sensory realism. They too are underpinned by similar industrial rhetoric and semantics surrounding 'immersion' and 'natural' or 'realistic' experience. Given a media landscape in which advancements of both 3-D cinema and broader 'haptic' technologies are ongoing, the remaining section reconsiders the specific kinds of tactility and 'immersion' recently industrially mobilised.

In the same way that 3-D cinema is concerned with the engineering of a 'realistic' sense of depth, so too is 'haptics' underpinned by the engineering of "realistic feelings of touch" (Paterson 2007: 12). Interestingly, however, there is a shift occurring in both these sectors. In addition to a focus upon the tactile (albeit in different guises) we are witnessing increasing industrial engagement with the wider multi-sensory palette, or what Thrift (2011: 5) labels the "mass produc[tion of] phenomenological encounter". Through unpacking recent technological iterations and advancements in both areas, namely '4-D' and '5-D' cinema and 'augmented reality' respectively, I aim to illustrate this increasingly sophisticated sensory engagement and to highlight some questions it puts forth to media geographers.

For those unfamiliar, '4-D' and '5-D' cinema are industry terms that refer to the addition of physical effects to (3-D) cinema. Akin to 3-D cinema, such 'innovations' can too be understood as iterative technologies and of course have historical lineages. Consider, for example, the presence a conductive capacity supplying a mild electric shock to film audiences in wired seats in screenings of the 1959 title 'The Tingler' (Heffernan 2002: 56). I seek not to obfuscate the refinement or redesign of such physical cinematic additions, but rather to focus upon the recent 4-D and 5-D cinematic innovations specifically as they illustrate the increasingly sophisticated sensory engagement of this wider technological shift.

A notable global 'motion effects theatre' company specialising in 4-D and 5-D experiences advertise them as such:

> Live the experience: 3D you see, 4D you feel, and 5D you move…With sight, sound, motion and touch, you'll experience a sensory sensation like none other. Be a part of the film… Feel the motion on the screen and the effects around you. With special effects including air blasters, leg ticklers, seat transducers and pops, water blasts, rain, fog, winds and even strobing - enter the 5th dimension with Media Nation's X4D… perfectly programmed to simulate the exact movement you see on the screen (Media Nation 2014: n.p.)

Akin to the gyrating 'motion seats' advertised by D-Box in the opening of this section, with the addition of such physical effects we witness an industrial shift from not only considering the (perceptually mimetic) construction of a 'realistic' 3-D object or view, to also a consideration of how 'realistic' an experience 'feels'. In that which 'Media Nation' refer to as "sensory entertainment" lies an appeal to our entire sensory palette. Rather than a focus on a more 'tactile' or depth-rich image, the addition of physical stimuli seeks to engage a human sensorium in concert. Rather

than to evoke a texture or reverberation through cinematography alone, we are physically stimulated to 'feel' the cinematic encounter. As a visitor to North Korea's 'Runga 4-D simulation centre' reported "the glasses, 3D scenes, music effect, and rhythmic facilities enable the viewer to feel a vivid reality" (Guardian 2014: n.p.).

Akin to such cinematic advancements, recent developments in the area of 'haptics', explored here through the example of 'augmented reality' technologies, have similarly sought to engage with a wider sensory palette in order to further 'immerse' users in the media environment. Augmented reality refers to the superimposing or mixing of three-dimensional virtual and synthetic images with the 'real world' (Brodlie and El-Khalili 2002: 35; Hedley et al. 2002: 119). Augmented reality can be seen as an extension of virtual reality, in which a user interacts with a wholly synthetic environment. Augmented reality has recently occupied the media limelight courtesy of a particular device, Google's notorious 'Glass'. The augmented reality sphere (often in combination with 'wearable' technology) is also frequently referred to as the "next generation of soon-to-be ubiquitous technology" (CNET 2014: n.p.) across technology media, blogs and forums more widely. 'Glass' will be revisited and expounded upon shortly.

Geographical scholarship has recently begun to consider augmented reality as an increasingly significant player in the wider media landscape. Notable explorations include Graham et al's (2012: 465) discussion of the rapid growth in "virtual representations of place" through the case of digitally augmented maps. Graham et al. (2012: 465) foreground questions around their role "in the production and experiences of places as augmented realities". Similarly, Graham and Zook (2013: 77) build upon this exploration of "augmentations and mediations of place" through an analysis of "online content indexed within Google Maps" and the "uneven linguistic geographies" that influence how "place is enacted and brought into being". Whilst such scholarship is invaluable in bringing to the fore questions around the co-constitutive character of such augmentations, it deals predominantly with mapping augmentations and the uneven politics of inclusion and exclusion. I similarly wish to acknowledge the rise and significance of the technology but to consider it through a different lens. Graham et al. (2012: 466) do reflect briefly upon the "dynamic, arguably more immersive and haptic reading performances (relative to analogue augmentations) via infinitely malleable, touchscreen interfaces", and it is this point this paper wishes to emphasise. It wishes to build upon this literature by considering augmented reality as illustrative of a wider media technology shift towards increasingly sophisticated multi-sensory engagement.

It is here I return to Google's 'Glass'. 'Glass' can be described as technology-enabled glasses with a small camera and screen in the top corner of the right side lens-frame. Functioning predominantly through voice, gesture controls and a small touchpad on its side, 'Glass' acts like a small smartphone, harnessing the ability to take pictures, record data, upload to social media, browse the web, and send messages (Google Glass 2014a: n.p.). 'Glass' thus blends virtual content such as navigation, communications and simple searches into a real world context (Engadget 2013: n.p.). Due to its utilisation of prescription glasses architecture, the camera positioning means 'Glass' operates at eye-level, providing a 'natural' or sensorially-mimicking first-person viewpoint. The technological strides exhibited by 'Glass' in the area of gesture control reflect this relentless drive for 'natural' experience and the (re)creation (and enhancement) of sensory functionalities. Such efforts to mirror or mimic sensory reflexes or technologically (re)create forms of muscle memory illustrate precisely this wider sensory engagement, mimicry, and the goal of technological integration. As Google's vice president and 'Chief Internet Evangelist' Vinton Cerf remarked, such devices strive to be our "sensory environment in context" (Cerf 2013).

'Glass' periodically went on sale in 'beta' format to those consumers it called 'Explorers' who wished to buy, test and feedback on the technology with a UK price-tag of £1000 prior to full public release (Google Glass 2014b: n.p.). 'Glass' sales have since been halted (January 2015), though Google reportedly remain "committed to the idea of smart glasses", and are continuing to develop them in a new division (BBC News 2015; Guardian 2015). Despite these staggered and stilted releases to date, already we are witnessing the development of augmented reality applications for 'Glass'. 'Layar', for example, is an application allowing users to compare real-world objects before them with a database of related virtual information via the verbal command: "Ok Glass, scan

this" (Wired 2014: n.p.). Uses include watching a movie trailer prompted by the scanning of a movie poster or looking at real-estate information when in front of a specific property (Wired 2014: n.p.). 'Glass' is also by no means the only augmented reality device to receive considerable attention in technology circles. Products such as the forthcoming 'Space Glasses' from 'Meta' allow users "to interact with virtual objects [3-D holograms] in the real world", by scanning "your environment and tell[ing] the computer where to place the 3-D graphics relative to the user" (CNN 2013: n.p.). The user's body is thus fully 'immersed' and both virtual and actual activities fully integrated into their experience. As Meta (2014: n.p.) itself advertises: "the strongest tools have never been those that divide us from the world we live in".

This section has sought to bring into conversation recent cinematic and 'haptics' developments in order to illustrate a wider media technological engineering and experiential shift beyond the 'tactile' and towards the 'multi-sensory'. Encompassing various forms of 'mimetic engineering', these developments are (packaged as) increasingly perceptually-convincing, 'natural' and 'immersive'. Looking forward, such analyses may be extended with reference to the development of a dialogue between explorations of 'mimetic engineering' and literatures acknowledging the perceptually co-constitutive character of technology. The 'technological unconscious', proposing that the sensorium is adaptive, coevolves and is constantly reinvented through interaction with technology (Clough 2000; Kinsley 2010; Thrift 2004, 2005, 2007, 2011), may provide one such avenue. The 'technological unconscious' appreciates the constitutive role of technology (or media technology device) as that more than mediation. Here, we may consider the example of the 'iPad' that is at once described as changing "the bodily expectation of the interface" and a technology that "millions…[will] be instantly familiar with" (Kinsley 2010: 2783). As has been illustrated through a discussion of 3-D cinema and haptic media technology, within these increasingly commercially lucrative fields the operational devices and technologies themselves (glasses, screens, seats, controllers) play a key role in both the emulation of the sensorial encounter and in the consumption experience itself. Exploring such technologies thus attends to both the concern that focusing only on media "communication content…truncates communication" (Adams 2013: 266), and acknowledges the importance of the changing function and role of technological devices. Here, further dialogue with literatures such as 'haptics' and 'user-interface design' may aid in unpacking complex questions around media physicality, illusion and interaction. Such questions could be more fully worked through in the context of such media where, at times, "action is tantalisingly close but never fully touchable" (Ross 2013: 406).

## Conclusion

This paper has aimed to provide a sustained consideration of the previously under-examined, yet commercially and popularly notable, media format of 3-D cinema. It first considered the 3-D cinema as an affective storytelling medium, both in terms of its depth-rich appeals and the industrial marketing rhetoric surrounding it. In so doing, it found the motif of 'immersion' as both entrenched and central in the medium's wider identity. The medium's central component of 'immersion' was then unpacked and an emergent coupling between 'immersion' and a particular form of perceptually-mimicking engineering (which could be termed 'mimetic engineering') explored. Finally, geographic literatures exploring the technological realm of 'haptics' and technologies of touch were drawn upon to both explore and complicate the association of 3-D cinema with 'tactility'. Here, the importance of considering the device itself as a key component of media consumption was noted. Recent advancements in both fields (cinema and 'haptics') were then drawn upon in order to propose a shift to the engineering of an increasingly sophisticated engagement with a wider sensory palette, relentlessly packaged as ever more 'immersive' consumer experience.

Whilst such advancements in 3-D cinema and related media technologies more widely may not yet have reached the fictitious heights envisioned by Aldous Huxley in the paper's opening passage, this sci-fi fantasy, underpinned by the same emulation of 'realistic' experience presented as an 'immersive' media quality, is certainly no longer the stuff of fantasy but the subject of fervent industrial research and development. Strides are being made in producing and cultivating ever more perceptually-convincing media encounters. Such encounters increasingly engage with a wider sensory palette, reflecting

sophisticated advances in 'mimetic engineering' across the wider media technological landscape. Given the commercial success and lucrative character of such advancements it is unsurprising that forthcoming technologies are following and extending such developmental trajectories.

In addition to 3-D cinema's advancements in "heightened sensory experience" (Klinger 2013: 424), a number of popular media devices are similarly boasting increasingly complex sensory considerations. From 'Meta's' aforementioned 'Space Glasses' to MIT's 'sensory fiction', which is described as "wearable and immersive" reading utilising "extra-lexical components like sound, temperature control, vibration, and ambient lighting to tell its stories" (The Atlantic 2014: n.p.), we are seeing an increasing sensory engagement and commodification across the wider technological media landscape. In the face of the rise of such technologies centred around multisensory verisimilitude, questions around the changing character of media 'immersion' and its underpinning by increasingly complex forms of 'mimetic engineering' are thus of increasing import.

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