

CARR CENTER FOR HUMAN RIGHTS POLICY HARVARD KENNEDY SCHOOL

Reimagining Reality: Human Rights and Immersive Technology

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Carr Center
Discussion Paper



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The Technology and Human Rights Fellowship is part of the Carr Center for Human Rights Policy's project to examine how technological advances over the next several decades will affect the future of human life, as well as the protections provided by the human rights framework.

[Immersive technology] is just like the atom splitting. It can be used for helping mankind, lifting mankind, or it can be used for destroying mankind. That's where we are with virtual reality. We're on the cusp of having powerful tools like fire. What are we going to do with it? How are we going to use it? How are we going to put in safeguards so that we don't get burned? ¹

- Dr. Thomas Furness

Developer of first immersive technologies

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Introduction

This paper will discuss the human rights implications of emergent technology, and focus on virtual reality (VR), augmented reality (AR), and immersive technologies. Because of the psychological and physiological aspects of immersive technologies, and the potential for a new invasive class of privacy-related harms, I argue that content creators, hardware producers, and lawmakers should take increased caution to protect users. This will help protect the nascent industry in a changing legal landscape and help ensure that the beneficial uses of this powerful technology outweigh the potential misuses.

Proponents of immersive technologies point to the transformational power of the medium. The experience of being in a VR environment for the first time is like stepping into a new world, where the program and head mounted display (HMD) create a digital blank slate for experience. Simply put, it feels real. Benefits like increased human connection, augmented empathy, and new opportunities for education are commonly listed as proof of VR's potential.² Critics caution against unfettered optimism and focus on the opportunities for misuse and abuse, like harassment and violations of consumer privacy.

Because of the decreasing cost and rapid pace of development of immersive hardware, we are at a tipping point. Society is poised at the cusp of widespread adoption of immersive

technologies by consumers, educators, advertisers, artists, journalists, and mainstream computer users. It is a rapidly growing player in the entertainment industry, encroaching on other large players like professional sports, video games, and film.³ But immersive technology is about to move from a tool for gamers, early adopters, and laboratory scientists to something that average people have in their living rooms. The Oculus Quest was a top gift for the 2019 Christmas season and sold out its entire stock going forward three months.⁴ It was equal in price to an Xbox or PlayStation gaming system, positioning it as a viable competitor to mainstream gaming.⁵ Over the next 3 years, VR and AR are each predicted to become a multi-billion dollar industry,⁶ with some estimates reaching \$150 billion dollars in combined AR and VR revenue in 2020.⁷

Furthermore, hardware improvements have made VR more accessible to consumers and workspaces. Resolution and rendering have increased to the point where artists perform concerts live in communal VR spaces before millions of fans.⁸ Rendering improvements have made it so professional sports can utilize live VR, as basketball is broadcasting one game a week in VR, with pro hockey, racing, and baseball leagues generating their own sports-based experiences for fans.⁹ The releases of self-contained HMDs have untethered VR from separate computer processors and cables, making the medium more affordable and portable for recreational users.¹⁰ NFL players review gameplay virtually, freeing them

¹ Telephone interview with Tom Furness, Professor, University of Washington (Aug. 4, 2019).

² *Id.* See also Virtual World Society, VIRTUAL WORLD SOCIETY, <https://www.virtualworldsociety.org> (last visited Dec 31, 2019). The Virtual World Society exist to promote affirming uses of new immersive technology to benefit humanity, with a particular focus on improving the lives of children. Please note that the author serves on the board of this non-profit organization.

³ *How Virtual Reality Is Changing the Entertainment Industry*, THE SPREAD (2019), <http://cinemajam.com/mag/features/how-virtual-reality-is-changing-the-entertainment-industry> (last visited Jan 1, 2020).

⁴ Travis Hoium, *Oculus Devices Sold Out in a Positive Sign for Virtual Reality*, THE MOTLEY FOOL, <https://www.fool.com/investing/2019/12/27/oculus-devices-sold-out-in-positive-sign-for-virtu.aspx> (last visited Jan 1, 2020).

⁵ Danny Paez, *New Xbox: Release Date, Price, Specs, & Games for Microsoft New Console*, INVERSE, <https://www.inverse.com/article/53838-new-xbox-project-scarlett-release-date-price-specs-features-games> (last visited Jan 5, 2020).

⁶ DIGI CAPITAL, *Ubiquitous \$90 billion AR to dominate focused \$15 billion VR by 2022*, <https://www.digi-capital.com/news/2018/01/ubiquitous-90-billion-ar-to-dominate-focused-15-billion-vr-by-2022/> (last visited Dec 31, 2019).

⁷ Mark Lemley & Eugene Volokh, *Law, Virtual Reality, and Augmented Reality*, U. PA. L. REV. 166, 28-29 (2018).

⁸ WIRED, *Live Concerts Take the Virtual Out of Virtual Reality*, <https://www.wired.com/brandlab/2017/07/live-concerts-take-virtual-virtual-reality/> (last visited Jan 1, 2020).

⁹ *Id.*

¹⁰ As of January 2020, the top untethered HMDs include Oculus Quest, Oculus Go, Lenovo Mirage Solo, and HTC VIVE Focus. Price points vary between \$199 and \$650 USD. See Will Greenwald, *The Best VR Headsets for 2020*, PCMAG, <https://www.pcmag.com/article/342537/the-best-virtual-reality-vr-headsets> (last visited Jan 6, 2020).

from the risk of physical injury.¹¹ AR devices are finding new applications in enterprise spaces, helping train surgeons to repair heart valves¹² and skilled mechanics to deal with complex repairs.¹³ These early successes have combined to create a new sense of possibility, hope, and excitement around the adoption and uses of immersive technologies.

However, as we have seen from the emergence of other new media – from the telegraph to the telephone, from the television to the internet – the promise of innovation comes with a corresponding sense of peril. **Because of the psychological aspects that make VR and AR immersive, and the potential for negative impacts on individual users and their communities, I argue that we should examine immersive media through a human rights-oriented lens.**

A human rights-based framework would integrate human dignity into the DNA of immersive systems, just like privacy-by-design frameworks foreground privacy-related concerns at the onset of product and policy development. Specifically, a human rights lens would mean that immersive creators and lawmakers should examine mismatches between existing privacy law and new forms of potential safety violations that implicate the fundamental rights of users – along with examining nascent risks inherent in both the interfaces and the immersive content itself.

To take a human rights-based approach to immersive technology, we should ask questions like: What risks emerge from the capabilities being built in as standard features into typical VR/AR hardware? What risks of user abuse or

violations of the right to freedom of expression, freedom of assembly, and safety of users can be reasonably anticipated? What does content moderation look like in an immersive environment? Do we need to reconceive of privacy risks in the immersive context? Given these inquires, what sort of actions can we take today to preserve human rights in virtual spaces?

Examining fundamental questions at an early stage in the lifecycle of immersive technologies may help stave off some of the pitfalls we most recently saw in the other forms of internet-based technologies, and may give us the opportunity to apply this powerful new medium in socially affirming and personally beneficial ways.

In this paper, I will first review the technology and terminology around immersive technologies to explain how they work, how a user's body and mind are impacted by the hardware, and what social role these technologies can play for communities. Next I will describe some of the unique challenges for immersive media, from user safety to misalignment with current biometrics laws. I introduce a new concept, biometric psychography, to explain how the potential for privacy-related harms is different in immersive technologies, due to the ability to connect your identity to your innermost thoughts, wants, and desires. Finally, I describe foreseeable developments in the immersive industry, with an eye toward identifying and mitigating future human rights challenges. The paper concludes with five recommendations for actions that the industry and lawmakers can take now, as the industry is still emerging, to build human rights into its DNA.



Virtual reality headset at Jisc Digital Festival
Jisc and Matt Lincoln

¹¹ JEREMY BAILENSON, *EXPERIENCE ON DEMAND: WHAT VIRTUAL REALITY IS, HOW IT WORKS, AND WHAT IT CAN DO* 14–17 (W. W. Norton & Company, 1st ed. 2018).

¹² HARVARD MEDICAL SCHOOL: *SCIENCE IN THE NEWS*, *Augmented Medicine: the power of augmented reality in the operating room*, <http://sitn.hms.harvard.edu/flash/2019/augmented-medicine-the-power-of-augmented-reality-in-the-operating-room/> (last visited Jan 1, 2020).

¹³ HEARTWOOD, *3D Interactive Tech Talk - Rolls Royce VR training, AR up skills in Automotive*, <https://hwd3d.com/blog/3d-interactive-tech-talk-rolls-royce-vr-ar-automotive/> (last visited Jan 1, 2020).

A Primer to Immersive Technologies

For those who have never tried immersive technology, it is a window into another world. Virtual reality, or VR, is an interface worn on the body that places users inside an interactive virtual environment.¹⁴ Putting on a VR headset allows you to experience the sights and sounds of a digital alternative environment. VR headsets use a system of cameras and sensors to track and respond to a user's eyes, movements, and gestures.

Augmented reality, or AR, can be defined as an interface that layers digital content on a user's visual plain.¹⁵ Augmented reality is often accessed through glasses or a smartphone. Rather than transporting a user to a new world, it enables a user to enrich the world they inhabit. Digital objects are overlaid upon the user's world, but there is no occlusion, meaning digital assets do not interact with objects in the user's environment.¹⁶ For example, generally, a puppy depicted in AR would be seen as layering over a table, and would not recognize obstacles as a surface to go around or sit upon.¹⁷

Mixed reality, or MR, combines VR and AR type experiences, displaying elements of virtual and actual environments together and sometimes switching between them. Computer-generated objects will treat objects in MR like actual obstacles and interact with them accordingly, like a puppy will go under a tabletop and around its legs. New VR-web browser combinations are crossing lines between the internet and VR usage, and raising expectations for further integrative work that can span mediums.¹⁸

Another popular term for VR, AR, and MR is spatial computing.¹⁹ As new interfaces between web browsers and VR content are

created and become commonplace, this term may gain more traction. However, in this paper, I will be referring to this body of innovation as "immersive technologies," to better account for both the hardware and the experiential aspects of this analysis, and to better incorporate new innovations that may emerge over time.

HOW DO IMMERSIVE TECHNOLOGIES WORK?

VR SYSTEMS

Functionally, VR works similarly to your old View-Master, if it had been combined with a motion picture.²⁰ A VR headset displays the video feed created by a computer processor that is either located externally or contained within a HMD. The HMD sends the two visual feeds to two LCD displays – a left and a right screen, one for each eye. Inside the HMD, there are additional lenses located between the screen and your eyes, which focus the image. Looking through the viewfinder places your gaze through those lenses, creating a stereoscopic three-dimensional effect, due to slight differences between the left and right images. This is the same way that left eye and right eye see slightly different perspectives that combine to create depth in your vision.²¹

As a general rule, the wider your field of view, the more immersive the experience will be. Most VR visual displays have a 100 to 110 degree range.²² Higher-end hardware will have foveated rendering, which means that it blurs the scenes at the edges of the periphery in the same way your everyday vision will have an area of central focus but blur at the edges.²³ Foveated rendering works via eye tracking,

¹⁴ PC MAGAZINE, *Encyclopedia*, <https://www.pcmag.com/encyclopedia/term/69784/ar-vr> (last visited Jan 1, 2020).

¹⁵ *Id.*

¹⁶ Kaitlyn Irvine et al., *XR: VR, AR, MR—What's the Difference?* VIGET, <https://www.viget.com/articles/xr-vr-ar-mr-whats-the-difference> (last visited Jan 5, 2020).

¹⁷ *Id.* However, new advancements in AR world reconstruction may allow for virtual elements to recognize the structure of their world.

¹⁸ See, e.g., MOZILLA, *Mozilla Mixed Reality*, <https://mixedreality.mozilla.org> (last visited Jan 1, 2020).

¹⁹ MAGIC LEAP, *What is Spatial Computing?* <https://developer.magicleap.com/learn/guides/design-spatial-computing> (last visited Jan 1, 2020).

²⁰ *View-Master*, NATIONAL TOY HALL OF FAME, <https://www.toyhalloffame.org/toys/view-master> (last visited Jan 5, 2020).

²¹ Zaynah Bhanji, *A New Reality: How VR Actually Works*, MEDIUM, <https://medium.com/predict/a-new-reality-how-vr-actually-works-663210bdf72> (last visited Jan 1, 2020).

²² *Field of View for Virtual Reality Headsets Explained*, VR LENS LAB, <https://vr-lens-lab.com/field-of-view-for-virtual-reality-headsets/> (last visited Jan 1, 2020).

²³ *HTC Vive Pro Eye hands-on: Gaze into VR's future with foveated rendering*, VENTUREBEAT, <https://venturebeat.com/2019/01/10/htc-vive-pro-eye-hands-on-gaze-into-vrs-future-with-foveated-rendering/> (last visited Jan 1, 2020).

Psychological realness leads users of immersive technologies to physiologically respond to virtual simulations in ways that are similar to their bodily response to real situations.

where the HMD uses the position of your pupils to determine what areas should be in focus and what areas can be of lesser resolution.²⁴ This can also conserve computing energy in an experience and allow developers to create more detail inside the focus area.²⁵

As you move, HMDs use sensors to track your motion, position you in space, and refresh your perspective. Tracking is the ability for hardware to calibrate and measure a user's head and eye movements and respond accordingly with a change in the user's point of view.²⁶ HMDs measure head position and rotation via spatial mapping techniques, using a system called six degrees of freedom; when properly calibrated, the picture follows the up-and-down, side-to-side, and tilt angle of a user's head, as measured on X, Y, and Z axes to determine the user's position and direction.²⁷

A combination of optical and non-optical sensors help position the body in space, and may prevent the user from tripping or accidentally harming herself while in an immersive experience. These include accelerometers, gyroscopes and magnetometers embedded inside handheld controllers or HMDs, that convert movement into electrical signals and so track motion.²⁸

Hand tracking is a separate mechanism using optical sensors, but this is quickly evolving. Controller-less interfaces interpret electrical impulses directly to enable gesture-based control of the VR software.²⁹ All these sensors together enable tracking the user's movements and behavior.

Quick hardware response to users' movement is critical to reduce latency and prevent users from feeling sick from immersive experiences. Human perception is fine-tuned and we may experience "simulation sickness" if rendering, tracking, or display features are incorrectly calibrated. The delay in time between a user moving her head/eyes and a change in her point of view is called latency.³⁰ At minimum, 60 frames per second must be rendered in a HMD to avoid the users feeling a sense of nausea or disorientation; many content providers choose to provide a higher rate for an enhanced experience.³¹ This is important because humans have high sensitivity to latency; flight simulator experiences have shown that we can detect latency lags of more than 50 milliseconds. In immersive environments, latency creates awareness of the artificialness of an environment and ruins the sense of an alternative reality.³²

Eye tracking in VR is of paramount importance, and techniques will be detailed in more depth later in the paper. In short, eye tracking involves use of an infrared camera to monitor eyes and the direction of a user's gaze inside the HMD.³³ These sensor results translate into more precise computer reactions in VR content and a more realistic point of view. Foveated rendering, as previously mentioned, can also help replicate visual realism in blurring the edges of peripheral vision; this effect can also help reduce stimulation sickness.³⁴

²⁴ *Id.*

²⁵ *Id.*

²⁶ *How Virtual Reality Works*, HOWSTUFFWORKS, <https://electronics.howstuffworks.com/gadgets/other-gadgets/virtual-reality.htm> (last visited Jan 1, 2020).

²⁷ *A Quick Guide to Degrees of Freedom in Virtual Reality*, KEI STUDIOS (2018), <https://kei-studios.com/quick-guide-degrees-of-freedom-virtual-reality-vr/> (last visited Jan 1, 2020). The X, Y, and Z axes are also respectively known as orientation, position, and rotation.

²⁸ *Understanding Sensors: Magnetometers, Accelerometers and Gyroscopes*, VIRTUAL REALITY SOCIETY (2017), <https://www.vrs.org.uk/virtual-reality-gear/motion-tracking/sensors.html> (last visited Jan 1, 2020).

²⁹ OCULUS, *Introducing Hand Tracking on Oculus Quest—Bringing Your Real Hands into VR*, <https://www.oculus.com/blog/introducing-hand-tracking-on-oculus-quest-bringing-your-real-hands-into-vr/> (last visited Jan 1, 2020).

³⁰ *Latency - Virtual Reality and Augmented Reality*, VR AR & XR WIKI, <https://xinreality.com/wiki/Latency> (last visited Jan 1, 2020). Latency can also refer to lags in other sensory perception, beyond just vision.

³¹ HOWSTUFFWORKS, *supra* note 26. The HMD is what determines the required rendering rate.

³² *Id.*

³³ VR.ORG, *How Does Eye Tracking Work?*, <https://www.vr.org/2018/02/22/how-does-eye-tracking-work/> (last visited Dec 31, 2019).

³⁴ HTC Vive Pro Eye hands-on, *supra* note 23. Sound that appears to emanate from a locational source and the Doppler effect can be similarly effective in aiding the user's sense of immersion.

AR INTERFACES

AR differs from VR because it superimposes virtual layers on physical spaces. Through the use of a system of cameras, along with a mounted computer in a HMD, the device analyzes a visual field and the locations of objects, and superimposes imagery or descriptions over the user's view.³⁵

Phone-based AR functions via a single camera, alongside a depth camera if it has one, to undertake SLAM (simultaneous location and mapping, conducted via algorithm).³⁶ These cameras are often used in conjunction with handset's accelerometer and gyroscope, collectively known as an inertial measurement unit (IMU). The SLAM algorithm combines these multiple sensors to determine where the phone is and in what direction and manner it is moving.³⁷

Current HMDs for XR³⁸ use the same orientation techniques, but with even more inputs to layer digital content onto actual spaces. Rather than a single camera, an HMD will reconstruct its surroundings from several wide angle, often lower resolution, cameras that all point in different directions. AR and XR eye tracking systems are usually a camera literally pointed at the viewer's eyes, some operating via infrared light. Older systems use a special infrared light field generated by the external "lighthouses," combined with its internal IMU to deduce user position and angle of movement.³⁹ Some AR systems, like the Magic Leap, use a single handset with more embedded sensors,⁴⁰ while others like the Microsoft HoloLens are completely hand-input driven.⁴¹

The AR camera and sensors create a separate computing layer from the display system. Once the device knows its location and orientation, it can render a virtual 3D world from the

user's perspective. The display system then overlays that rendering in front of the viewer's vision.⁴²

THE SOCIAL ROLE OF IMMERSIVE TECHNOLOGY

There is a temptation to think of immersive media as an extension or next generation of entertainment, gaming, or social media. However, I argue that because of the psychological and bodily components, it is fundamentally different. Nevertheless, it is important to begin by understanding the similarities.⁴³ Just like social media and gaming platforms, many types of immersive media enable users to connect with others and communicate with people across a physical distance. This interaction is mediated via hardware and software interfaces. The online space and immersive media enable users to connect with people, to find potentially far-flung individuals who have similar ideas and interests, and to allow them to form social groups.

Gaming has been the primary vector pushed by the immersive industry, to this point. Pokémon Go was the breakthrough game for mobile AR in 2016, demonstrating that users would be willing to track and seek out virtual creatures in outdoor locations using a phone-based AR interface, and physically chase them down.⁴⁴

Because of the psychological aspects of immersive technologies, there are important distinctions that potentially impact a user's human rights.

³⁵ MAGIC LEAP, *supra* note 19.

³⁶ Telephone interview with Aaron Moffatt, Chief Technology Officer, Immersion Analytics (Dec. 12, 2019).

³⁷ HOWSTUFFWORKS, *supra* note 26.

³⁸ Extended Reality (XR) refers to all real-and-virtual environments generated by computer graphics and wearables. The 'X' in XR is simply a variable that can stand for any letter. XR is the umbrella category that covers all the various forms of computer-altered reality, including: Augmented Reality (AR), Mixed Reality (MR), and Virtual Reality (VR).

³⁹ Interview with Aaron Moffatt, *supra* note 36. See also Magic Leap One Teardown, IFIXIT, <https://bit.ly/2Z2Df4L> (last visited Jan. 1, 2020).

⁴⁰ *Id.*

⁴¹ *Microsoft HoloLens: Cheat Sheet*, TECHREPUBLIC, <https://tek.io/3bqSC9G> (last visited Jan 1, 2020). But see Ash, *Sorry Microsoft, Controllers Are A Must For AR Smart Glasses*, MEDIUM, <https://bit.ly/2LrS5K1c> (last visited Jan 1, 2020).

⁴² Interview with Aaron Moffatt, *supra* note 36.

⁴³ The most similar forum that comes to mind may be social VR, based on its intentional similarity to non-immersive social networking. However, this comparison may not hold as emergent gaming platforms, like Fortnite, blur the boundaries between online gaming, social media, and performance space. For example, musical artist Marshmello did a February 2019 concert within Fortnite, and 10.7 million people logged in and attended from all over the world. More people would have been counted as attendees, if you were to tally online live streaming of the performance. Over 27 million people watched the official YouTube recouping. See Andrew Webster, *Fortnite's Marshmello concert was the game's biggest event ever*, THE VERGE, <https://www.theverge.com/2019/2/21/18234980/fortnite-marshmello-concert-viewer-numbers> (last visited Jan 1, 2020). Since genres keep becoming more and more fluid, defining analogous media may be a temporary exercise, at best, to help us understand how immersive media function within a society.

⁴⁴ Susie Rack, "How Pokémon Go has changed my life," BBC NEWS, January 1, 2020, <https://bbc.in/2WX6C5S> (last visited Jan 1, 2020).

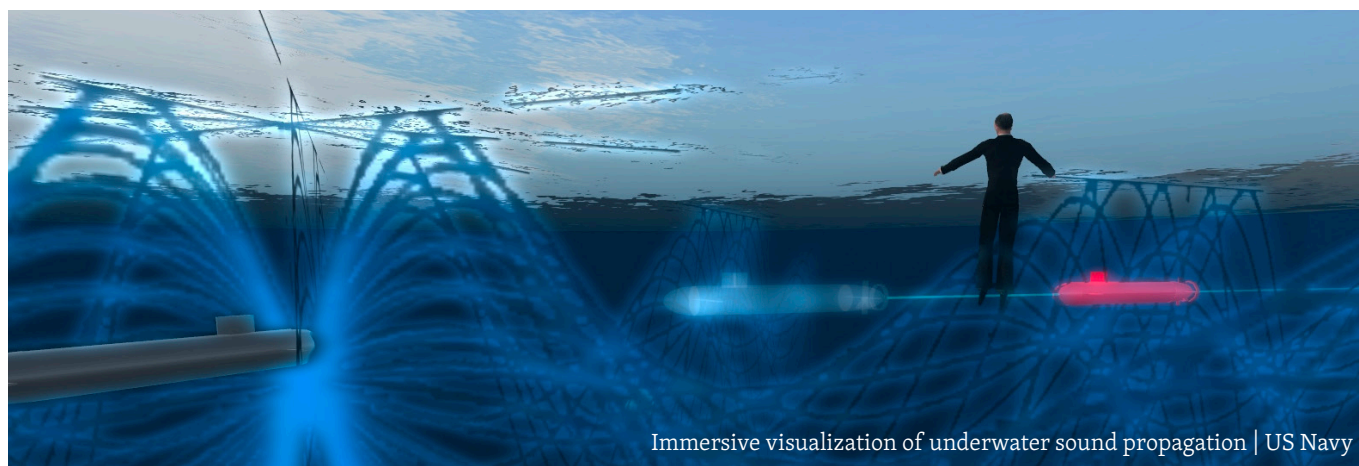
Lifted by gaming popularity, Facebook's Oculus has sold over 1.5 million headsets to consumers.⁴⁵ Sony HTC Vive, a competitor VR system, has sold 1.3 million devices.⁴⁶ The top-performing HMDs have been focused on programming that is entertainment-based, like interactive gaming experiences for users. These successes may show that that consumer-based VR, bolstered by gaming, has now arrived. Other AR and mixed reality headsets have not gotten the same traction, as the use case for the average person (and not an enterprise application or commercial customer) may not yet be as clear.⁴⁷

It is a mistake to give into the temptation to treat immersive technologies like new forms of preexisting electronic interfaces and apply the same regulatory approaches to this nascent medium. VR and AR are more than new video games or novel social networks. **The same type of challenges that I'll identify in this paper – namely user safety and privacy-related challenges – are found in internet-based platforms. However, because of the psychological aspects of immersive technologies, there are important distinctions that potentially impact a user's human rights.**

PSYCHOLOGICAL CHARACTERISTICS OF IMMERSIVE EXPERIENCES

Several characteristics set apart immersive technologies from other types of innovations, including social media. First is **immersion** itself, meaning that the user feels like they are in another environment.⁴⁸ To describe this for non-users, immersion sets the scene. When you put on a headset and the experience loads – say in an underwater marine environment⁴⁹ – images of the ocean appear to surround around you in every direction. Sounds from sea creatures and bubbles appear to emit from the physical location they would be expected to, if you were actually standing on the seabed. Light filters downward from the surface to the sea floor.⁵⁰

Content generates patterns of stimulation for the user, including light photons for the eyes, acoustic input for the ears, and tactile or haptic stimulators for touch. The way these stimuli are presented will give the user a sense of immersion. In short (and as detailed in-depth further in this paper), the immersive features lead to a sense of verisimilitude between oneself and the programming through an all-encompassing setting.



Immersive visualization of underwater sound propagation | US Navy

⁴⁵ Hoium, *supra* note 4.

⁴⁶ *Id.*

⁴⁷ A. J. Agrawal, *3 reasons augmented reality hasn't achieved widespread adoption*, THE NEXT WEB, <https://thenextweb.com/contributors/2018/02/16/3-reasons-augmented-reality-hasnt-achieved-widespread-adoption/> (last visited Jan 1, 2020). The article notes that AR technology has taken off in the form of filters for popular image sharing and messaging apps, like Snapchat filters. These are not traditionally thought of as AR, which demonstrates how the technology may have already arrived without users realizing that they are adapting to a new medium.

⁴⁸ *Hate in Social VR*, ANTI-DEFAMATION LEAGUE, <https://www.adl.org/resources/reports/hate-in-social-virtual-reality> (last visited Jan 1, 2020).

⁴⁹ For an iconic experience in VR, theBlu allows you to come eye-to-eye with a humpback whale. Reviews of the products demonstrate the user's wonder and awe at their sense of immersion. See WEVR, *theBlu Franchise*, <https://wevr.com/theblu> (last visited Jan 1, 2020).

⁵⁰ More underwater experiences are available. See *Best VR Underwater Adventure Games for Deep-Sea Explorers*, VRGAMECRITIC, <https://vrgamecritic.com/article/best-vr-underwater-exploration-adventure-games> (last visited Jan 1, 2020).

Second, there are specific embodiment aspects to the technology. Users must have a sense of active **presence**.⁵¹ This has been defined as “the illusion of non-mediation” or the impression that one feels like she is communicating without interfaces.⁵² Jessica Outlaw, head of the Outlaw Lab at Concordia University, studies the design-based impact of immersive technologies. She illustrates this with a personal example of how she feels like she is truly interacting with another individual while experiencing VR:

[W]hen I'm in a VR headset and I talk to people I know, I actually have the sense of being there with them and having an embodied experience...I create memories with them in these virtual environments...I don't feel like there's a huge difference between hanging out with my friends in a virtual space compared to hanging out with them in the actual physical world.⁵³

In order to create presence, VR pioneer and Stanford professor Jeremy Bailenson emphasizes that content creators need to properly execute tracking, rendering, and display, to avoid simulation sickness from cognitive disassociation.⁵⁴

Third is the concept of “**embodiment**,” or feeling like an avatar or virtual body is your physical body, that separates immersive experiences from social media networks.⁵⁵ This is well illustrated by Mel Slater's “rubber hand illusion,” where researchers placed a toy hand – or a virtual rubber hand in the VR experiment context – in a user's field of vision in a headset. Users who watched processed the poking, prodding, and abuse that researchers inflicted on the

toy as real bodily experiences. The brain formed a connection to the foreign body.⁵⁶ Embodiment can be beneficial, like in clinical applications where it has been shown to help alleviate phantom limb pain.⁵⁷ But it also brings a strong potential risk for virtual social experiences, if you are considering the violence and harassment that have come to characterize many online social spaces.⁵⁸

It is the combination of immersion, presence, and embodiment that allow users to perceive they are in an alternative reality. In psychological research, users often report feeling that they are completely immersed in virtual experiences.⁵⁹ Embodied experiences allow you to interact fully with features of the environment, and in social or multi-user environments, with other individuals in the virtual space.

It's not simply the immersive quality that defines these experiences, but the way our minds memorialize what we perceive. Dr. Thomas Furness, one of the earliest developers of immersive technologies, compares the “enormous power” of virtual worlds as being akin to “splitting the atom.”⁶⁰ This is because it “awakens spatial memory like no other medium has” and because of the active nature of immersive experiences.⁶¹ There is no separation between you and the objects of your interaction, which can be useful for certain contexts, like educational or therapeutic experiences, and more problematic in other virtual experiences, like gaming that involves committing acts of violence. Furness says these experiences are retained like they are “drawn on the brain in permanent ink.”⁶²

⁵¹ Cummings, J.N. & J.J., Bailenson, *How immersive is enough? A meta-analysis of the effect of immersive technology on user presence*, VHIL, <https://vhil.stanford.edu/pubs/2016/how-immersive-is-enough/> (last visited Jan 1, 2020).

⁵² Eric Johnson, *Full transcript: Stanford virtual reality expert Jeremy Bailenson on Too Embarrassed to Ask*, VOX (2016), <https://www.vox.com/2016/8/4/12371450/jeremy-bailenson-stanford-university-virtual-reality-too-embarrassed-to-ask-podcast-transcript> (last visited Jan 1, 2020).

⁵³ Interview with Jessica Outlaw, Outlaw Lab Director at Concordia University, in Portland, OR. (July 22, 2019).

⁵⁴ BAILENSON, *supra* note 11 at 17–20.

⁵⁵ Cortese, Michelle and Andrea Zeller, *Designing Safer Social VR*, MEDIUM, <https://immerse.news/designing-safer-social-vr-76f99f0be82e> (last visited Jan 1, 2020).

⁵⁶ *Id.*

⁵⁷ *Virtual reality eases phantom limb pain*, SCIENCEDAILY, <https://www.sciencedaily.com/releases/2017/05/170531102921.htm> (last visited Jan 1, 2020).

⁵⁸ According to Pew Research, 4 out of 10 Americans report personally being harassed online. Maeve Duggan, *Online Harassment 2017* (2017). Initial research in social VR, like that of Dr. Outlaw, shows a higher proportion in this new forum.

⁵⁹ Interview with Jessica Outlaw, *supra* note 53.

⁶⁰ Interview with Thomas Furness, *supra* note 1.

⁶¹ *Id.*

⁶² *Id.*

How our brains recall being in a virtual environment is similar to the way we create memories of offline experiences.

Furness's assertions are backed by neuroscience. How our brains recall being in a virtual environment is similar to the way we create memories of offline experiences. When scientists have measured brain activity in MRIs, they have found that when one experiences a virtual event and subsequently recalls it, the response in the hippocampus is akin to the way one would predict the brain to respond with an actual event.⁶³ Psychological realness also leads users of immersive technologies to physiologically respond to virtual simulations in ways that are similar to their bodily response to real situations.⁶⁴

As Professor Mark Lemley describes, VR/AR is:

"...in a word, a visceral experience. Things that happen there aren't physically real: If the bad guy shoots you in *Bullet Train*, you don't die in real life. But they feel real indeed.

And those feelings can in turn have real physical consequences. You could literally be scared to death (or at least into a heart attack) by a game that felt sufficiently real. Even if you aren't physically harmed, you will have experienced what you saw and did in VR in a way that you do not on the Internet or in a non-VR video game."⁶⁵

Because of all these facets, immersive experiences are psychologically different than socializing in video game worlds or interacting with others on social networks.

CONTENT-BASED FEATURES OF IMMERSIVE INTERFACES

Sensory perception, and the interfaces that enable it, are further dimensions of immersive technologies that allow users to create alternative realities. Two features are essential for creating effective immersive hardware: components that allow for measurement and components that allow for the production of stimuli.⁶⁶ Since I've already discussed the technical aspects of how immersive hardware works, I will highlight the most important aspects for virtual world building. At its core, immersive technology relies on hardware for signal acquisition. First, it measures unique features of bodily movement and its functioning, like that of the head, the eyes, the hands, the fingers, and the feet. Second, it can measure emotional or physiological states, through mapping activity in the brain via electroencephalography (the measurement and recording of electrical activity in different parts of the brain) or electromyography (tracking signals that activate muscles).⁶⁷ For some time, scholars have thought about the implications of gathering biometric data, but as I will argue later in the paper, the introduction of these techniques into HMDs fundamentally changes the implications of data collection in immersive technology. The combination of measurement of the body with metrics about one's thoughts and emotions is the most important distinction in distinguishing personal information gathered in immersive technologies from personal information gathered from pure biometric data.

Several features of content can enhance the immersive qualities of a VR or AR experience. First, a full **panoramic field of view** can make the user feel as if she is truly in an alternative space. The image quality does not need to be photorealistic (in fact, representative environments are often more effective for users, as the brain inputs missing details). However, the graphics should be rendered with a sufficient quality to engender suspension of disbelief.⁶⁸

As previously mentioned, programming **three-dimensional audio**, including sound coming from the direction of the apparent source and varying in volume as you approach or walk away from it, provide more data for users to perceive environments as real.⁶⁹

⁶³ T.I. Brown et. al, *Prospective Representation of Navigational Goals in the Human Hippocampus*, 352 *SCIENCE* 1323 (2016).

⁶⁴ BAIENSON, *supra* note 7, at 28.

⁶⁵ Lemley & Volokh, *supra* note 6, at 30.

⁶⁶ Interview with Thomas Furness, *supra* note 1.

⁶⁷ *Id.* These measurements and how they function will be described in depth later in this paper.

⁶⁸ *Id.*

⁶⁹ *Id.*

In addition to sound, allowing for a sense of movement or **spatial mobility** inside an experience, made possible by six degrees of freedom, can contribute to the senses of reality. Increasingly portable and affordable hardware, like untethered HMD of the Oculus Quest and Oculus Go, helps produce the feeling that a user is really there in a virtual world, without the limitations of mediation.⁷⁰ New touch-based developments, like haptic gloves⁷¹, and handsfree controllers will make the virtual reality seem even more real.

It is the combination of the rules (like those governing content, data collection and use, behavior, actors) alongside constraints in technical systems that create the field of play for human rights concerns in immersive environments.

Challenges for Immersive Media

THE NEED FOR SAFETY-BASED FEATURES IN IMMERSIVE EXPERIENCES

What happens to freedom of expression and public safety when new media blends offline and online worlds, and brings in the most formidable challenges of both realms?

Content moderation is a particularly tricky challenge for immersive technologies. Interventions placed in VR and AR hardware can prevent certain user actions that occur within individual immersive experiences. Because of active presence, embodiment, and the all-encompassing nature of immersive experiences, visceral content like threats of violence can feel more real in a virtual space because it is not abstract; it is more than just words on the screen. As the examples this paper will review will show, safety-based transgressions of community norms can implicate users' right to freedom of expression and freedom of assembly, in a similar way that online harassment silences voices and forces underrepresented voices off social media.⁷²

⁷⁰ Hate in Social VR, *supra* note 48.

⁷¹ Adi Robertson, *Teslasuit's new VR gloves let you feel virtual objects and track your pulse*, THE VERGE, <https://bit.ly/2T2XcEv> (last visited Jan 5, 2020).

⁷² Danielle Citron makes this same argument about online harassment on social media, and how it impacts the freedom of expression-based rights of the targets by attempting to silence their voices. See Danielle Citron, *Cyber Civil Rights*, 89 BOSTON UNIV. LAW REV. 66-125 (2009), available at <https://ssrn.com/abstract=1271900>.

⁷³ One of the first public conversations about layers of the internet stack and how they impact content moderation was the debate around Cloudflare terminating its services for the infamous white supremacist website, the Daily Stormer. Matthew Prince, *Cloudflare, WHY WE TERMINATED DAILY STORMER* (2017), <https://blog.cloudflare.com/why-we-terminated-daily-stormer/> (last visited Dec. 31, 2019). The internet stack is a concept used to discuss what technical processes happen to create online spaces, including differing underlying network technologies and players that enable websites to exist. For more information on what is meant by the internet stack, see *The Internet Protocol Stack*, <https://www.w3.org/People/Frystyk/thesis/TcpIp.html> (last visited Jan 5, 2020).

⁷⁴ Taylor Lorenz, *Virtual Reality Is Full of Assholes Who Sexually Harass Me. Here's Why I Keep Going Back*, <https://www.mic.com/articles/144470/sexual-harassment-in-virtual-reality> (last visited Dec 31, 2019).

⁷⁵ *Id.*

Looking at the different technical levels in an immersive experience, there are different avenues for potential content moderation. This is similar to content moderation on the internet, where there are different options and questions about power, actors, and responsibility based on the different layers of the internet stack where moderation may occur.⁷³ For immersive content, the first layer of potential moderation space would be looking at user behavior itself, via the actions and choices that one's avatar projects in the virtual world. Second would be the content of the virtual environment itself. Third would be the aspects built into interfaces and platforms themselves. Some of these layers, like avatar behavior, will pose more of a foreseeable risk than others.

Online harassment in virtual worlds and digital communities has been well documented – and one could imagine problems and solutions that implicate the different immersive stack layers of user behavior, content itself, and platform features. Just like social media, the targeting impacts underrepresented groups in VR, primarily minorities, women, and marginalized communities.

Social VR refers to interactive forums where users gather to socialize in virtual communal spaces. Almost as soon as social VR came into being, reports of abuse of users in the experiences followed. In 2016, journalist Taylor Lorenz described entering into Altspace VR, a popular social VR forum:

Within two minutes of walking into the welcome room...I was given my first unsolicited "virtual reality kiss." Shortly after, my skinny brown-haired avatar was swarmed by male users rubbing on me and asking if I was as skinny in real life or just a fatty behind an avatar. I felt ripped from the virtual world and transported back to middle school.⁷⁴

Her colleague, who also donned a female avatar, had a similar experience. Even though the platform then invested in moderators, terms of service banning harassment and lewd behavior, and blocking tools, Lorenz felt the demographics of users and the social VR feature set the stage for such abuse to occur.⁷⁵

In one of the first detailed public recountings of sexual harassment in VR, a journalist writing under the pseudonym Jordan Belamire described her experience of having her personal space invaded and her character groped in QuiVr, a VR archery experience, in less than three minutes participating in the platform.⁷⁶ According to Belamire's account, this is how the interaction occurred:

In between a wave of zombies and demons to shoot down, I was hanging out next to BigBro442, waiting for our next attack. Suddenly, BigBro442's disembodied helmet faced me dead-on. His floating hand approached my body, and he started to virtually rub my chest.

"Stop!" I cried. I must have laughed from the embarrassment and the ridiculousness of the situation. Women, after all, are supposed to be cool, and take any form of sexual harassment with a laugh. But I still told him to stop.

This goaded him on, and even when I turned away from him, he chased me around, making grabbing and pinching motions near my chest. Emboldened, he even shoved his hand toward my virtual crotch and began rubbing.

There I was, being virtually groped in a snowy fortress with my brother-in-law and husband watching.

As it progressed, my joking comments toward BigBro442 turned angrier, and were peppered with frustrated obscenities. At first, my brother-in-law and husband laughed along with me—all they could see was the flat computer screen version of the groping. Outside the total immersion of the QuiVr world, this must have looked pretty funny, and definitely not real.

Remember that little digression I told you about how the hundred foot drop looked so convincing? Yeah. Guess what. The virtual groping feels just as real. Of course, you're not physically being touched, just like you're not actually one hundred feet off the ground, but it's still scary as hell.⁷⁷

Other reports of harassment in VR have documented sexual, gender-based, racial, ethnic, religious, and homophobic targeting.⁷⁸ In 2018, the research firm The Extended Mind produced a study of the experiences of women in social VR. The results were not surprising, if you consider the experiences of Belamire, and quite discouraging: 49% of women reported experiencing at least one incident of harassment in VR.⁷⁹ Many of them never went back to the virtual experience. The harassing results were not just limited to women, as 30% of male respondents reported racist or homophobic content, and 20% experienced violent comments or threats on the platform.⁸⁰

In response to concerns about user behavior, companies have started to create content moderation features that take into account user control, volition, and consent. Many platforms now generate an intimate buffer that match onto offline cultural approximations, like providing an approximately 12- to 18-inch zone around a user for a private area.⁸¹ At the F8 conference, Oculus described how it was protecting personal space for users.⁸² For example, when a user avatar's "safety bubble" is invaded by another user in a Facebook social VR app⁸³, both avatars become invisible to each other. Other settings give a user the ability to revoke consent to participate in social engagements. Hitting "Pause" lets a user stop the action in a VR setting if they feel uncomfortable. A user can 'mute' another user's avatar to make it disappear completely. The apps also have live moderators to help police

⁷⁶ Jordan Belamire, *My First Virtual Reality Groping*, MEDIUM, <https://medium.com/athena-talks/my-first-virtual-reality-sexual-assault-2330410b62ee> (last visited Jan 1, 2020).

⁷⁷ *Id.*

⁷⁸ Hate in Social VR, *supra* note 48.

⁷⁹ Jessica Outlaw, *Virtual Harassment: The Social Experience of 600+ Regular Virtual Reality (VR) Users*, THE EXTENDED MIND, <https://extendedmind.io/blog/2018/4/4/virtual-harassment-the-social-experience-of-600-regular-virtual-reality-vrusers> (last visited Jan 1, 2020).

⁸⁰ *Id.*

⁸¹ Cortese & Zeller, *supra* note 55.

⁸² Outlaw, *supra* note 79.

⁸³ At the time these were Facebook Spaces and Oculus Venues. These were shut down on October 25, 2019 as Facebook Oculus prepared to launch Facebook Horizon, its new social VR platform. FACEBOOK SPACES, <https://www.facebook.com/spaces/> (last visited Jan 1, 2020).

Perceived threats in virtual spaces – like somebody invading physical space, intimidating a user, or even assaulting an avatar – may be interpreted by our brains as actual threats.

bad behavior.⁸⁴ The developers of Quivr responded quickly to reports of the groping, and coded remedial measures like Oculus had done – and more. They created a personal space bubble that covered a whole person, and not just limited parts of a person’s body like Oculus had done.⁸⁵

Individual developers have also been responsive to some concerns over user safety. One of Facebook’s developer partners, Harmonix, operates a multi-player lounge in its Dance Central VR experience. If a user finds their personal space is invaded, they can make a double thumbs-down hand signal at the avatar of the harasser. The harasser is muted and frozen, and subsequently relocated to another part of the dance floor.⁸⁶

Prevention will be increasingly important as immersive spaces evolve into interactive communities, beyond normal social VR platforms. As previously mentioned, some new platforms will span the spatial computing spectrum, across VR and traditional computer and smartphone technologies.⁸⁷ Mozilla’s Hubs is a social platform that uses spatialized audio, 3D environments, and media composition features to support collaboration in virtual reality, or through a “flat” screen on desktop or mobile devices.⁸⁸ Even in these mixed spaces, where some of immersive media’s psychological impacts may be different, preventing user abuse and unwanted contact will be important.

Prevention should be prioritized as immersive technology continues to evolve. For example, in September 2019, Oculus announced Facebook Horizon, a new social VR-based world for the Oculus Quest and the Rift Platforms that will be unveiled in 2020.⁸⁹ The company describes how this new platform will function as a fully-realized virtual world:

Starting with a bustling town square where people will meet and mingle, the Horizon experience then expands to an interconnected world where people can explore new places, play games, build communities, and even create their own new experiences.

Before stepping into Horizon for the first time, people will design their own avatars from an array of style and body options to ensure everyone can fully express their individuality. From there, magic-like portals—called telepods—will transport people from public spaces to new worlds filled with adventure and exploration. At first, people will hop into games and experiences built by Facebook, like Wing Strikers, a multiplayer aerial experience.

But that’s just the beginning. People will also jump into various other Horizon worlds, built using the World Builder, a collection of easy-to-use creator tools. Everyone will have the power to build new worlds and activities, from tropical hangout spots to interactive action arenas, all from scratch—no previous coding experience needed. Whether people choose to build, play, or simply hang out, Horizon will ensure a welcoming environment through new safety tools and human guides—Horizon Locals—to answer questions and provide assistance, if needed.⁹⁰

This will matter all the more in fully-immersive digital worlds like Horizon. As shown in the Quivr example, perceived threats in virtual spaces – like somebody invading physical space, intimidating a user, or even assaulting an avatar – may be interpreted by our brains as actual threats. Users cognitively might not always be able to discern different feelings from between being assaulted in a virtual environment and being assaulted in a physical environment.

⁸⁴ Mark Sullivan, *Facebook is preemptively trying to fix social VR abuse*, FAST COMPANY, <https://www.fastcompany.com/90342844/abuse-on-social-vr-facebook-is-trying-to-fix-it-before-it-goes-mainstream> (last visited Jan 1, 2020).

⁸⁵ Lemley & Volokh, *supra* note 6, at 87-88.

⁸⁶ Sullivan, *supra* note 84.

⁸⁷ See, e.g., MOZILLA, *supra* note 18.

⁸⁸ HUBS BY MOZILLA, <https://hubs.mozilla.com/> (last visited Jan 1, 2020).

⁸⁹ OCULUS, *Introducing ‘Facebook Horizon,’ a New Social VR World, Coming to Oculus Quest and the Rift Platform in 2020*, <https://www.oculus.com/blog/introducing-facebook-horizon-a-new-social-vr-world-coming-to-oculus-quest-and-the-rift-platform-in-2020/> (last visited Jan 1, 2020).

⁹⁰ *Id.*

New features of Horizon are being rolled out progressively, and more updates were released in December 2019. These included: “messaging with your Oculus pals, along with photo and video sharing and livestreaming to Facebook. You can create events to set up a time to play games with your buddies or arrange meetups, and form parties that all your Oculus friends can join (parties were invite-only until now). Your Facebook friends will also be able to group up with you in VR when you send them links via Messenger.”⁹¹

Users will be asked to sign into Facebook to use these features, and to take other social actions like joining parties, adding friends and visiting people’s Homes.⁹² While this is not mandatory to log in, your Facebook information will be used to inform social features, recommendations, ad targeting, and VR events and advertisements. The ties between Oculus and Facebook services are going to become more intertwined, with “new features such as Facebook Group sharing options and watch parties on Quest on the way.”⁹³

If the initial challenges of social VR cannot be dealt with, they will likely be augmented – and evolve into new challenges – in novel environments like Hubs and Horizon, where user-generated content will open additional avenues for innovation and expression, alongside exploitation and abuse. Additionally, as large companies like Mozilla and Facebook invest in the immersive technology space, the closer ties between social media platforms and social VR platforms may become troubling to advocates concerned about user privacy.⁹⁴

⁹¹ OCULUS, *supra* note 89.

⁹² *Id.*

⁹³ OCULUS, Introducing New Features From Facebook to Help People Connect in VR and an Update to Our Privacy Policy, <https://www.oculus.com/blog/introducing-new-features-from-facebook-to-help-people-connect-in-vr-and-an-update-to-our-privacy-policy/> (last visited Jan 1, 2020).

⁹⁴ *Id.* Facebook has tried to alleviate these concerns. According to their FAQ: “You won’t have to log in with Facebook to use the VR platform. If you do, you’ll still keep your existing Oculus friends, username and profile. You can decide to display your real name (as per your Facebook profile) on Oculus and whether to automatically add your Facebook friends as Oculus contacts. You’ll have control over what you share from Oculus to Facebook as well, along with who can see those posts.” The privacy policy changes won’t affect third-party apps and games. An FAQ spells out the types of data that Oculus and Facebook will share if you connect accounts. A beta for the complete Facebook Horizon social VR world is slated for full release in 2020.

⁹⁵ Molly K. McGinley et. al, The Biometric Bandwagon Rolls On: Biometric Legislation Proposed Across the United States, THE NATIONAL LAW REVIEW, <https://www.natlawreview.com/article/biometric-bandwagon-rolls-biometric-legislation-proposed-across-united-states> (last visited Jan 1, 2020).

⁹⁶ 740 ILL. COMP. STAT. ANN. 14/10, available at <http://www.ilga.gov/legislation/ilcs/ilcs3.asp?ActID=3004&ChapterID=57>.

⁹⁷ *Id.*

⁹⁸ *Id.*

COVERAGE UNDER EXISTING BIOMETRICS LAWS

The area of immersive technology that has the highest potential for human rights abuses may be biometric data and its limitations, due to the type of information that can be collected and a fundamental mismatch with existing law. Biometric information and biometric identifiers, as typically defined, are not a clean fit with the technical functions and capabilities – and risks – of immersive technologies.

Existing legal definitions of biometric information do not reflect the development of immersive technologies, when you consider factors like what features are available with hardware, how those features function, what information about users is available, and how that information could be used. As of November 2019, three states had laws governing biometric information. California will follow under the CCPA on January 1, 2020. At least four more states are considering laws covering biometrics.⁹⁵

The nation’s most robust and litigated biometric law, The Illinois Biometric Information Privacy Act, has two separate and distinct definitions for “biometric identifier” and for “biometric information.”⁹⁶ Under the Illinois state law, a “biometric identifier” is a bodily imprint or attribute that can be used to uniquely distinguish an individual. It is defined as “a retina or iris scan, fingerprint, voiceprint, or scan of hand or face geometry.”⁹⁷ Exclusions from the definition of biometric identifier are “writing samples, written signatures, photographs, human biological samples used for valid scientific testing or screening, demographic data, tattoo descriptions, or physical descriptions such as height, weight, hair color, or eye color” and biological material or information collected in a health care setting.⁹⁸

“Biometric information” under the statute is defined as “any information, regardless of how it is captured, converted, stored, or shared, based on an individual’s biometric identifier used to identify an individual” and “does not include information derived from items or procedures excluded under the definition of biometric identifiers.”⁹⁹

The statute protects both biometric identifiers and biometric information.¹⁰⁰ But the functioning of hardware may implicate how the statute is applied. For example, from the Illinois law’s two-step definition it is unclear whether facial recognition software that identifies faces from photographs is subject to the law’s protections; scans of facial geometry are considered “biometric identifiers,” but photographs are excluded under the list of biometric identifiers, and information “based on” an excluded item cannot be “biometric information.”

New innovations will create more challenges and ambiguities. For example, controller-less VR mechanisms are on the cusp of usage.¹⁰¹ This creates an untested area of the law, which may vary depending on the mechanism used to create scans of “hand geometry” that allow users to create their own interface. Would a court find that connecting this information with a user’s Facebook or Oculus account to be identifying? Or is the measurement of the hand a physical description like height or weight that would be excluded from the definition? It is not certain that the technology will work the same way in different platforms, so a ruling based on the type of control and not the technical specifications would also risk creating inconsistent results.

There are two other state-level statutes specifically directed toward biometrics privacy, in Texas and Washington.¹⁰² Both of these are directed specifically toward placing constraints on the collection of biometric data for commercial purposes. The Texas statute is similar to the Illinois law, defining “biometric identifier” as “a retina or iris scan, fingerprint, voiceprint, or

record of hand or face geometry.”¹⁰³ The Washington statute is broader, defining “biometric identifier” as “data generated by automatic measurements of an individual’s biological characteristics, such as a fingerprint, voiceprint, eye retinas, irises, or other unique biological patterns or characteristics that is used to identify a specific individual.”¹⁰⁴ The definition of “biometric identifier” does not include items such as a: “physical or digital photograph, video or audio recording or data generated therefrom, or information collected, used, or stored for health care treatment, payment, or operations under the federal health insurance portability and accountability act of 1996.”¹⁰⁵

At least one state, Delaware, has added “biometric data” to a list of personal information protected by a general statute relating to data security, referring simply to “[u]nique biometric data generated from measurements or analysis of human body characteristics for authentication purposes.”¹⁰⁶ Proposed federal legislation directed toward more general protection of personal data, similar to the Illinois law, defines “biometric information” as “including a retina or iris scan, fingerprint, voiceprint, or scan of hand or face geometry.”¹⁰⁷ Overall, state biometric protections are centered around the concept of identity based on physical identifiers.

There are two constraints embedded in each of the definitions. First, they rely on narrow physiological categories of data that may not cover data captured in immersive systems. Second, and even more importantly, such data is only covered if it is “for authorization purposes.” This second constraint creates a huge loophole. Physiological data used to determine a person’s likes, interests, or motivations – rather than their identity – is almost certainly not covered. While there is limited opportunity to capture this data from non-immersive technologies, the richness of immersive environments and data capture creates ample opportunity to leverage data in this way.

⁹⁹. *Id.*

¹⁰⁰. 740 ILL. COMP. STAT. ANN. 14/15

¹⁰¹. Introducing Hand Tracking on Oculus Quest—Bringing Your Real Hands into VR, *supra* note 29.

¹⁰². The California Consumer Privacy Act (CCPA) will also cover this area, but as part of an omnibus privacy bill. As of the time of writing, it is still unclear how the bill will be enforced, and thus is it not a central part of this analysis.

¹⁰³. TEX. BUS & COMM. § 503.010.

¹⁰⁴. WASH. REV. CODE § 19.35.010.

¹⁰⁵. *Id.*

¹⁰⁶. The Delaware statute is an example of what a definition of biometric data can look like; since the statute itself is directed only at data breach notification requirements rather than the treatment of biometric information, I will not focus on it going forward. 6 DEL. C. § 12B-101.

¹⁰⁷. S.1214, § 2(10)(B)(iv).



Biometric Processing | US Army

INTRODUCING “BIOMETRIC PSYCHOGRAPHY”

I propose **“biometric psychography”** as a new term for this novel type of bodily-centered information, not linked to identity, but to interests. This term encompasses behavioral and anatomical information used to identify or measure a person’s reaction to stimuli over time, which provides insight into a person’s physical, mental, and emotional state, as well as their interests. It is a combination of biometrics and psychographic information, which is a term adopted from advertising that refers to metrics that evaluate a consumer’s activities, interests, and opinions through their cognitive attributes, like emotions, values, and attitudes.¹⁰⁸ To illustrate the distinction, think of biometrics like static images of fingerprint swirls that connect you to your unique personhood and identity; psychographics, on the other hand, are more akin to consumer profiles that map an individual’s buying preferences or her shifts in opinion over time. This difference is important because of the character and implications of the information that could be included as biometric psychographics.

Although limited, law and scholarship exists to regulate and access the impact of traditional identity-focused biometrics. But there is nothing, as of yet, on the implications of biometric psychography.

What type of information would be included as biometric psychographics? One part is biological info that may be classified as biometric information or biometric identifiers. Looking to immersive technologies, the following biometric tracking techniques may count under this definition, depending on jurisdiction and local law:

- Eye tracking and pupil response
- Facial scans
- Galvanic skin response¹⁰⁹
- Electroencephalography (EEG)
- Electromyography (EMG)
- Electrocardiography (ECG)¹¹⁰

¹⁰⁸. What are psychographics? Definition and meaning, BUSINESSDICTIONARY.COM, <http://www.businessdictionary.com/definition/psychographics.html> (last visited Jan 3, 2020).

¹⁰⁹. Galvanic skin response is a change in the electrical resistance of the skin caused by emotional stress, measurable with a sensitive galvanometer. It is used in lie-detector tests.

¹¹⁰. #517: Biometric Data Streams & the Unknown Ethical Threshold of Predicting & Controlling Behavior, Voices of VR Podcast, <http://voicesofvr.com/517-biometric-data-streams-the-unknown-ethical-threshold-of-predicting-controlling-behavior/> (last visited Jan 2, 2020).

These measurements tell much more than they may indicate on the surface. To elaborate, facial tracking can be used to predict how a user experiences feelings. It can trace indications of the seven emotions that are highly correlated with certain muscle movements in the face: anger, surprise, fear, joy, sadness, contempt, or disgust.¹¹¹ EEG shows brain waves, which can reveal states of mind. EEG can also tell information about one's cognitive load. How aversive or repetitive is a particular task? How challenging is a particular cognitive task?¹¹² Galvanic skin response shows how intensely a user may feel an emotion, like anxiety or stress, and is used in lie detector tests.¹¹³ EMG senses how tense muscles are and thus can detect micro-expressions that would make it hard for people to fake involuntary reactions.¹¹⁴ This is useful in indicating whether or not people may be telling the truth or a lie. ECG can similarly indicate truthfulness, by seeing if one's pulse or blood pressure increases in response to a stimulus.¹¹⁵

What makes biometric psychography different than biometric data is that it reveals not only one's present physical and/or emotional state, but what external triggers are provoking those responses. Put simply, this information may tell not only who someone may be, but also what stimuli they are responding to, and make inferences through records changes in physical state over time – meaning what a particular person is paying attention to and how they feel about it.

To illustrate this more concretely, biological observations can be combined with eye tracking to record how you are reacting and what you are reacting to. Imagine if, in a VR game, you show excitement seeing a brand new red car. Your gaze lingers on the vehicle and your body responds with signs of pleasure. Now imagine that this information is sold to advertisers, who begin peppering your online experience with advertisements for this car.

Immersive technologies can measure biometric information and retain data far beyond the law's focus on biometric identifiers. Immersive technologies are not limited to static

measurements or images, because sensors track how users move dynamically through space over a period of time. Furthermore, they constantly record changes in the environment and how that change may impact the user's condition over time. It's not just your real identity, which is mostly known by the platforms of VR/AR experiences from your financial information and account information. Instead it's a new quality of information that is comprised of your real identity combined with stimuli – indicating what you uniquely may think and like and want.

EXAMPLE: EYE TRACKING AND PUPILLOMETRY

For example, eye tracking and pupil dilation measurements are one of the key elements of biometric psychography. Eye tracking is an anatomical measurement based on tracking the movement of the eye and where it focuses, revealing what a person is looking at. Pupillometry is the study of changes in the diameter of the pupil as a function of cognitive processing.¹¹⁶ This helps scientists study perception, language processing, memory and decision making, emotion and cognition, and cognitive development.¹¹⁷

Pupillometry specifically studies how the pupil dilates and contracts in response to stimuli. The measurements track a physical change in the body's state over time. In a VR context, the data on the HMD will record not only the user, but also the potentially the stimuli that created that change. This can indicate what has visual salience to a user, where the eye lingers, how much attention was paid to an object or event, and what path a users' gaze takes. In short, pupil dilation can act as an "involuntary like button."¹¹⁸

How does this work? Tracking users' gaze and eye position is typically done via projectors that create a pattern of near-infrared light on a user's eyes, gathering high-frame-rate images of the light patterns and of the user's eyes. The patterns are processed by algorithms, looking at the images

^{111.} *Id.*

^{112.} *Id.*

^{113.} *Id.*

^{114.} *Id.*

^{115.} *Id.*

^{116.} Sylvain Sirois & Julie Brisson, *Pupillometry*, 5 WIREs COGN. SCI. 679–692 (2014), <https://onlinelibrary.wiley.com/doi/abs/10.1002/wcs.1323> (last visited Jan 3, 2020).

^{117.} Pupillometry 101: What You Need to Know, IMOTIONS, <https://imotions.com/blog/pupillometry-101/> (last visited Dec 31, 2019).

^{118.} Avi Bar-Zeev, *The Eyes Are the Prize: Eye-Tracking Technology Is Advertising's Holy Grail*, VICE, https://www.vice.com/en_us/article/bj9ygv/the-eyes-are-the-prize-eye-tracking-technology-is-advertisings-holy-grail (last visited Jan 3, 2020).

to calculate the eyes' position and gaze point.¹¹⁹ If this information is combined with measuring minute movements of facial muscles and reactions of pupils, then emotional response can also be gauged.¹²⁰

On a more technical level, most methods of eye tracking will apply a camera pointed at the eye and use infrared light (IR):

IR illuminates the eye and a camera sensitive to IR analyzes the reflections. The wavelength of the light is often 850 nanometers. It is just outside the visible spectrum of 390 to 700 nanometers. The eye can't detect the illumination but the camera can.

We see the world when our retinal detects light entering through the pupil. IR light also enters the eye through this pupil. Outside the pupil area, light does not enter the eye. Instead, it reflects back towards the camera. Thus, the camera sees the pupil as a dark area – no reflection – whereas the rest of the eye is brighter. This is “dark pupil eye tracking”. If the IR light source is near the optical axis, it can reflect from the back of the eye. In this case, the pupil appears bright. This is “bright pupil eye tracking”. It is like the “red eye” effect when using flash photography. Whether we use dark or bright pupil, the key point is that the pupil looks different than the rest of the eye.

The image captured by the camera is then processed to determine the location of the pupil. This allows estimating the direction of gaze from the observed eye. Processing is sometimes done on a PC, phone or other connected processor. Other vendors developed special-purpose chips that offload the processing from the main CPU. If eye tracking cameras observe both eyes, one can combine the gaze readings from both eyes. This allows estimating of the fixation point of the user in real or virtual 3D space.¹²¹

Eye tracking is seen as an increasingly important technology in VR.¹²² Eye tracking kits for developers by the start-up Tobii were announced to great acclaim in January 2018 and are currently in use.¹²³ Microsoft HoloLens and Magic Leap encourage their third-party developers to create applications using eye tracking data.¹²⁴

The value of eye tracking isn't just biometric psychography. Remember foveated rendering, a key element for increasing immersive experiences, cannot be done without eye tracking to see what a person is looking at and thus what areas to enhance or to blur.¹²⁵

The visual salience of eye tracking and pupil dilation monitoring can indicate additional things outside of identity, with obvious implications for user privacy, human rights, and the risk of self-censorship. The pupil dilation measurements can show a frightening range of implications, like who a user is sexually attracted to, to whether a user may have a propensity for developing illnesses like dementia. HMD that include eye-tracking capabilities as standard hardware features will be able to gauge what their users are looking at, how long their attention is captured, and how users may feel about what they are seeing – which would be valuable data for advertisers, previously only able to be measured in laboratories. This “mind reading” capability may change the fundamental nature of the technology, and put users on guard for self-censorship of their innermost thoughts, feelings, and emotions.

The visual salience of eye tracking and pupil dilation monitoring can indicate additional things outside of identity, with obvious implications for user privacy, human rights, and the risk of self-censorship.

¹¹⁹ *Id.*

¹²⁰ *Id.*

¹²¹ *How Does Eye Tracking Work?* – VR.org, <https://www.vr.org/2018/02/22/how-does-eye-tracking-work/> (last visited Jan 3, 2020).

¹²² Ed Klaris & Alexia Bedat, *VR & AR: Virtual Reality, Augmented Reality & Biometric Data after 2017*, MEDIUM, <https://blog.klarislaw.com/vr-ar-virtual-reality-augmented-reality-biometric-data-after-2017-ed-klaris-alexia-bedat-a15e9cb000a1> (last visited Jan 3, 2020).

¹²³ Tobii XR SDK Homepage, <https://vr.tobii.com/sdk/> (last visited Jan 3, 2020). Tobii has many offerings, including a platform-agnostic developer's kit for eye tracking, which can use any programming language. For our purposes, the most interesting offering is the Tobi G2OM, a machine learning algorithm to accurately predict what the user is looking at.

¹²⁴ Bar-Zeev, *supra* note 118.

¹²⁵ HTC Vive Pro Eye hands-on, *supra* note 23.

What the Future Holds

In the next foreseeable generation of immersive media, we may start to see pupil dilation hardware, advanced hand, limb and eye tracking, and haptic or neurological interfaces as standard features in off-the-shelf interfaces in VR and AR systems.

Oculus has already announced hand tracking to eliminate the need for controllers. In mid-December 2019, Oculus Quest launched hand tracking on its devices, eliminating the need for controllers. This feature relies on scans of the hand, plus predictive AI from neural networks, to create a 3D model of the hand in virtual space.¹²⁶

Other companies are going even farther, using brain waves to control computer devices, demonstrating prototypes of neural link sensors that eliminate the need to gesture at all. In November 2019 at Slush, a major start-up conference in Finland, a company called NextMind showed a live demo of a non-invasive, brain-computer interface.¹²⁷ The device sits on the back of a user's head, and translates brain signals instantly from their visual cortex into digital commands for any device in real time.¹²⁸ On stage, the user demonstrated how he could control the movement of a cursor via his thoughts, through a sensor placed against his head and mounted on the back of a VR HMD.¹²⁹

Some of these developments are extraordinarily beneficial for traditionally marginalized or disabled communities. Consider a haptic shirt that allows the deaf to "feel" different instruments and experience music for the first time.¹³⁰ Haptic gloves that allow you to feel touch in virtual experiences will open up new realms of verisimilitude. Pupil dilation is already being innovated for mindfulness-related immersive therapies, to harness the ability to map the individual mindscape as a method to heal.¹³¹

Innovation may be driven by a desire to improve user experiences and to personalize products, but this could provide a slippery slope for privacy protections and human rights.

WHERE DOES THIS LEAVE THE LAW?

Existing laws do not account for new paradigms being created in immersive technology. Many questions prompted by the new technology bring us beyond current frontiers of the law: How are scans of user data collected? How is the information stored? How often is the information updated? How long is data retained? How would a court determine the difference between a single picture and a stream of information? Would the muscle tracking over time be considered a part of facial geometry, as described by the biometrics statutes above? Are these uses limited to identity or are they an expansion of the concept?

As the technical capabilities change, more omissions and grey zones in the law may become clear. For example, physiological characteristics related to locomotion can be outside of legal definitions of biometric data or biometric identifiers. This would include gait tracking, where people can be identified in crowds by the way they walk. Because of the length of your bones and the idiosyncrasies of your movement, the combination of your head tilt while in a VR/AR headset and the quality of your gestures in an immersive environment can be just as personally-identifying as your fingerprints or your retinas or your vocal patterns.¹³² This blend of data sets and development of unique identifiers was not contemplated when statutes were written.

Current VR and AR hardware do not track all of these types of characteristics in consumer-based headsets. This inquiry has primarily been confined to laboratory and research environments – or bespoke applications crafted for certain customers. For example, police departments in China use AR overlays to apply facial recognition to crowds and identify suspects.¹³³ American militaries are also developing AR-enabled interfaces for targeting enemies in the battlefield or out of a crowd. Facial recognition is already being tested in AR-interfaces by military actors.¹³⁴

¹²⁶. OCULUS, Using deep neural networks for accurate hand-tracking on Oculus Quest, <https://bit.ly/2ZoQVHw> (last visited Jan 3, 2020).

¹²⁷. *NextMind Lets You Control Devices with Your Thoughts*, Wearable Technologies, <https://bit.ly/36pa1Pe> (last visited Dec 31, 2019).

¹²⁸. *Id.*

¹²⁹. *Id.*

¹³⁰. Take, for example, the work of Dr. David Eagleman, who is using technical interfaces to create new "senses" for the disabled. While his haptic vest is not discussed in terms of integration with immersive technology, that is a foreseeable use, especially in conjunction with gaming or romantic applications. See Jeremy Hsu, *Real "Westworld" Haptic Vests Better Than Fiction*, DISCOVER MAGAZINE, <https://www.discovermagazine.com/technology/real-westworld-haptic-vests-better-than-fiction> (last visited Jan 3, 2020).

¹³¹. Companies like Tripp are harnessing the power of immersive technology for therapeutic and wellness purposes. See TRIPP: Fitness for your Inner Self, TRIPP, <https://www.tripp.com/> (last visited Jan 3, 2020).

¹³². Interview with Kent Bye, Voices of VR Podcast host, in Portland, OR. (July 22, 2019).

¹³³. Josh Chin, *Chinese Police Add Facial-Recognition Glasses to Surveillance Arsenal*, WALL ST. J., <https://www.wsj.com/articles/chinese-police-go-robocop-with-facial-recognition-glasses-1518004353> (last visited Jan 3, 2020).

¹³⁴. Al Restar, *US Army Is Testing Facial Recognition Goggles*, Z6 MAG (2019), <https://z6mag.com/2019/07/22/us-army-is-testing-facial-recognition-goggles/> (last visited Jan 3, 2020).

Given the drive toward consumer adoption, which will likely incorporate location-based advertising models and the sale of user data to third parties, it is also foreseeable that companies will start to incorporate more and more features to delve into the physical and emotional states of their users, creating a demand for biometric psychographics. The ability to tell advertisers more about their targeted audience – including what they pay attention to, what their emotional state is upon viewing or interacting with products, and personal characteristics about their users’ health and well-being – will make them a more-primed customer. This should warrant expansions or additions to the law, and clarification of current statutes, in order to protect the right to privacy.

HOW COULD BIOMETRIC PSYCHOGRAPHY IMPLICATE HUMAN RIGHTS?

The combination of data sets implicit in immersive technology may produce further invasive results for users that amount to more than a violation of consumer privacy. As previously mentioned, measuring eye motion alongside pupil response already has diagnostic worth. Many people are surprised by how much can be revealed through evaluating the motions of the eye, like examining saccades, the scanning motions that our eyes use to create our picture of the world, or “smooth pursuit” motions made by the eye in tracking a moving object.¹³⁵ Some researchers have found that autism in some young children can be gauged by irregular eye motion patterns. Other serious ailments, like schizophrenia, Parkinson’s disease, ADHD, and concussions can also be diagnosed through eye tracking.¹³⁶

This could have serious implications. For example, scientists in Germany conducted a study asking subjects to complete a maze in VR. They found that users’ performance on the task was correlated to predicting their risk of developing Alzheimer’s disease.¹³⁷ Performance on a VR game is not the type of information that those who created health privacy laws may have anticipated as related to one’s medical health – and imagine if those results were to be available for purchase by third parties, like insurers.

Previous examples have mentioned how pupil dilation, in particular, can measure very intimate information, like user’s innermost thoughts and desires. Bluntly, it is frightening to think that companies could use information, like a user’s likely sexual orientation, to enrich existing commercial profiles. There is a risk of censorship, in the most fundamental

¹³⁵ Bar-Zeev, *supra* note 118.

¹³⁶ *Id.* See also Eye Tracking Could Diagnose Brain Disorders, LIVE SCIENCE, <https://www.livescience.com/23274-eye-tracking-gaze-brain-disorders.html> (last visited Jan 3, 2020).

¹³⁷ David Schultz, *Alzheimer’s disease tied to brain’s navigation network*, SCIENCE, <https://www.sciencemag.org/news/2015/10/alzheimer-s-disease-tied-brain-s-navigation-network> (last visited Jan. 5, 2020).

¹³⁸ Interview with Thomas Furness, *supra* note 1.

way, if users find themselves trying to limit what they feel, think, or express, if that information is able to be monetized or researched. At the same time, many of these factors are unconscious, meaning that even if a user wanted to self-censor or hide their preferences, they could not.

If third-party or direct developers are able to integrate different data sets in ways that are unanticipated or harmful to consumers, this could result in the revelation of information that users do not intend – or meaningfully consent – to reveal. Without uniform legal restrictions or voluntary constraints outside of identifying information, which is the focus of current biometrics regimes, there is the potential for companies to be susceptible to another Cambridge Analytica-type mass violation of user trust. Furthermore, it is challenging to inform users of the deeper and full implications of collection of their data, since most people do not understand how involuntary bodily indicators of emotional responses, mental state, or health can be disclosures of fundamentally private information, like truthfulness, inner feelings, and sexual arousal. It remains to be seen what impact the newest state-level privacy regimes, like the CCPA, will have on consumers, and what effect allowing consumers to voluntarily choose to limit the sale of their personal information may have on immersive technologies, where new types of data sets and personal information are evolving alongside the increasing popularity of the medium.

VULNERABILITIES IN INTERFACES AND EXPERIENCES

The biometric richness of immersive technology also creates a new and significant security risk, both in the context of privacy and user health and safety. Cybersecurity concerns for immersive hardware are not yet a mainstream concern for advocates. However, when you consider the character, quality, and amount of information that is discernable in a VR experience, a hacker would likely find immersive hardware to be a veritable honeypot of information.

Tom Furness fears that VR/AR hardware could be weaponized if a bad actor decided to physically harm users. Put simply, with the plane of vision in a HMD, the monocular and binocular vision must work in tandem to allow the eye to focus on something that is close up but appears far away. If this is not done well, vision can be impacted – and even disabled – for months.¹³⁸ If the hardware is vulnerable to a hack, a malign actor could foreseeably modify a headset to intentionally blind a user. The risks of these systems, that rely so intimately on bodily functions and physiology, extends beyond privacy.

Other theorists have identified other potential vulnerabilities in VR/AR content that could cause harms to users. These could include: manipulating AR directions to mislead users or put them in perilous situations, misrepresenting one's identity in VR spaces, theft of virtual goods in a gaming environment; virtually impersonating others, or adding/deleting content in a manner that could result in scaring or shocking the user (which may have physical consequences).¹³⁹ Without adequate protection of the integrity of software or experiences, this could result in a misuse and abuse of programming.

Some hardware providers are creating biometric systems as a more secure alternative to passwords. Microsoft's HoloLens2 is creating a digital signature based on your Iris-ID, for example, but advocates warn about the potential volatility of having such permanent information be connected with your online accounts in the case of an exploit:

If the signature of the current eyes matches the recorded signatures, then you are you. Assuming your iris signature is unique and remains protected, this is better than passwords.

The best security practice...is to store these signatures on device, in a hardware-enforced encrypted "vault." A determined hacker would have to steal and crack your physical device, which could be a slow and painful process. This makes exploits, especially mass exploits, more difficult. Optionally copying this data to the cloud could add some user convenience (e.g., system backup & restore, cross-device logins). But it could make it easier for someone to obtain your signatures and "replay" them in your absence to impersonate you.

Resetting passwords is easy. Changing your eyes is hard. Just one breach is enough to ruin things for life.¹⁴⁰

There are greater risks for hacking when immersive technologies interface with public authority. As previously mentioned, police departments in China use AR overlays to apply facial recognition to crowds and identify suspects¹⁴¹ and militaries are also developing AR-enabled interfaces for targeting enemies in the battlefield or out of a crowd.¹⁴² The potential for hacking leading to misidentification of friendly targets or allies may be a foreseeable danger for defense applications of immersive technology.

¹³⁹. Lemley & Volokh, *supra* note 7.

¹⁴⁰. Bar-Zeev, *supra* note 118.

¹⁴¹. Chin, *supra* note 133.

¹⁴². Restar, *supra* note 134.

Virtual spaces may engender new types of social experiences, based on the ability to personify inanimate objects, create new environments, manipulate the laws of physics and nature, and embody different types of physical forms.

Solutions

Given the increased risk profile of immersive technologies, what can companies, experience developers, regulators, and legislators do proactively to mitigate adverse human rights outcomes from AR and VR?

DEVELOP VALUE-BASED HEURISTICS AND CLEAR USER UNDERSTANDING OF EXPERIENCE RULES TO IMPROVE USER SAFETY.

Virtual spaces may engender new types of social experiences, based on the ability to personify inanimate objects, create new environments, manipulate the laws of physics and nature, and embody different types of physical forms. However, few people know what social conventions are applicable when you interact with someone who, perhaps, appears to be a talking flying toaster.

The VR/AR industry is still new enough that interplatform operability is an unresolved issue. As multiple HMDs and systems evolve, users will develop distinctive ways to gesture, to interact, and to navigate spaces, and these will be tied to the specific immersive experiences they are experiencing and the technical limitations of the platforms that host them.¹⁴³ These resultant behavioral codes may not transfer across the immersive ecosystem, and pose a further challenge to users trying to interpret what communications mean in a new type of social environment.

Until there is a common vernacular and physical vocabulary of how to interact in virtual spaces that encompasses variable elements of expected behaviors, interactivity, and the heuristics or unspoken rules of the environment, a clear

statement of norms will help limit harmful behaviors. This can be done in two ways. First, as will be discussed further below, social media has tackled the problem of shifting social conventions and volatile meanings by initiating community moderation solutions.¹⁴⁴

Second, creators of hardware systems and immersive content alike can make user behavioral expectations clear in platform onboarding experiences. Oftentimes this introductory programming is the first experience that a user will have in a virtual world, and can be formative in their expectations of how to behave and what to expect from others.

Level setting can take different forms, and designers will need to choose if they want to penalize users who violate the norms of behavior they wish to instill, if they want to apply positive reinforcement for users who demonstrate pro-social behaviors, or if they integrate the two approaches. Whatever the case, clarity is paramount. For example, the now-defunct Facebook Spaces had its users, upon entering a new social space, view expectations for conduct within the room, reading: “Be welcoming. Be respectful. Be kind.”¹⁴⁵ Reminders that there is a person on the other side of the experience could do much to set the mold for cultural conditioning and recalibrate user expectations about what is and is not allowed in virtual spaces.

Experimentation on social media has shown that prominently displaying rules for users, alongside making clear expectations about positive user behavior, can deter casual misbehavior and inadvertent harms. A study on abuse in Reddit forum showed that prominently displaying rules, in a

¹⁴³. For example, Beat Saber is the most popular and commercially successful VR game, where a player can slice blocks flying at them with light sabers in time to a musical soundtrack. It is available in 90 degree and 360 degree formats on the Oculus Quest. However, users of the PSVR, another gaming system, will find Beat Saber is only available in the original head-on format, and cannot be updated based on the technical limitations of the PSVR.

Another foreseeable example, where technical specifications shape and modify user interaction, is that foveated rendering on certain VR systems will train users to engage in certain behaviors, like looking directly at what they are interested in to get a more detailed view.

The challenges with technological limitations shaping interactivity look similar to the challenges of having multiple versions of the same immersive experiences. Both circumstances will mean that the players of Oculus will develop different ways of interacting with Beat Saber than the PSVR users – and thus different ways of communicating with each other.

While this is natural in a nascent industry, it is a potentially large challenge in immersive media, where there is a disconnect between communication strategies and common heuristics to interpret communication. As such, the technical-social aspects of product design should be considered when evaluating potential risks to user safety and human rights.

¹⁴⁴. Dr. J. Nathan Matias has been conducting scientific studies of the effectiveness of community-based moderation on Reddit, and his body of work emphasizes how this can be a more flexible, impactful, and viable alternative to top-down content moderation based regimes. See Dr. J. Nathan Matias, J. NATHAN MATIAS, <https://natematias.com/> (last visited Jan 4, 2020).

¹⁴⁵. Michelle Cortese & Andrea Zeller, *How to protect users from harassment in social VR spaces*, THE NEXT WEB (2020), <https://thenextweb.com/syndication/2020/01/02/how-to-protect-users-from-harassment-in-social-vr-spaces/> (last visited Jan 4, 2020).

short digestible format, made it more likely that these rules would be followed and greatly reduced accidental or careless violations.¹⁴⁶ It is reasonable that communicating the rules of virtual experiences, in a short, clear, cogent and user-friendly way, would have a similar impact.

DIFFERENT LEVELS OF SPECIFICATION IN CONTENT MODERATION LAYERS.

As previously mentioned, those designing virtual environments should understand that there are multiple levels where content moderation can take place in an immersive system. These include: the content layer, like individual immersive experiences (akin to software); the behavioral layer, which hosts user-to-user interactions and interactivity between users and the environment; and the account layer, where users register and access features of the immersive platform. Given these three layers, what type of content moderation should be in place for virtual environments?

The behavioral layer is the most challenging level to navigate, because there are many actors and factors, and direct ties to freedom of expression. Social VR platforms have experimented with live moderators, but reports from initial experiments showed that this ended up like the hall monitor in middle school, meaning misbehavior resumed or increased once the monitor was out of sight.¹⁴⁷ An additional hurdle will be how moderators should function with the expectation of privacy in public VR spaces with private rooms within. Platforms must venture to make live moderation not seem like a Big Brother-like presence that impinges on the privacy of users in online spaces, while simultaneously not creating spaces that sanction abuse.

The social norms could choose to mirror more closely what social norms are in a physical environment, in terms of how to model appropriate social behaviors. However, there are admittedly preexisting issues with like existing social norms function, as many people from vulnerable populations who find offline norms to be wanting would likely agree. Women and members of other groups who experience offline harassment may not want to see malignant or harassing offline behaviors legitimized in new online arenas.

An alternative vision for content moderation would be value-driven by community bonds, with overlap between multiple different groups to counteract filter bubbles. Research done by scholars of behavioral interaction in online spaces have found that community-driven moderation regimes have a degree of success, because they can personalize rules for forum purposes, for user expectations, and for the shifting desires of the group.¹⁴⁸

Finally, looking to the account layer, content moderation may look different than online harassment, because of the different risk profile with different types of information in the stack. Immersive companies should recognize the inherent risks in their hardware and software, and apply best practices in mitigating cybersecurity risk. This could include mandating security audits of hardware by outside expert, with a mind to privacy, security, and user safety.

Audits could also apply to redlining immersive content. For example, imagine the risks inherent in experience-based virtual economies, that allow you to purchase upgrades and additional features to enhance your interaction with others and the immersive architecture. In a VR game, this marketplace could include intimate information as location, media engagement, and even who you are communicating with and how. Furthermore, intra-experience transactions and subscriptions for games may mean that financial information is bundled with a user's data.

To protect vulnerable users and populations, just as they do in other online environments, companies should examine some of the strategic vulnerabilities in immersive experiences' features. These could include mass exposure to screennames, as a facilitator for password hacking, or use of names or locations for phishing and social engineering. Additionally, companies should be looking to the security records and practices (like breach notification and response, malware protection, and multi-factor authentication availability) of third party providers of content, like Steam or other external content marketplaces, to avoid metaphorically bringing bedbugs into their house. Overall, companies should be responding promptly and thoroughly to insecurities in infrastructures and applications – whether or not they are immersive experiences.

¹⁴⁶ J. Nathan Matias, *Posting Rules in Online Science Discussions Prevents Problems & Increases Participation*, CIVILSERVANT, http://civil-servant.io/r_science_sticky_coments_1.html (last visited Jan 4, 2020). Based on insights like these, Twitter revamped its community standards, to distill rules into Tweet-length missives that can be prominently displayed.

¹⁴⁷ Lorenz, *supra* note 74.

¹⁴⁸ See, e.g., Dr. J. Nathan Matias, *supra* note 144.

INSTITUTE A RATING-BASED SYSTEM FOR VR/AR ENTERTAINMENT.

Another suggestion, outside the hardware context, would look to solutions that influence social systems outside of user behavior, focusing on the immersive experiences themselves. Other media like video games, music, and motion pictures have developed ratings systems to help users make informed decisions about the content that they wish to expose themselves or their children to. Some ratings break down types of content into recommended age-appropriate brackets. While this would not prevent potential negative impacts of user misbehavior or negate exposure to explicit content, like graphic violence, it would provide users with information to make decisions about what type of immersive experiences they wish to partake in. With such a scheme, users would be able to make more informed, deliberate, consensual experiences about what they are about to experience in VR. This is very important, considering the features of immersive experiences that make it feel real and implant as memories do in our psyche.

PROTECT PRIVACY WITH MEANINGFULLY INFORMED USER CONSENT, COMBINED WITH USER-BASED CONTROL OVER DATA GATHERING AND STORAGE.

A VR interface can be described as “six cameras in a mounted headset.”¹⁴⁹ As more sensors are built into the HMD, thorny questions about data storage will continue to emerge. Will users be given the option to not have the headsets transmit or store data remotely? Is this even a viable option, given the amount of data generated by immersive experiences and the industry’s goal of platform interoperability? How does mixed reality browser-HMD interactivity complicate the issue?

Care should be taken to evaluate how preexisting data laws will apply in an immersive context, especially given the risk factors that exist with networked data and the potential for bodily and psychological impacts stemming from immersive systems. Additionally, looking forward to foreseeable legal development, there is a strong potential for conflict of laws, given that so few states have biometric laws on the books.

A model for these challenges could be looking at the gradual codification of online harassment laws that has been full of missteps and growing pains. At first, early efforts to combat harassment demonstrated a fundamental gap in

understanding, as some legislators added “cyber” or “online” to existing statutes in ways that did not make sense with how the technology functioned. An example would be a state-based harassment law that required abuse directly communicated between the target and the perpetrator, which may not be applicable to some online interactions.¹⁵⁰

True informed consent should require a level of genuine understanding by the users about how their data is being collected, applied, stored, and brokered. In addition, users should be given control over how these processes occur, with opt-out being the default setting instead of opt-in.

Finally, data localization is a best practice to be recommended. The retention of sensitive user data should ideally be situated in the HMD itself, and not sent, stored, or retained on external servers. In this way, fundamentally private information can be gathered or saved, and even applied to improve the user’s experience, while still remaining in the possession of the user herself and not third parties. If necessary, the information can be accessible by authorities, but the difficulty of doing so would ensure that this is done only in extraordinary circumstances, likely under the color of law.

CREATE INDUSTRY-WIDE CODES OF CONDUCT.¹⁵¹

At this point, where the immersive interfaces are constantly in flux and the industry is still evolving, it would be risky to develop legislation to address specific harms. However, this does not mean that eventual legislation is not a good idea. In the interim, codes of conduct, voluntary constraints, and careful examination of the foundational features of immersive systems should be undertaken to prevent harm.

Immersive technologies should aspire to do better than internet-based platforms, so there is an opportunity to not repeat some of the fundamental mistakes of online media. Luckily, a framework already exists that can help. Under the U.N. Guiding Principles for Business and Human Rights (UNDPs), companies have a roadmap to determine their role in promoting and implementing human rights.¹⁵²

The UNDPs, also known as the Ruggie Principles, promote a framework where governments must protect human rights, companies must respect human rights, and both must provide access to remedy when human rights are violated. Other industries with high levels of operational risk – like oil, gas,

¹⁴⁹. Telephone interview with Daniel Robbins, Principle UX Designer at Sony HTC Vive (July 29, 2019).

¹⁵⁰. DANIELLE CITRON, *HATE CRIMES IN CYBERSPACE* 124 (Harvard Univ. Press, 1st ed. 2014).

¹⁵¹. U.N. Guiding Principles for Business and Human Rights, https://www.ohchr.org/documents/publications/guidingprinciplesbusinessshr_en.pdf (last visited Jan 4, 2020).

¹⁵². *Id.*

mining, and nuclear – have come together to form codes of conduct. This self-governance allows them to share best practices, to collectively take action to anticipate harms and provide remedies, and to reduce shared risks that spread across the industry. Immersive companies should consider how their operations, policies, and procedures would fare under the UNDPs – and build this understanding into their core business practices while they are still in a nascent phase.

The first step to compliance with the UNDPs is looking at cross-cutting principles in an industry and creating a consensus-based agreement between stakeholders. Currently there is no industry code of conduct for the immersive industry. Given the deep and broad potential for user harms, this would be a proactive step to help the companies anticipate and address challenges – and for users to ensure that protections are in place to prevent or mitigate harms. In this way, we can ensure that human rights can have a formative role in the fundamental workings of these new companies and technological systems.

Conclusion

New forms of innovation open up new realms of possibility – and new frontiers where we should exercise caution. The immersive technology space is no exception. Human rights-based concerns like freedom of expression, safety, and security, should be a serious consideration in immersive technologies, based on the way they interact with our bodies and minds.

Regulators and legislators have faced similar problems when trying to integrate emerging online media into our social fabric and legal paradigms. Looking to social media, online harassment, and other challenges with integrating safety and freedom of expression in online spaces may offer a roadmap for anticipating and addressing emerging problems with immersive experiences.

Anticipated fit – or misalignment – with current conceptions of privacy laws can help show us where we can foresee challenges regulating the storage, application, use, and sale of personal information in immersive environments.

Finally, there are things that can be done today to protect users in immersive spaces from future harms. Looking to how online data is best protected from exploitation can serve as a model for new immersive interfaces with the potential for strong physical or psychological impacts. Other volatile industries have been able to integrate human rights-based evaluations based on the UNDPs to help them understand risks and provide remedy when harms occur. The immersive tech industry should take heed and do the same, at this pivotal moment.

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