Cite forthcoming chapter as: Carter, M. & Egliston, B. (2024) Virtual Reality Mobilities: Data, Power & Space in the Metaverse. In *The Routledge Companion to Mobile Media (2nd Edition),* G. Goggin & L. Hjorth (eds.) London: Routledge. [author copy]

17

Virtual Reality Mobilities: Data, Power and Space in the Metaverse

Marcus Carter and Ben Egliston

Introduction

Head-mounted Virtual Reality (VR) is a site of renewed interest for major players in the tech industry. Since 2012, it has morphed from a niche hardcore gaming tool to a technology that is central to social-media giant Meta's (formerly Facebook) metaverse ambitions. Understanding this change necessitates understanding VR not as a technology of wholly virtual presence—like the Star Trek holodeck—but as an evolved form of mobile media, with a vastly expanded capacity for data extraction, biometric surveillance, and data analytics.

In this chapter, we will overview Meta's history with VR, providing an account of the history of modern VR; from Oculus' Kickstarter origins following the 2014 acquisition by Facebook; its transformation into a new form of mobile media within Reality Labs; and its centrality to Facebooks "Meta" rebrand as "the future of social media". With a focus on the "Quest" line of mobile VR headsets that now hold a dominant two-thirds share of the global VR market, it is our intention in this chapter to reframe VR as a new form of mobile sensor, offering a counter perspective that calls for examining VR as a new type of locative and spatial media.

In doing so, we highlight the potential harms and implications of the "VR everywhere" that the metaverse imagines and begin to speculate about how VR—as a form mobile media—might lead to new forms of harm, inequality and discrimination. On this basis, we also call for greater critical attention to VR in mobile media studies.

A Brief History of Virtual Reality

Modern Virtual Reality was born in 2012, when Palmer Luckey's Oculus VR company launched a crowdfunding campaign on Kickstarter. Described as a "truly immersive virtual reality headset for video games", Luckey's VR was developed within what Maxwell Foxman describes as a "distinctly hacker culture", with the Rift cobbled together from disassembled smartphone components and with origins traced back into Luckey's posting on modding

forums such as MTBS3D and RetroMod.[1] The version of the headset demonstrated at that year's E3 was literally held together with duct tape, and the Oculus Kickstarter wasn't even for a commercial device, but a 'developer kit' that encouraged early adopters to create content for the emerging platform. In close partnership with Id Software's John Carmack—creator of classic shooter games including *Doom* and *Wolfenstein*—Oculus re-introduced VR as the ultimate gaming platform: a fantasy of total immersion and embodiment that was lauded by pundits as promising a paradigm-shifting leap forward in game experience. It subsequently raised US$2.5m from almost ten thousand contributors on Kickstarter.

Luckey didn't invent VR; it has a much longer history. For our purposes it can be useful to draw a history of VR back to the stereoscope, a viewing device that became popular in the 1850s and 60s which, when coupled with the relatively new medium of the photograph, enabled the viewing of real scenes in 3D. Stereoscopy, as it came to be called, rapidly became popular as an accessible form of travel, and later for education, where it was proposed as a revolution in educational technology.[2] Scholars such as Jussi Parrika and Jaako Suominen have theorized the stereoscope as a form of mobile media—for its capacity "to capture the user and transport him or her to another universe", and as part of a movement of mobility that characterizes the Victorian mediascape.[3] While millions of stereoscopes were created, the medium's popularity waned in the 1910's as mass radio became more accessible, but the underlying technology remains today in enabling VR devices such as the *Google Cardboard*.

Digital virtual reality first emerged in the 1960's in computer scientist Ivan Sutherland's *Sword of Damocles* head position sensor—a mechanical arm suspended above the user that was able to track movements of the user's head to update the digital display—giving the sensation of being 'inside' a virtual environment. However, while Sutherland's innovations demonstrated most of the basic principles for VR, the computing power necessary to power the simple computer display made practical applications of the technology out of reach, at the time. The US Airforce (grappling with the challenge of training pilots to fly increasingly complicated machines) and NASA (who had the challenge of putting humans in even more dangerous places) funded the research and development in the 1980s to solve these practical problems, but despite significant advances in graphical fidelity and interface designs, VR remained inaccessible. VR—and the literal supercomputers needed to power it—cost tens, if not hundreds of thousands of dollars.[4]

The consumer hype around VR reached its first peak with the announcement of the Sega VR at the 1993 Consumer Electronics Show. Promising entry "into the game" for $200, SEGA VR was framed by marketing slogans that capture the fantasy that VR presents players today, with engrossed players exclaiming that its "hard to remember it's just a game", that "it's like being there", or that "it's like you've got a movie living in your head". Although SEGA claimed that the SEGA VR was terminated because the VR effect "was so realistic, it could potentially cause injury to children playing it" by their forgetting they were in a virtual world, the real reason was motion sickness; as many as 40% of VR users during development became 'cybersick'. Virtual Reality so often leads to motion sickness because its central objective is to trick the sensorial capacities of the body to make it feel like the user is actually in the virtual environment. This is what creates the incredible sensations of embodiment and presence in a VR world. For the most part, VR does this extremely well, but when there is a conflict between our perception (what we see) and our proprioception (what we physically feel), our bodies—trained by a million years of evolution—assume that we have been poisoned, and that vomiting up that poison is the best solution. After this spectacular product cancellation, VR entered what is referred to as a 'long winter', waiting for computing hardware to catch up to the exacting proprioceptive demands of the body.

By 2012, the technology had caught up, primarily thanks to the mobile phone. Luckey's VR headset made use of the technological advancements in miniaturization, LCD screen quality, and processing power that had occurred due to the proliferation of the smartphone. While these advances haven't entirely solved the problem of VR induced motion sickness (which has been shown to be sexist in its effect[5]), VR captured the imagination of the gaming community as the next frontier in hardcore gaming.

Virtual Reality, Facebook, and the Metaverse

Within 2 years of the successful Kickstarter campaign, Oculus was purchased by Facebook for more than $2 billion dollars. Following Facebook's IPO (the then-highest technology IPO in US history), the company underwent a process of significant expansion in a series of high value corporate acquisitions. Beyond facilitating entry into new markets, the telos of Facebook's expansion is an integration of a range of different technologies into an already existing suite of social software—a dynamic of 'enclosure', or, as Anne Helmond et al. put it, a way to

"facilitate its rapid entry into new markets, thereby generating and solidifying asymmetrical platform growth and dependencies."[6]

Since the 2014 acquisition, VR has become a central part of how Facebook publicly imagines its future, with its 2021 'metaverse' rebrand to Meta solidifying this push.[7] Oculus did not present value to Facebook as a gaming technology, but as a new form of social media. As we discuss in our work studying what we dub as Facebook's 'Oculus Imaginary',[8] significant focus has been paid by Facebook on refining the social functionality of VR, through corporate acquisitions and the expansion of sensors onboard VR devices. VR is the way for the Facebook platform to expand its boundaries, embedding itself into new markets of end-users but also to developers and businesses (and, as we discuss, a further method for data accumulation). As we've theorized, this is a form of infrastructuralization[9]; through Reality Labs—Meta's VR/AR research and development division, with operating expenses exceeding US$10bn per year—Meta has attempted to consolidate complementary firms, attract third-party platform complementors, and form partnerships across academia and regulatory spaces—and in doing so has systematically sought to create conditions for its infrastructural vision to emerge.[10]

In this narrative Facebook (now Meta) and Oculus (a discarded and no longer used brand) depart from dominant and existing imaginaries of VR as a completely immersed experience, or of VR as gaming media. Instead, VR is imagined as part of an everyday repertoire of communication, something with a high capacity for affect and creating feelings of proximity at distance. Meta have developed high-profile applications including the now defunct *Facebook Spaces*, and *Horizons*—both of which aim to support the vision of using VR environments to mediate social interactions between users. In advertisements for these applications, and other projects from Reality Labs such as *LiveMaps* and *Project Aria*, Meta describe a vision for a hypermobile form of social media that bridges and hybridises both physical worlds via augmented realities and mobility through infinite virtual realities that will become part of our everyday in the 'metaverse'.

Commercial enthusiasm for such a paradigm of computing remains to be seen, but Meta's enormous investments into making the metaverse a reality mean that it is likely we will encounter some form of it over the next decade. But why this push for infrastructuralization? One compelling case for Meta's motivations in this area can be seen in the impact of Apple's App Tracking Transparency (ATT) framework, introduced in 2021, which requires iPhone

applications to ask for a users' permission before collecting user data and sharing that data with third parties. This mobile data was a huge source of revenue for Meta, and losing access to it had a huge impact upon Meta's ability to sell targeted advertisements, and measure the success of those adverts, with Meta's CFO David Whener estimating the negative impacts of ATT on revenue as $10bn in 2022.[11] As of late 2022, Meta's share of the VR market is estimated to be over 70%, ensuring their capacity to control access to the data that will be generated by VR users, and in the future, commercialize it.

Virtual Reality as Mobile Media

What this history of VR describes is a shift—in both the popular imaginary about the device, but also in hardware configuration—from immobile computing hardware to a new form of mobile media. Recognizing this shift can be useful for understanding how VR enables new types of mobilities, but also in understanding the ethical implications of VR as a data sensor.

The line of VR headsets that were launched through the Oculus Kickstarter was the 'Rift'. This version used external sensors (which were in fact just webcams) placed on the desk in front of the user to track a 'constellation' of infrared LEDs on the headset that blinked in specific patterns, allowing the software to deduce the position of the headset. Combined with inertial measurement units inside the headset (an IMU is a combination of gyroscopes, accelerometers and magnometers), this gives VR software sufficiently high frequency updates about where the display is, in real time, enabling an immersive VR display.

One of the challenges with this approach to tracking the position of the display is that it tethers VR to a single location. For Facebook, a company which understands the importance of mobility in the ubiquitous adoption of its products, this restriction was seen as a barrier to VR's widespread adoption. As early as 2016, Facebook was working on a completely self-contained mobile VR headset, which ultimately became the Oculus Quest (released in May 2019). The Quest functions via something called visual-inertial simultaneous localization and mapping (Vi-SLAM). SLAM is a computational method of constructing a digital map of the environment that a device is located within. Pokémon Go, for instance, uses Vi-SLAM in mobile devices for its AR effect, using visuals from the smartphone camera and inbuilt inertial measurement units to track the phone's position in space, allowing it to interface with content (i.e., Pokémon) 'anchored' to objects in the real world. The Quest is reliant on a combination

of IMUs and "inside-out" cameras that feed into a system that Oculus calls 'Insight'. In a post on the Facebook AI blog, Facebook engineers explain:

> Image data from cameras in the headset helps generate a 3D map of the room, pinpointing landmarks like the corners of furniture or the patterns on your floor. These landmarks are observed repeatedly, which enables Insight to compensate for drift (a common challenge with IMUs, where even tiny measurement discrepancies build up over time, resulting in inaccurate location tracking).[12]

This way VR's data collection has been externalized via systems like the Quest is also part of a trajectory of software development that might later enable ubiquitous AR devices, something that Mark Zuckerberg has spoken candidly about in media interviews and earnings statements and is reflected in recent Quest EULA changes. The move to a mobile headset like the Quest also gives Meta more control over the platform, as each VR system becomes its own independent computer (over which Meta has complete control), rather than an external screen to another company's computing platform.

Now, it's worth noting that all VR use is location aware: the play of VR games is often about an awareness of our own body, and the sense of fantasy or empowerment when that body is given an extraordinary sense of presence in a virtual environment. It is also location aware in the sense that we are aware of the limitations of our body, and our physical environment, when in VR, so that we do not punch a wall while playing a VR boxing game. But these technological changes to VR, driven by Meta's interest in infrastructuralizing VR and controlling it as a platform, expand the locative affordances of VR in a way that places it upon the trajectory of modern locative media where location has become the "primary descriptor of that participant"[13], and at the granular scale of millimetres rather than meters (as currently enabled by technologies like GPS). We might fruitfully draw parallels here between the types of data practices and issues seen in other technologies of body surveillance, such as wearable computing.[14]

In our work elsewhere, we develop the argument that it is in this way that VR has become "concretized", meaning - via the thinking of Gilbert Simondon – that it has become internally coherent and synergistic with a wider network of technical objects and human actors.[15] The concretization of the Quest can be understood in terms of developments in the hardware and software layers comprising its navigational 'stack', using IMU's and Vi-SLAM

to become untethered, but also its integration with the Facebook ecosystem, of data centres and ad networks, and potential to advance the company's surveillance capitalist ambitions. In this way, mobile VR headsets such as the headset are distinct from other forms of VR, despite their similar end use of generating virtual environments. The framework of concretisation allows us to take the Quest for what it really is—a data intensive digital sensor that is increasingly (and uncritically) taken into our homes, without a privacy protecting alternative to choose from.

Metaverse Mobilities: Virtual Reality Everywhere

Underlying the 'metaverse' is the idea of VR, everywhere. But what would this mean? In 2019, Reality Labs released a video publicizing its research project 'Live Maps', part of the "core infrastructure" that will underpin "tomorrow's AR experiences". In a slick, CGI-infused advert, Reality Labs proposes the creation of a shared virtual map that uses machine vision, alongside localization and mapping technology, using information crowd-sourced by "tomorrow's smart devices". It is in this ambition that we see how the concretization of VR into mobile VR promises an entirely new form of locative mobile media, outwardly sensing millimeter precise, and constantly updated information about the world. It is difficult to speculate about the impact that this kind of technological stack might have upon society and how we navigate the physical world, and connect with one and other, but mobile media studies is best situated to tackle this question. Inwardly, our use of VR also discloses an extraordinary amount of data about the user. As Jeremey Bailenson writes:

> commercial systems typically track body movements 90 times per second to display the scene appropriately, and high-end systems record 18 types of movements across the head and hands. Consequently, spending 20 minutes in a VR simulation leaves just under 2 million unique recordings of body language.[16]

This data is so granular and detailed that it likely presents the risk of biometric (re)identification of users across all of our interactions with VR. Both Pfeuffer et al. (2019) and Miller et al. (2020) have recently demonstrated the potential to identify specific individual users based on unique behavioural biometric markers via movements of the hand, head and eye—data that can be captured by current VR devices. The implications of this are profound, as it suggests that

the anonymous use of VR may never be possible unless privacy protections are baked into the headset at the system level.

Meta's next generation of VR headset, the Meta Quest Pro features new forms of eye and face tracking not in previous headsets. In the official privacy notice, Meta state that "this feature is used to make your avatar's eye contact and facial expressions look more natural during your virtual interactions with other users and to improve the image quality within the area where you are looking in VR" [citation?]. In an interview following the announcement of the headset, Zuckerberg frames eye-tracking as enabling "the ability to now have kind of eye contact in virtual reality … have your face be tracked so that way your avatar — it's not just this still thing, but if you smile or if you frown or if you pout, or whatever your expression is, have that translate in real time to your avatar."[17]

This promise of increased presence discounts the enormous risks of gaze-data. In a recent review of research, Jacob Leon Kröger and colleagues identified the breadth of personal data that can be inferred from eye-gaze data.[18] They found that this includes "information about a person's biometric identity, personality traits, ethnic background, age, gender, emotions, fears, preferences, skills and abilities, drug habits, levels of sleepiness and intoxication, and physical and mental health condition", concluding that "devices with eye tracking capability have the potential to implicitly capture much more information than a user wishes and expects to reveal."[19] Where one of the key principles that typically underscores questions of data ethics and privacy is one of informed consent, we question whether informed consent is even possible with the introduction of this kind of data collection technology to a consumer device, envisioned by Zuckerberg as becoming as pervasive as the mobile phone.

Virtual Reality Harms

One of the reasons that VR has previously received little interrogation in scholarly circles is that—as a gaming technology—the potential applications of its data are not immediately clear, or are in relatively benign use-cases such as targeted advertising. However, with its 'Metaverse' push Meta are invoking a vision for VR that sees it applied in society more broadly, in contexts such as education and workplaces. One of the most prominent announcements at Meta's 'Connect' dev conference in 2022 was Meta's partnership with Microsoft, to bring Microsoft's enterprise and workplace applications (such as Word, Excel, PowerPoint and Teams) into

Meta's VR platform. In his keynote, Zuckerberg describes this partnership as "the foundation of the virtual office of the future."

Where VR tools are not just a means of immersive simulation, but also of data collection, the "virtual office of the future" is problematic in the context of data-driven employee tracking and analytics apparatuses that are already being advanced in workplaces like Amazon warehouses, and through software suites like Microsoft 365. This particular example assigns individual employee 'productivity scores' based on their use of related software, offering this surveillance ensemble a data picture of the users body, space, attention, and cognition, which has the rhetorical power of being 'complete'. Unlike the data captured about a desktop worker—which is always incomplete—there is a fantasy put forward by VR companies that VR's enclosure of the user has the capacity of VR to quantify the entire cognitive and physical experience of the user, and therefore offer unparalleled insight.[20]

An example of this being deployed today can be found in the partnership between US supermarket chain Walmart and the VR training company STRIVR. In 2018, Walmart's purchase of 17,000 Oculus Go VR devices—Meta's first mobile headset—was widely reported as an enormous endorsement of Meta's move toward mobile VR. VR provides Walmart the opportunity to simulate events that would be difficult to run as physical training scenarios (like a Black Friday shopping crowd), learn how to use new technology before it is installed, and for soft skills training such customer service, empathy and dealing with difficult conversations. These examples make sense as an application of VR as an educational technology in enterprise. There are clear logistical benefits—an infrastructure of VR headsets means training can be quickly created and distributed across its stores at scale, circumventing the labour and travel costs and limitations of human teaching staff—in addition to the capacity for VR to create novel learning experiences based on its realistic simulations and videos.

Our concern though is with the application of data analytics to these training scenarios and the introduction of new forms of algorithmic bias via their use to automate parts of decision making. In a blog post, Senior Vice President for Associate Experience Drew Holler describes how Walmart is using VR in the hiring process:

> "[Walmart] developed a skills-based assessment that uses virtual reality to simulate everyday obstacles. Once a candidate completes a 15-minute assessment, leaders use the results to help them remove subjectivity and unconscious bias from the selection process. This solution enables a people-led, tech-empowered way of working."[21]

Elsewhere, Holler also describes the promotion—and 10% pay rise - for a 12-year employee based on performance in the VR training. While Holler emphasizes that VR assessment is only one of the "data points" used in hiring decisions, the VR companies we examined enthusiastically frame the potential for the complete automation of these decisions. Our point here isn't that performance in VR can't sometimes predict success in the real world, but reiterate Mark Andrejevic's point that "the choice to implement automation within the existing socio-economic context carries with it a set of built-in tendencies that have important societal consequences".[22]

VR's fantasy of perfect data—that it captures for objective analysis a mirror-like reflection of the learning experience—is likely based on normative and exclusionary assumptions.[23] In the context of VR learning analytics, this has the potential to be a form of what Shea Swauger refers to as 'Eugenic Gaze' as it may codify xenophobia, ableism and white supremacy behind the black-box of algorithmic bias, "while avoiding equity-based critiques because of our belief in the neutrality of data and technology".[24] The expansion of VR as an increasingly mobile form of media, and the introduction of further data collection capabilities—such as tracking the physical space of the user via Vi-SLAM or tracking users' eye-gaze (for which the data-related harms remain relatively unknown)—only further exacerbate the potential for harm.

Conclusion

> "We believe the metaverse will be the successor to the mobile internet, we'll be able to feel present—like we're right there with people no matter how far apart we actually are"[25] - Mark Zuckerberg, 2021

Informed by scholarly perspectives towards mobile media, in this chapter we've discussed VR as a form of mobile media that relies on, and registers, its location to function. As such our focus has been on the increasing data-collection capabilities VR, which we've situated in an account of VR's technological function, and emerging centrality to tech giant Meta. On the basis of our research into Meta, and VR firms more generally, we've provided insight into some of the existing and emerging threats that VR presents, specifically focusing on examples of surveillance and data analytics in varying workplaces.

As noted by Gerard Goggin and Larissa Hjorth in the introduction, studies of the mobile internet challenged many of the taken-for-granted assumptions made about the PC internet, and its impacts and experience.[26] As we conclude, we want to briefly speculate on the implications of Mark Zuckerberg's claim above, made during the Facebook Connect event in 2021 in parallel with the company's rebrand to 'Meta'. Zuckerberg presents VR—and the embodied internet of the Metaverse—as an inevitable endpoint on the trajectory that saw the transition from desktop to mobile computing, a claim supported by the more recent shift from text to image to video, enabled by the affordances of the smartphone. On this trajectory, he claims, "the next platform and medium will be even more immersive, an embodied internet."[27]

So, if VR is a successor to the mobile internet, what are the implications for mobile media studies? What taken-for-granted assumptions have we made about mobile media, that the emergence of a ubiquitous VR might encourage us to reassess? What is different about VR, and needs critical attention? As we see it, there are three key areas. Firstly, Meta's dominant market share (as high as 70%, by some estimates) is establishing it as the gatekeeper over an enclosed platform, in contrast to the competition we see today between Google's Android and Apple's iOS ecosystems. What will it mean if Meta is the sole platform? What has been overlooked in mobile media studies, as a result of a taken-for-granted interplay between two competitive ecoystems? Secondly, as described here VR involves a significantly more intense surveillance of the body than mobile media. How will this change our experience of the internet, and computer use more broadly. How has the characteristics of mobile data shaped discourses and practices in a way that the richer data picture captured VR may not? Thirdly, what are the implications of the greater presence in a wholly digital environment that VR is claimed to have? How does this differ from the locative and spatial presence of mobile media?

Notes

[1] Maxwell Foxman, "Making the Virtual a Reality: Playful Work and Playbour in the Diffusion of Innovations," *Digital Culture and Society* 7, no. 1 (2022)

[2] Clive Thompson, "Stereographs were the original virtual reality," *Smithsonian Magazine,* October, 2017, https://www.smithsonianmag.com/innovation/sterographs-original-virtual-reality-180964771/

[3] Jussi Parikka and Jaakko Suominen, "Victorian Snakes? Towards A Cultural History of Mobile Games and the Experience of Movement," *Game Studies* 6, no. 1 (2006).

[4] Marcus Carter and Ben Egliston, *Fantasies of Virtual Reality* (Cambridge, MA: MIT Press, 2024).

[5] This is because women are much more likely to experience motion sickness than men, due to differences in the way that women process depth information and the poor fit of the headset which is designed for the male body. See Justin Munafo et al., "The virtual reality head-mounted display Oculus Rift induces motion sickness

and is sexist in its effects," *Experimental brain research* 253, no. 3 (2017): 889-901; Kay Stanney et al., "Virtual reality is sexist: but it does not have to be," *Frontiers in Robotics and AI* 7, no. 4 (2020).

[6] Anne Helmond, David Nieborg and Fernando van der Vlist, "Facebook's Evolution: Development of a Platform-As-Infrastructure," *Internet Histories* 3, no. 2 (2019): 123-146.

[7] Jordan Frith, Leighton Evans and Michael Saker, *From Microverse to Metaverse* (London: Emerald Insights, 2022).

[8] Ben Egliston and Marcus Carter, "Oculus Imaginaries: the promises and perils of Facebook's virtual reality," *New Media & Society* 24, no. 1 (2020).

[9] Ben Egliston and Marcus Carter, "'The metaverse and how we'll build it': The political economy of Meta's Reality Labs," *New Media & Society* (2022).

[10] Ibid.

[11] Sami Fathi, "Apple's Privacy Measures to Cost Facebook $10 Billion in 2022," *MacRumors,* February 2, 2022, https://www.macrumors.com/2022/02/03/facebook-10-billion-in-2022-apple-measures/

[12] "Powered by AI: Oculus Insight," *Meta Reality Labs*, last modified September 22, 2019, https://ai.meta.com/blog/powered-by-ai-oculus-insight/

[13] Jason Farman, *Mobile Interface Theory: Embodied Space and Locative Media* (London: Routledge, 2020)

[14] Katherine Hepworth, "A panopticon on my wrist: the biopower of big data visualization for wearables," *Design and Culture* 11, no. 3 (2019): 323-344.

[15] Ben Egliston and Marcus Carter, "The material politics of mobile virtual reality: Oculus, data, and the technics of sensemaking," *Convergence* 28, no. 2 (2022): 595-610.

[16] Jeremy Bailenson, "Protecting nonverbal data tracked in virtual reality," *JAMA Pediatr.* 172, no. 10 (2018): 905-906.

[17] Adi Robertson, "Mark Zuckerberg confirms new Meta VR headset will launch in October," *The Verge,* August 26, 2022, https://www.theverge.com/2022/8/25/23322159/mark-zuckerberg-joe-rogan-meta-quest-cambria-headset-launch-date-october

[18] J.L. Kröger, O. Lutz, and F. Müller, "What Does Your Gaze Reveal About You? On the Privacy Implications of Eye Tracking" in *Privacy and Identity Management. Data for Better Living: AI and Privacy*, ed. M. Friedewald et al. (London: Springer, 2020).

[19] Ibid.

[20] Marcus Carter and Ben Egliston, "What are the risks of VR data: Learning Analytics, Algorithmic Bias and a Fantasy of Perfect Data," *New Media & Society* 25, no. 3 (2021): 485-504.

[21] Drew Holler, "Customers are Changing. Jobs are Changing. At Walmart, the Future of Work is Bright," *Walmart News,* October 30, 2019, https://corporate.walmart.com/news/2019/10/30/customers-are-changing-jobs-are-changing-at-walmart-the-future-of-work-is-bright

[22] Mark Andrejevic, *Automated Media* (London: Routledge, 2019): 26.

[23] Which have in the past been gendered, classed, and raced in their outlook, see Kate Crawford and Trevor Paglen, "Excavating AI: The Politics of Training Sets for Machine Learning"; Noble, *Algorithms of Oppression* (NY: NYU Press, 2018); Anna Hoffman, "Terms of Inclusion: Data, discourse, violence" *New Media & Society* 23, no. 12 (2020).

[24] Shea Swauger, "The Eugenic Gaze: Algorithmic Test Proctoring in Higher Education," *Hybrid Pedagogy* (2020).

[25] Mark Zuckerberg, "The Metaverse and How We'll Build it Together," *Connect 2021 Keynote,* October 29, 2021, https://www.youtube.com/watch?v=Uvufun6xer8

[26] Larissa Hjorth and Gerard Goggin, T*he Routledge Companion to Mobile Media* (London: Routledge, 2016).

[27] Mark Zuckerberg, "The Metaverse and How We'll Build it Together," *Connect 2021 Keynote,* October 29, 2021, https://www.youtube.com/watch?v=Uvufun6xer8