Check for updates

Article

new media & society
1–25
© The Author(s) 2022
Article reuse guidelines:
sagepub.com/journals-permissions
DOI: 10.1177/14614448221119785
journals.sagepub.com/home/nms
SAGE

'The metaverse and how we'll build it': The political economy of Meta's Reality Labs

Ben Egliston
Queensland University of Technology, Australia

Marcus Carter
The University of Sydney, Australia

Abstract
Spatial computing – that is, a form of human–computer interaction that retains or manipulates referents of real object and spaces – is an increasingly intense focus for Meta. In 2018, Meta launched 'Reality Labs' (RL), a research and development division to oversee the company's production of spatial computing technologies. Drawing on a media historiographical approach from platform studies, this article charts the development of the company's spatial computing ambitions through RL from 2018 to 2022. In so doing, we find that Meta attempts to consolidate complementors through acquisitions, capture policymakers and academics, convene third-party businesses and developers, and expand its ecosystem through enhancing platform programmability. We argue that RL's efforts to grow the platform from within, and through drawing in third-parties, signals an ambition to grow their spatial computing offerings such that they take on a central, infrastructural role in society.

Keywords
Augmented reality, Facebook, infrastructure, Meta, metaverse, platforms, spatial computing, virtual reality, wearables

Corresponding author:
Ben Egliston, Queensland University of Technology, Brisbane, QLD 4059, Australia.
Email: ben.egliston@qut.edu.au

Introduction

In October 2021, Facebook sought a new identity: Meta. The name change, a symbolic move (rather than a corporate restructure, à la Google and Alphabet), reflected what CEO Mark Zuckerberg saw as a distinctive shift in the future of the company's corporate strategy. This was a shift from its 'family of apps' to focusing on the 'metaverse', a technological stack reliant on new forms of spatial computing, a form of human–computer interaction which retains and manipulates referents of real objects and spaces (whether material spaces like the built environment, or the organic space of the human body). As Zuckerberg explains in a promotional video – 'the Metaverse and how we'll build it' (Meta, 2022) – the company's rebrand represents a vision where Meta provides both the software and hardware for a transforming society, through its advances and significant investment in Virtual Reality (VR), Augmented Reality (AR), wearable technology, and smart-home technology. As Meta envisions it, how we engage with (mediated) space has implications for user subjectivity and agency (echoing now-common understandings of space and mediation, see, for example, Humphreys, 2005), with key applications (as Meta have it) to come for 'how we work, play, and connect with one another' (Abrash, 2015).

This concentration on spatial computing does not represent a new trajectory. The company has had a central interest in VR since its acquisition of American VR company Oculus in 2014, and since 2018, it has operated an internal (although public-facing) research and development division 'Reality Labs' (RL), focused on spatial media and predominantly, AR and VR (although also coming to encompass smart-home tech, wearables and AI).[1] In this article, we develop a historical account of RL, as a critical site for understanding how the 'metaverse' is being developed. Our account covers the period of May 2018 (RL's inception) to February 2022 (the point in time where RL expenditures were first announced, coinciding with the company's historic US$230 billion 1 day drop in market capitalisation, see Murphy et al., 2022).

Our approach to studying RL is informed by media historical accounts of Facebook, particularly those borne out of platform studies (see Helmond et al., 2019; Nieborg and Helmond, 2019; Van der Vlist and Helmond, 2019). Consistent with this approach – wearables and with broader theorisations of platforms (e.g. Burgess and Baym, 2020), we understand 'platform' in the sense of a sociotechnical arrangement – taking stock of technical aspects (e.g. programmability), business models and regulatory or policy relations. Such an approach is useful to 'consider the larger environments in which platforms operate' (Helmond et al., 2019: 126), and how those environments change over time.

Inspired by Van der Vlist and Helmond's (2019) approach to multisided and multilayered platform history we examine RL's growth across the following three main areas: (1) corporate acquisitions, (2) corporate partnerships (such as with businesses, advertisers, academia and policymakers) and (3) platform programmability (specifically, the programmability of software through software development kits [SDKs] and application programming interfaces [APIs]). In so doing, we engage two main and related research questions. First, how have RL's spatial computing ambitions taken shape across 2018–2022 (as evidenced through acquisitions, partnerships and developer API/SDK changes)? Second, what does the changing (but not new) relationship between Meta and spatial media tell us about the company's aims and logics in the present (and for the future)?

In engaging these questions, we aim to put into perspective Meta's recent financial and technological practices as intensified efforts to broaden and deepen the company's reach across society. We argue that RL's actions over 2018–2022 reveal a vision for a spatial computing future where its technologies are integrated widely across economy and society (from software development to use in business), a dynamic of what Plantin et al. (2018) would call 'infrastructuralisation'. By this, they refer to the way that platforms take on a central role in society such that society becomes dependent on them to function (e.g. cloud computing infrastructures like Amazon Web Services, which are used by companies like Netflix to the NASDAQ stock exchange). Through RL – which has attempted to consolidate complementary firms, attract third-party platform complementors, and form partnerships across academia and regulatory spaces – Meta has systematically sought to create conditions for its infrastructural vision to emerge.

The article proceeds by providing an overview of existing literature on the development (and the growth) of Meta, situating the need for scholarship that focuses on Meta's more recent investment in and development of spatial computing. Following this, we outline our approach to platform historiography and subsequently introduce our study material and method for data analysis. The following sections comprise our findings, examining RL's growth in three main ways: through consolidation through acquisition of complementary firms, through capturing and convening academics, policymakers, and platform complementors through partnerships, and through expansion through SDKs and APIs for Oculus and SparkAR. We conclude with a discussion of our findings and provide some direction for future study.

Related work

The growth of Meta

Much has been made of Meta's growth over time. Media scholars have provided 'big picture' histories of the company's rise since 2004 (see, for example, Brügger, 2015; Bucher, 2021). Scholarship on Meta's change over time has also focused on the public-facing, discursive presentation of the Facebook platform (see, for example, Haupt, 2021; Hoffmann et al., 2018; Rider and Murakami Wood, 2019). In fields like Internet studies, media studies and platform studies, scholars have also attended to the platform's growth across specific domains. One fruitful area of study is towards the company's acquisitions and development of certain software companies and apps – namely, Instagram (Leaver et al., 2020) and Messenger (Nieborg and Helmond, 2019). Crucially, these studies situate these individual applications within wider political-economic debates about Meta, such as the necessity of data flows for the viability of its advertising platform. Critical legal scholarship has focused on the company's business model, and its development over time. For example, Srinivasan (2018) accounts for the growth of Meta's data capture apparatus across the Internet, from market entry to its development of data-harvesting plugins that power its advertising network. From a media and platform studies perspective, for Van der Vlist and Helmond (2021), the growth of Meta's advertising business has been analysed in terms of an interrelated set of 'partners' – that is, advertisers, businesses and content creators – who have been granted special access to Meta's advertising API, enabling them to create content, access particular kinds of data, and so on, in a way that expands the bounds of the Facebook platform. Likewise engaging the Facebook API, Bodle (2011) argues that longitudinal analysis of API changes can be used to study how Meta configures relations between new features and business strategies. More recent work has shown how Meta has tended to update its API in response to public criticism and controversy (Van der Vlist et al., 2022). Analysis has also focused on the relationship between Meta and hardware, particularly that of the company's integration of geolocative mobile media technologies (Goggin, 2014; Wilken, 2014) as a key aspect of its momentous growth as an advertising giant in the early-mid 2010s.

Meta's relationship with VR and AR – particularly its relationship with Oculus – has been of increasing focus in media and platform studies, yet a subject of limited focus in platform history. Scholarship that might be characterised as using a historical approach, such as Evans (2019) or Saker and Frith (2020) place Oculus as a point on a much wider historical trajectory of both the VR medium but also of visuality more generally. Another body of research focuses on changes in the discursive framing of VR by Oculus' executives, developers and public relations (PR) spokespeople. Work by Egliston and Carter (2022a) focuses on the discourses of 'platformisation' at Oculus' developer conferences in 2018 and 2019. Media historians Nagy and Turner (2019) likewise write of Oculus' developer conferences, and the company's attempts to invoke the failed expectations of the 1990s VR craze as distinct from the ostensibly more credible VR futures of Oculus. Elsewhere, Harley (2020, 2022) touches on the cultural politics that inhere within statements by industry leaders, and the 'discursive newness' of how VR is framed in these statements, done in ways that 'elid[e] its gendered and colonialist media histories' (2020: 71). Egliston and Carter (2022c) have paid attention to Oculus' trajectories of technological development (or what they term its 'technicity'), arguing that advances in sensor capacity (from the 2016 Oculus Rift to the 2019 Oculus Quest) are inherently an area of political economy, specifically, of surveillance capitalism. A final area of research has focused on changes over time in Oculus' data and privacy policies for end-users and businesses (see Egliston and Carter, 2021), noting the way that they gradually signal compliance with data regulations over time as well as note shifts in their structure and language. As noted previously, despite there being a growing literature that attends to Oculus, and specifically its VR technologies, we lack wider perspective on Meta's broader spatial computing ambitions (which more broadly include wearables, augmented reality, smart-home tech, as well as the kinds of AI infrastructures supporting their functioning).

Such a perspective is crucial because spatial computing research and development is a now-expansive part of Meta's expenditure (see Meta, 2022a). In 2021, Meta reported almost a fifth of its employees were working on RL projects, with 10,000 employees (Byford, 2021) across RL's 12 main divisions (Meta, n.d.). In 2022, the company reported (for the first time) RL's revenues and expenditure – surpassing US$20 billion since 2019, with half of that being spent in 2021 alone (Murphy et al., 2022). In the context of significant scholarly interest in Meta's growth, and its material and discursive efforts to frame its platforms as infrastructure, the lack of research into Meta's increasingly sizable investments in spatial computing is significant.

Platform historiography

Historical approaches to studying platforms have generally sought to reconstruct the 'past lives' of platforms. Given that platforms are multilayered and multisided, approaches to platform history differ markedly. For example, cultural studies inflected approaches (e.g. Burgess and Baym, 2020) have paid attention to – among other things – vernacular practices and end use. Materialist accounts rooted in software studies have accounted for change in a platform's technical architecture at the level of both software and hardware (Egliston and Carter, 2022c). Studies interested in the histories of a platform's financialisation have examined years of financial reporting (Elmer, 2018). Feminist platform histories (e.g. Anable, 2018) are attentive to suppressed moments within wider master narratives. To understand the growth of Meta's spatial computing efforts, we draw on the approach to platform history set out by Van der Vlist and Helmond (2019; and adopted in a range of work since, for example, Helmond et al., 2019; Nieborg and Helmond, 2019; Van der Vlist and Helmond, 2021) – a branch of platform history that is particularly attentive to (1) the multilayered and multisided nature of platforms, and their change over time and (2) the political-economic implications of these changes.

Taking stock of multilayered and multisided shifts in platforms positions us to think about a platform's growth beyond visible end-user related dimensions. We can flesh out our understandings of what platforms are, what they do, and how they change by attending to the ways that platforms expand their boundaries through corporate acquisitions (Birch et al., 2020), third-party app development (Blanke and Pybus, 2020; Van der Vlist et al., 2022), business partnerships (Helmond et al., 2019), and policy and influence on regulation (Phan et al., 2022; Whittaker, 2021). Taken together, the capitalisation of platform companies and the accrual of platform power should be understood as distributed, as made up of various practices and operations happening at different levels (cf. Van Dijck et al., 2019). In this sense, the approach to platform history set out by Van der Vlist and Helmond (2019) provides a means to get at platform histories in terms of their multisided and multilayered – that is, distributed – nature.

The second characteristic of this work is its explicitly normative or critical dimension, specifically, its attention to platform power. Where platform histories at once attempt to reconstruct the past of platforms, an aim across much of the literature is to examine which actors benefit from a platform's growth, and in what ways (e.g. network effects, data capture). In short, critical work on platforms stands to gain much from taking stock of the often-ignored processes through which infrastructuralisation and platformisation happen – with platform history well placed to track how these processes change, and accrue power for platforms, over time.

Data and method

The study material consisted of information about Meta's acquisitions,[2] information about partnerships, and changelogs to the SparkAR API and Oculus SDK. We determined these three main types of documents for studying Meta's spatial computing operations through engaging with literature and primary source material from a wider project on the political economy of mixed reality conducted by Carter and Egliston (which involved some engagement with Meta and Reality Labs), as well as a wider literature on

Table 1. Documents comprising the study's sample, May 2018 to January 2022.

	Document source	Type	Type quantity	Total quantity
Acquisition	SeekingAlpha Database (https://seekingalpha.com/symbol/META), Oculus Blog (oculus.com/blog)	Artificial Intelligence (AI) company	6	14
		Game company	7	
		Other software company	1	
Partnership	Developers.facebook.com https://research.facebook.com/programs/research-collaborations/	Developer partnerships	10	19
		Enterprise partnerships	3	
		Policy/regulation	3	
		Education	1	
		Academic partnerships	2	
API/SDK change	Twitter.com/oculus_dev, developers.oculus.com. https://developers.facebook.com/blog/spark_ar_studio/, https://sparkar.facebook.com/ar-studio/learn/changelog/	Oculus SDK changelog	35	121
		SparkAR API changelog	86	
Total				154

API: application programming interface; SDK: software development kit.

platform history and growth (Helmond et al., 2019; Nieborg and Helmond, 2019) which draws on a combination of technical documentation (e.g. API changes) and forms of managerial, financial and developer-related documentation.

To collect data, we drew from several sources (see Table 1). Most of the material was from a primary source. This included material published on various RL-related web domains, and Meta's presence on other social media (e.g. Twitter).[3] Secondary sources were also used where primary source documentation was not available. For this, we relied on material sourced through the SeekingAlpha database – which accumulates financial data (e.g. earnings reports) and trade press articles on corporate activity (e.g. mergers and acquisitions). We sampled these documents with maximum variation (within the parameters of being within the scope of RL) and within the date range of May 2018 and January 2022, resulting in 154 text-based documents. Data ranged from several pages of text (e.g. funding guidelines for an academic grant programme) to short paragraphs (e.g. some versions of the software updates). Locating documents involved keyword searches through Google,[4] through the search functionality on Meta's own web pages and the search function of SeekingAlpha (our keywords started with broader terms like 'developer partnership' but we began using more specific and targeted phrasing as we grew familiar with the material, for example, 'responsible innovation'). Documents that are cited in this article are referenced in Appendix 1.

We analysed these documents using qualitative content analysis (Schreier, 2020). After each author independently familiarised themselves with the material – reading it and taking notes – we organised the material into its broadest category, chronological time. To facilitate our analysis, we used an iterative coding system – common in qualitative approaches to the analysis of textual data (Creswell, 2007). We first manually coded the material. We used a mixture of inductive and deductive coding. Inductively, we organised data according to patterns or concepts in the material (e.g. 'data and privacy' or 'growing third-party software developer network'). Deductively, we arranged materials around actual or imagined relation to specific user groups (e.g. developers, academics, end-users, etc.), keeping with the attention to multisidedness in platform historical work. From there, we consolidated the coded material to form our final categories which captured the essence of RL's practices from 2018 to 2022. The timeline was then further contextualised around key events – such as public statements or announcements by the company and controversies.

Results and discussion: the growth of Reality Labs

RL is Meta's mixed reality and spatial computing 'research and development group' (Matney, 2018), founded in May 2018. In 2020, the scope of RL was described as covering three currently existing technological projects – Oculus (VR), SparkAR (mobile AR) and Portal (smart-home/video conferencing technology) – as well as more speculative research and development projects (largely centred around wearable AR). RL is made up of 12 research and development 'labs' across the world, each of which focuses on specific areas of spatial computing design (e.g. the London RL group focuses on SparkAR, where the Zurich group focuses on computer vision – such as that used in the Quest's odometry stack, see Meta, 2019). In 2021, RL became the name for Meta's financial reporting segment for its spatial computing revenues and expenditures.

RL is a second iteration of the company's existing internal research and development division, Oculus Research (which was founded in 2014, following Meta's acquisition of Oculus). RL represents a reorientation of Oculus Research in several ways. First, where Oculus Research largely existed to pursue the research relating to VR software and hardware – that is, essentially an inward facing division (with the exception of its academic publishing) – RL took a more public-facing profile. While RL continues publishing with academic socieities such as the Association for Computing Machinary (in the proceedings of conferences like SIGGRAPH), RL sought to present ongoing research to lay audiences in the form of blog posts (see https://tech.fb.com/ar-vr). Second, RL expanded scope from Oculus and VR products specifically to a wider suite of spatial computing interfaces, such as mobile (and more speculatively, head-mounted) AR, embodied computing and wearables, and smart-home tech (and, to facilitate the development of these technologies, advances in AI such as computer vision). Third, RL represented the further integration of Oculus – the company's major spatial computing product – into Meta's family of apps (see Egliston and Carter, 2021).[5]

In what follows, we analyse RL's growth across 2018–2022 by exploring the three main themes drawn out of the empirical material: 'Consolidating' (through acquisitions), 'Capturing and convening' (through partnerships) and 'Expanding' (through SDKs and APIs for Oculus and SparkAR). Figure 1 shows the incidence of these practices of growth over the study period. We argue that RL's efforts to grow the platform from within, and through drawing in third parties, signal an ambition to grow their spatial computing offerings to the point that they take on a central, infrastructural role in society.

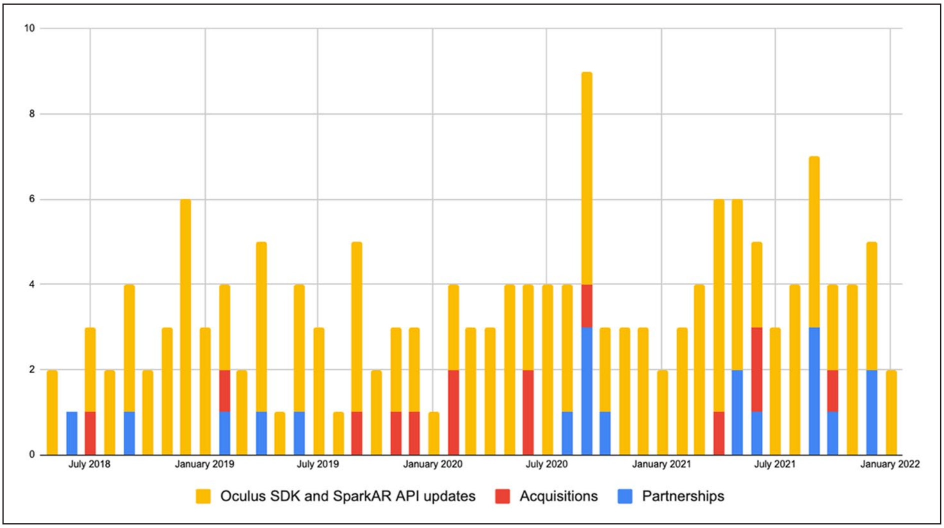

Figure 1. Partnerships, acquisitions and API/SDK changes, May 2018 to January 2022.

Consolidating through acquisitions

Meta sought to consolidate firms complementary to RL through series of acquisitions across 2018–2022. The company has pursued a strategy of corporate acquisitions ever since its initial public offering in 2012 (Helmond et al., 2019), and through its historically high revenues and margins (from its lucrative advertising business).[6] While the acquisition of WhatsApp in 2014 for US$16 billion remains the company's highest value acquisition (Kuchler and Bradshaw, 2014), it is RL-related acquisitions that comprise the largest proportion of acquisitions since RL's launch in 2018.[7] Meta's acquisitions relating to RL have fallen into the following two categories: software development (predominantly videogame development) and spatial computing companies (e.g. computer vision, mapping software).

On the former, where Meta has made efforts to frame Oculus as moving 'beyond' the narrow purview of gaming, and towards a form of 'social media' (as suggested by Egliston and Carter, 2022a), most RL-related acquisitions fall into the category of videogame software companies. This series of acquisitions began in 2019 with the acquisition of Beat Games, the developers of Beat Saber – one of the most popular VR titles (RLA, 2019b). This was followed in the 2020 acquisition of VR developer Sanzaru Games (RLA, 2020b) and Ready at Dawn (RLA, 2020d). The year 2021 saw further acquisitions of VR-specific developers, such as Downpour Interactive (RLA, 2021a) and BigBox VR (RLA, 2021c). A further notable acquisition was Unit 2 Games (RLA, 2021b) – who develop a game-engine application – lining up with RL's publicly stated ambitions to create customisable virtual environments for the 'metaverse'. Beyond game companies, Meta acquired the VR fitness software developer Within in 2021 (RLA, 2021d) – its highest value acquisition at US$400 million (an acquisition that became the focus of investigation by the Federal Trade Commission in July 2022).

Of RL's acquisitions, these are the most end-user facing, in the sense that the aim is to acquire development teams with proven commercial track records to entice users into entering the Oculus ecosystem – a strategy long employed by the videogame console industry. It is in this sense that acquiring first-party developers to attract end-users represents what Nieborg and Helmond (2019) call the 'inward' expansion of platforms – where platforms develop features to facilitate adoption and engagement by end-users. As Zuckerberg (2015) notes in a leaked email, such acquisitions are, in the company's eyes, key to generating the network effects that Meta see as central in maintaining dominance in the VR market.

The second category of acquisitions was companies which developed some form of mapping or machine vision technology. These generally fell into the following two subcategories – AI companies interested in capturing and/or rendering data about physical environments, and AI companies that capture and parse body activity. In 2019, RL acquired CTRL Labs (RLA, 2019b) – a neural interface startup. At the time of acquisition, CTRL Labs was developing wristbands that translate neuromuscular signals into machine-interpretable commands – which in 2021 form a key part of Meta's narrative about the future of RL's computing interfaces and has since been integrated into Meta's Neuromotor Interfaces lab (one of the 12 reality labs; Meta, 2021a). As RL highlight in a demonstration of internal research, CTRL Labs has had a central role in the development of brain computer interfaces that the company seeks to pair with VR and AR hardware (Meta, 2021a). In 2020, RL acquired Lemnis Technologies (RLA, 2020e), a headset manufacturer with specific focus on eye-tracking technology. Eye tracking has since become a focus for RL in what it has termed Project Cambria (Robertson, 2021) – a development codename for a VR/AR system with improved sensor abilities (e.g. tracking facial expression).

Beyond interfaces for sensing the body, RL's other AI acquisitions that emerged in our dataset were to do with tracking and graphically rendering the physical environment. On the stage of its 2019 Oculus Connect conference, RL showcased its vision for 'LiveMaps' (Meta Quest, 2019a) – a project of creating a digital map of the world to render it augmentable through technologies like smart glasses (a project which the company would later develop into more expansive AI projects for tracking and rendering spatial data, specifically, data about the built environment, such as the urban environment, or one's living room). We see this in specific internal projects like Aria in 2020 (which created 3D scans of the environment that could be modelled in AR and VR headsets, see Reality Labs, 2020) and Ego4D in 2021 (a research programme to build a dataset of 2D first-person video recorded through prototype AR headsets to be used in training AR-based assistant AI, see Meta, 2021b). Coinciding with this vision, RL acquired numerous AI companies that develop software for mapping and computational modelling of physical space. In 2019, RL acquired Grokstyle (RLA, 2019a), an AI company for mapping space in AR (with a particular focus on retail, such as placing digital representations of furniture and using AI to identify furniture that may match with the room's décor). A further range of acquisitions relate to RL's announcements from 2019 to 2021 concerning augmented reality and 'digital mapping'. In 2020, Meta-acquired (and integrated into RL) Mapillary (RLA, 2020c) – a mapping company for crowdsourcing maps based on image data. Likewise, that same year, the company acquired Scape Technologies (RLA, 2020a) – a 3D mapping and ‘scene reconstruction’ technology, one that at time of acquisition was building a ‘visual engine’ that allows camera devices to understand their environment, using computer vision. This builds on the use of similar techniques that Meta uses in the odometry stack of its Quest console (see Hesch et al., 2019).

Taken together, RL’s acquisitions signal infrastructural ambitions in two ways. Its acquisitions of game companies indicate an attempt at inward expansion, a form of horizontal integration of the company’s VR software/services, to attract and maintain end-users through a roster of first-party developers and content. In contrast, through its vertical integration strategies, namely its acquisition of companies in the spatial computing software space (e.g. mapping, computer vision, who do not necessarily operate within VR and AR development specifically), the company signals an ambition to build a technical infrastructure on which its present and future spatial computing ambitions will rely.

Capturing and convening through partnerships

Meta’s efforts to facilitate the growth of its spatial computing ecosystem also took less direct forms, particularly through RL’s extensive range of partnership programmes. Distinct from acquisitions, partnerships do not involve equity or the control of assets. Rather, in exchange for the provision of development resources or an investment of capital, actors external to RL produce content, policy, research, in ways that are ultimately amenable to Meta’s business interests.

The nature of RL’s partnerships included business partnerships (such as with businesses leasing enterprise hardware and software, or advertisers and marketers) and institutional partnerships (such as with universities, civil society and advocacy groups), partnerships which dually work as methods for creating optimal market conditions for the company to operate in the VR and AR space (namely, attempts to assuage or pre-empt concerns relating to privacy or data-related harm) as well as for attracting users into the ecosystem (specifically, users *beyond* end-users, such as businesses or content developers). In short, complementor partnerships *convene* – as we might understand it after Barnett (2008: 411) – ‘calling out to others, attracting their attention’, requiring an ‘active response’ (here, through usage or participation). Academic and policy partnerships can be seen as a form of *capture* (see, for example, Táíwò, 2022), a form of control exercised by powerful corporate institutions over other institutions (even very powerful ones, such as academia and government) – creating a channel between these (non-corporate) spaces and corporate interest.

The first form of partnerships is corporate partnerships, by which we generally refer to forms of business-to-business partnerships between Meta and content developers, and advertisers and marketers. These partners might be understood as complementors, that is, those individuals or organisations who create and provide complementary tools, products or services for Meta’s VR and AR platforms Oculus and SparkAR.

Developer partnerships were a common form of corporate partnership across RL. Encompassing AR and VR and promoted by (but pre-existing the formation of) RL, partnership programmes include Oculus Launchpad (a development incubator), which centred around providing resources and promotion for emerging VR development (see RLP, 2019; RLP, 2020a; RLP, 2021a). Subsequently, in 2021, an ‘XR Hackathon’ (RLP, 2021h) was announced by Meta. The XR Hackathon – more focused on RL’s ambitions than the broader Facebook Hackathon scheme – centres around numerous key areas of research and development, such as ‘Hand and Body Tracking Performance AR Effects, and Voice and Hand VR Experiences’. Other programmes include the Creator Accelerator Program (RLP, 2021f), a creator incubator which has placed focus on teams developing content for the company’s ‘metaverse’ software, Horizons.

Through these kinds of developer initiatives – whether through more formal partnerships to community hackathons – there are the following two goals: the ‘outward’ expansion of Oculus through the creation of a developer ecosystem and the creation of content, to attract or maintain end-users. The aim, as Zuckerberg (2015) suggests, is Meta’s AR and VR being ‘completely ubiquitous in killer apps’. To meet this need, Oculus announced in 2021(Oculus Blog, 2021) that in addition to its Oculus App store (its main digital distribution platform, from which it takes a 30% cut of sales), it would allow distribution of experimental and in progress works, subject to a less strict process of review than the app store, through the AppLab platform (from which the company takes a lesser 15% cut of sales) – a less restrictive pipeline for development from which Meta profits (and indeed, such an area of concern for anticompetitive conduct that it has warranted an investigation in 2022 by the US Federal Trade Commission, see Nix and Gurman, 2022).

The second form of partnership was business partnerships. This spanned, generally, the following three main areas: advertising and AR, VR and enterprise, and smart-tech and enterprise. The former is centred on Spark AR, Meta’s platform for mobile AR development (released to select developers in July 2018, and to the public in 2019, see Roberts, 2019). Spark AR largely centres on developing AR face filters used across Facebook, Messenger and Instagram, filters which can be used by brands in advertising campaigns. This is facilitated through the Spark AR Partner Network (RLP, 2020e), launched by Meta in October 2020. The partner network, as the description reads, operates as a ‘two-sided marketplace’ that Meta has ‘quietly nurtured . . . through strategic partnerships with select creators and brands’ (as of 2020, there are 77 AR content and brand partners). Spark AR creative partners can include both individual creators as well as creative agencies. On the ad-buy side, Spark AR partners range from individuals with a business to large brands. The value proposition of this platform, as Meta sees it, is much like its broader ad platform: it allows the ‘self-service’ purchase of AR ads – which the company frames as a powerful form of native advertising across its social platforms.

The second form of business partnerships is around Oculus’ VR and its use in enterprise settings – such as providing training and evaluation in workplaces. The partnership, called Oculus for Business, was announced at the F8 conference in 2019 where it was described as ‘transform[ing] work with virtual reality, training, collaboration, design, and more’ (Meta Quest, 2019b). Like the Spark AR programme, the Oculus for Business programme sought to attract multisided parties into the platform – namely, software developers who would create the training and simulation software which businesses would purchase or lease and which would run on Meta’s hardware. In a vein similar to its model with Spark AR, in 2020 Oculus for Business launched its

'Independent Software Vendor' (ISV) programme (RLP, 2021g), in which Meta – through its partnership website – provides 'access' to these vendors, who create software for Oculus platforms. As RL has it, its ISVs are 'helping companies take advantage of what we call the "superpowers" of VR – special capabilities that improve collaboration, productivity, remote work, training, and more'. Coinciding with the ISV partnership came an enterprise edition of the Oculus Quest, sold to businesses. Through this partnership programme, RL aims to attract enterprise software developers (who can make money developing for Oculus products) and businesses, who not only pay to access the requisite hardware and software, but advance the societal reach of spatial computing for RL.

A third, yet much more minor, product partnership is Portal for Business (from September 2021, RLP, 2021d). Portal, a 'smart video' device initially marketed as a domestic technology (essentially as a video phone) is framed as a solution for business communication, particularly considering remote working arrangements (much as it claims with Oculus for Business). In contrast to the business partner programmes for SparkAR and Oculus, Portal offers little specifically for businesses beyond being tied to Facebook Work accounts – which enable direct communication between businesses and their customers.

A separate, but crucial part of RL's partnerships schemes is accruing capital beyond economic capital. Specifically, since 2020, RL has sought to partner with non-industry actors, such as civil society groups or academia – particularly those interested in tech 'ethics' – doing so to cultivate what Phan et al. (2022) call 'virtue capital' or to achieve what Bietti (2020) calls 'ethics washing' – acts of capturing ethics as 'an industrial input to maintain a system of production . . . aligned with existing structures of profit-making' (Phan et al., 2022: 5).

RL's first attempts to cultivate virtue capital can be seen in programmes like the 'VR for Good Creators Lab' (see, for example, RLP, 2018b), a programme that pairs filmmakers with charities to produce VR film content centred around social justice issues such as racism and gender discrimination (e.g. 'VR for understanding – breaking barriers around the transgender community', or 'VR for action – Travelling while Black explores America past and present').[8] More centrally, throughout 2020, RL's partnerships and attempts to accrue virtue capital are increasingly focused on the policy space – in likelihood as a response to growing critiques of its practices within RL specifically, and across the company more broadly. RL's partnerships since 2020 have been centred on what Meta refers to as 'responsible innovation' (RI). RI is a general approach to technological research and development that seeks to embed social benefit and moral responsibility, centred around areas like 'anticipation, reflexivity, inclusion and responsiveness' (De Hoop et al., 2016: 118). A central tenet of these approaches is the incorporation of both community groups and public or lay perceptions and experiences of technology into research and development (European Commission, n.d.). As critics identify (e.g. Stilgoe et al., 2013), RI is a common way that technology companies offset negative perceptions of societal harm.

RL's first RI initiative was concurrent with its September 2020 announcement of Project Aria, an internal research and development programme for a pair of AR glasses, which as the company imagines it, will augment physical space with contextually specific information using AI (with its assistant AI under development by the Redmond, Washington lab; see Tech at Meta, 2021). The principles generally sought to address expectations of risk that were immediately raised with Project Aria, and thus, likely lie ahead in the future of AR. They are ‘Never surprise people’, ‘Provide controls that matter’, ‘Consider everyone’ and ‘Put people first’. As RL note, these principles were developed in consultation with ‘external experts’ (RLP, 2020d), yet they do not state who these individuals and groups are. As critics like Applin and Flick (2021) argue, RL’s RI statements amount to little more than an attempt at pre-empting critique of Aria, particularly considering previous internal experiments (such as the infamous emotional contagion study, see Hallinan et al., 2020).

Coinciding with its RI policy for RL, Meta Research – Meta’s academic research division – broadened the scope of its research focus areas to include RL-related projects covering AR and VR. In 2020 and 2021, as part of an academic grant scheme, Meta attempted to solicit research from academics external to Meta, with AR and VR becoming the focus of two funding rounds (of US$75,000 grants) to do with ‘Explorations of Trust in AR, VR and Smart Devices’ (RLP, 2020b) – emphasising ‘security, privacy, integrity, and ethics’, and ‘Responsible Innovation in AR/VR’ (RLP, 2021b). It is notable that despite Meta developing data sensitive VR technologies, this was the first major public-facing engagement with the question of data privacy (Carter and Egliston, 2021) – likely in response to critique of Meta’s VR emerging at the time by civil society and privacy advocacy groups (e.g. XRSI, 2020) and by regulatory bodies in Germany (see Bundeskartellamt, 2019) throughout 2020. Notably, Meta has used its academic grant scheme as a shield against growing state regulatory pressures against the company and its VR (see Meta, 2022b: 15) – its investments, a means through which the company narrates its own past on terms that benefit its future growth. Notably, Meta suggests that a principles based approach to regulation (following from its RI principles) will be the key in the legislative regulation of VR. For example, in response to a review of the Australian Privacy Act published in December 2020, Meta notes of VR regulation that a ‘prescriptive set of rules may deter innovation and result in a net negative outcome for consumers’ and instead ‘strongly support the retention of a flexible and principles-based approach to privacy regulation’ (Facebook, 2020: 39).

In October 2021, almost a year after the company’s announcement of Aria and RI principles, RL released the Ray Ban ‘Stories’ smart glasses, the first outcome of a 2020 partnership with eyewear conglomerate Luxottica Group (RLP, 2020c). Accompanying the announcement of these glasses were the company’s principles for ‘responsible use’ (RLP, 2021c). Unlike the broader RI principles from 2020 (which the company links to on its privacy page for Stories), the Stories principles focus on the end user and interpersonal harm (such as forms of social surveillance that might take place in using the device, which allows the recording and uploading of images and video to social media). These principles, RL suggest, were developed in partnership with ‘third-party experts’ (all of whom received Meta funding, see Mac, 2021), namely, the non-profit groups the Future of Privacy Forum, the National Network to End Domestic Violence, the National Consumers League, the Information Technology and Innovation Formation, Access Now and the LGBT Technology Partnership. As RL put it (RLP, 2021c), the goal of engaging these organisations is to ‘drive a dialogue around the standards and expectations for these new technologies' and to 'establish new norms in an open, inclusive way'. Reflecting the inadequacies of this 'consultation', one group involved in the consultations – Access Now – voiced their frustrations that their 'top recommendation – to prioritise alerting bystanders that they are being recorded – was ignored' (Leufer, 2021).

In October 2021, Meta announced another internal development project – Ego4D (Meta, 2021b) – a more expansive effort to train the assistant AI that would be used in its smart glasses and future smart-home assistant AI. This would see a 700-user cohort (of Meta employees and contractors) sent into the world wearing prototype glasses to generate the dataset necessary to train image recognition algorithms. Directly coinciding with Ego4D, the company announced a US$50 million investment in RL geared around regulation and policy – particularly, an effort to engage lawmakers and academics (RLP, 2021e). The investment, the 'XR Programs and Research Fund' (announced September 2021) came shortly after allegations of impropriety in its platform governance by company whistle-blowers Frances Haugen and Sophie Zhang (Vaidhyanathan, 2021). The fund, announced by CTO Andrew Bosworth and head of global affairs, Nick Clegg, was an effort to fund 'external research' centred on areas of risk such as privacy, safety and integrity, and equity and inclusion (yet, in line with Bennett's (2021) critique of Meta's calls for government regulation more broadly, they are efforts which evade discussion of problems that inhere in the company's business models and practices). The prospect of growing investments in RL that are geared around policy and academic engagement should cause pause for researchers, not inasmuch that any individual actor or policymaker is compromised in their integrity, but rather, as Whittaker (2021) suggests, because 'questions and incentives' asked by regulators or scholars will now in some way bear Meta's interests.[9]

Through partnerships with regulators and academics, RL attempts to capture critics and detractors as well as create narratives of virtue. Furthermore, many of RL's spatial computing offerings are far off existing (outside of experimental research and development (R&D) settings). Suggesting that we need to address ethical or regulatory issues *now* has a further benefit for Meta. It is to say that AR and VR are not technologies of the distant future but are technologies that are encroaching on the present. This is valuable to Meta in its efforts to 'sell' spatial computing to prospective users and developers (and its investors). Through partnerships with businesses and developers, RL convenes forms of third-party engagement with its technology. Through adoption by cross-sectoral businesses, to creating ostensibly supportive environments for developers, RL attempts to grow the influence of their spatial computing offerings across society.

Expanding through platform modularity (developer APIs and SDKs)

In coming to operate as infrastructure, a common technique of platform companies is increasing the programmability or 'technological extensibility' (Nieborg and Helmond, 2019) of platforms. Put differently, platforms become more 'modular' (as Birch and Bronson, 2022 put it) – they provide the technological architecture allowing complementors to 'slot in'. A common approach is through platforms providing third-party developer access to APIs and SDKs. An API is a set of protocols or tools for building software, particularly, in interfacing with the resources provided by another piece of software. SDKs, while fulfilling a similar function, refer to a more complete toolkit for software creation which often include APIs. In both cases, these resources allow software developers to build upon platform technology in ways that tend to serve platform owner interests (e.g. creating new content or functionality which attracts or retains new users). In years since RL's formation, platform changes occur across two main domains – Oculus' VR SDK and Spark AR's developer API, which were visible through their respective changelogs – that is, a document that shows implemented changes.

The Oculus SDK provides tools for the development of software across the suite of Oculus technologies. Updates to the Oculus SDK were largely focused on facilitating development of software using popular software development tools Unity and Unreal. As existing scholarship has suggested, software development engines like Unity and Unreal (the two engines on which most of the world's videogames are made) benefit Oculus' interests by potentially drawing in developers who are working with these common software tools (cf. Egliston and Carter, 2022a; Foxman, 2019). These changes vary in degree, some minor (e.g. updating a shader) and some more major. For example, in version 31 (RLPPR, 2021c) of Oculus' software update, the company has stated it would be moving towards interoperability with its compatibility with OpenXR – an XR development standard which provides an API allowing developers to work across a variety of AR and VR devices (as opposed to working with numerous proprietary APIs, locking developers into developing for particular devices). Theoretically, such a development standard would be beneficial for the medium of XR development, rather than Meta specifically. There is a sentiment of interoperability that Zuckerberg (2021) would go on to echo in 2021, announcing that 'the metaverse will not be created by one company' (n.p.). Openness is a means through which Meta at once signals good intention of bolstering the nascent XR ecosystem. But at the same time, it is also the means through which RL is structuring, and deriving value from multisided interactions – specifically, by encouraging development on RL's platform. For the company that currently dominates the VR market, this gesture towards decentralising its ecosystem means little, in effect further producing economically and structurally centralised outcomes for Meta.

Beyond APIs and SDKs to facilitate increased engagement from developers, RL has released updates to allow for specific forms of engagement with VR software, such as the hand tracking SDK released in December 2019 (RLPPR, 2019), or the PassThrough API for Developers in July 2021 (which allows developers to create applications where Oculus VR headsets essentially work as augmented reality, placing the digital interface over a greyscale image of the room surrounding the user, captured by the device's inbuilt cameras; RLPPR, 2021b). While Meta have suggested that these data would not be used for advertising purposes, as critics have argued elsewhere (see Egliston and Carter, 2021), its privacy policies leave the possibility open for incorporating these data into its advertising apparatus. Of note, the company has recently filed for a patent for an ad-buying auction system – like what is in effect in the Meta's adtech platform – facilitating commerce between buy and sell sides in VR (see Carmi, 2021), representing the potential for the capitalisation of (new forms of) attention that take place on its platform.

Beyond VR, the other aspect of Meta's spatial computing is Spark AR. Across the sample, the period 2018–2020 largely focused on incremental updating of the API to allow for enhanced fidelity of visual effects and tracking of AR applications. These included enhanced incorporation of light into AR effects, to position and rotation of the eyes and irises (see, for example, RLPPR, 2018b), to effects that move with body position (see, for example, RLPPR, 2021d). Much like the Oculus SDK, the Spark AR API updates are also characterised by interoperability with programming applications and an attempt to mediate workflow (e.g. programming language compilers like Babel, used in software and graphics development, see RLPPR, 2018a) or through the addition of graphical assets through a centralised interface (the July 2020 'Blocks' feature which allows users to quickly add pre-made effects, RLPPR, 2020). While these updates are framed by Meta around democratising access to spatial computing development, as we note earlier, AR is increasingly a key part of the company's diversification of its range of mobile advertising formats, and its competition with AR-focused Snapchat. Furthermore, updates to Spark AR in 2021 have integrated AR face filters into the video call features of Messenger and Instagram – further situating AR not as a niche but a prominent feature within the participatory and vernacular culture of visual social media (cf. Gibbs et al., 2015).

In summary, changes in platform programmability to RL's existing technologies (specifically, increasing modularity) represent a double movement of outward expansion. They open the platform up for software developers to work with Meta's technology, which will create both end user and developer dependencies on emerging forms of Meta-owned spatial media.

Conclusion

Through our platform historiographical account of RL across the period 2018–2022, our goal has been to more systematically understand *how* RL's spatial computing vision is constructed. This is important because, as mentioned earlier, most understandings of Meta's relationship with spatial computing focuses on VR and Oculus – rather than the broader RL ensemble – and purely on what Meta *says* through the technophilic, and often hyperbolic discourse of its C-suite, marketers, and engineers (cf. Egliston and Carter, 2022a), rather than what they *do*. RL's practices, as we have shown in this article, tell the story of consolidating, expanding, convening and capturing. RL has sought to expand their platform boundaries (through APIs and SDKs, shaping standards for VR and AR development), and through partnerships which convene the engagement of businesses and complementors. They have consolidated complementary firms and competitors through acquisitions. They have sought to capture regulators and academics through funding schemes and partnerships. Doing so, RL stridently advances a vision of its spatial computing offerings as 'infrastructural' – that is, growing its power and presence in economy and society.

Given the normative, political-economic underpinnings of the platform historiographical methodology, we conclude with some implications going forward for future technopolitical interventions into spatial computing, and particularly into Meta's activities in the sector. One area is governance and oversight. Meta's corporate practices to do with spatial computing have, largely, enjoyed cover from scrutiny by regulators. One framework – competition law – has recently seen some application by regulators across the world (in the United States, the Federal Trade Commission and Department of

Justice, in Germany the Bundeskartellamt). Regulators are investigating claims that Meta's VR-related acquisitions constitute anti-competitive conduct (particularly in the context of the company already controlling most of the VR market), and that Meta's Oculus app store privileges its own first-party apps over similar competing titles.

While we do not dispute the need for regulatory intervention here, our broader platform historiographical analysis of RL suggests we need to think *beyond* competition law (which is limited by its narrow focus on market health and consumer welfare). Meta's growing spatial computing ecosystem indicates that its expansion might be problematised in terms of the enhanced capacities for surveilling and profiling users that it affords both Meta and its complementors. While nascent work by academics (Carter and Egliston, 2021) and privacy advocacy groups (XRSI, 2020)[10] has begun attending to issues of data and privacy that inhere in Meta's VR offerings (as well as potential regulatory solutions), further work will need to look at the company's growing spatial computing ensemble. Work here might draw inspiration from existing scholarship in media studies (Egliston and Carter, 2021) and computer science (Trimananda et al., 2022) which has sought to audit data and privacy policies of Oculus, its developer SDK guidelines, and the apps published on its app store; an approach which could productively inform governance and oversight initiatives.

Yet, as our study shows, RL's expansion is as such that it cannot always be addressed through top–down regulation; for instance, RL's virtue capital generating partnerships with academics. It is here that we find resource in Whittaker's (2021: n.p.) claim that future efforts might start by 'naming the dynamics' where academia and industry 'blur' to begin to 'to envision and demand alternative futures'. Critical scholarship on Meta's spatial computing might begin to address the comingling of research and industry through further examining the specific kinds of academic projects that Meta is funding, as we have begun here. But beyond this, we must confront the fact that Meta's ability to launder its acquisitions and research and development, and to derive virtue capital at a time where the company is perhaps under more scrutiny than ever, is enabled by issues surrounding academic labour. Meta's research funding is especially appealing to a largely precarious academic workforce faced with a paucity of publicly funded research. The problem of capture, then, might be addressed through a coalitional politics (cf. Táíwò, 2022), between critical platforms scholars and those advocating for better conditions in our own institutions such that these financial incentives from big tech are less appealing.

Future work on platformisation and spatial computing may also look beyond the case of Meta. While Meta dominates much of the spatial computing market, other firms compete in the space. As previous research by Egliston and Carter (2022b) has revealed, the way that competitors (such as Microsoft or Vuzix) have sought to grow the influence of their spatial computing (largely AR) offerings has been through contracts with various arms of the state – such as the military and police. Comparative study across the wider sector may provide entry points for further work by scholars, policymakers and regulators.

Fuding

The author(s) received no financial support for the research, authorship and/or publication of this article.

ORCID iD

Ben Egliston https://orcid.org/0000-0002-7878-7208
Marcus Carter https://orcid.org/0000-0002-4866-4928

Notes

1. The notion of a metaverse has been advanced in recent years by venture capitalists and other technology firms, such as Mozilla, Microsoft, HTC, Epic Games, UbiSoft, QualComm and Nvidia – offering a range of software and hardware to support the production of persistent networked spaces.
2. Acquisitions here specifically denote the acquisition of other firms. This is distinct from the acquisition of 'talent' from competing firms, a common practice in the tech sector. While Reality Labs (RL) undoubtedly does this, particularly in the context of its 2021 hiring frenzy (Byford, 2021), the company does not publicly disclose these acqui-hires.
3. The use of Twitter was necessary in capturing a more complete range of changelogs. Facebook's Oculus developers' page did not archive the entire history of changelogs). Due to limited captures available through archival tools like the Wayback Machine, we relied on other sources like the Oculus for Developers Twitter feed (which provides a chronological timeline of software updates, with links original SDK documentation on Meta's website).
4. We searched broadly – rather than limiting our Google searches to the Meta web domain – as Meta's own primary source material was not always hosted on a Meta domain.
5. For example, new Oculus devices requiring a Facebook account as of 2020 (where Oculus had previously operated relatively autonomously), or the Oculus name being retired.
6. Although as Birch et al. (2021) note, Facebook's corporate strategy centres less on acquisitions than others in the 'big five' tech companies.
7. Meta's acquisitions relating to the project of the current RL began prior to RL itself. As noted in our prior work (Egliston and Carter, 2022a), in 2015, Facebook acquired Surreal Vision (a UK-based 'computer vision' developer, specifically interested in real-time 3D scene reconstruction, and 'presence and telepresence', and in 2016, The Eye Tribe [an eye-tracking startup]). In an internal email from 2015, Zuckerberg notes that corporate acquisition in the VR and AR space would be central in 'accelerating' Facebook's VR and AR development (and allowing it to get ahead of its competitors such as Sony and Valve, creating platform dependency on Oculus as a dominant platform).
8. As of 2020, the programme was discontinued, perhaps telling given the critiques of VR as an 'empathy machine' that have emerged over the last several years (e.g. Bollmer, 2017).
9. A full review of Meta's funded projects was beyond the scope of this work. Social sciences projects funded by Facebook tended to focus on developing solutions to problems that were not result of Facebook's own actions as a platform company (e.g. dealing with VR-based interpersonal harm – harm done by *someone else* on its platform).
10. Of note, the XRSI would later partner with Meta (2021b), see RLP (2021i).

References

Abrash M (2015) VR's grand challenge. Available at: https://www.oculus.com/blog/vrs-grand-challenge-michael-abrash-on-the-future-of-human-interaction/

Anable A (2018) Platform studies. *Feminist Media Histories* 4(2): 135–140.

Applin S and Flick C (2021) Facebook's Project Aria indicates problems for responsible innovation when broadly deploying AR and other pervasive technology in the commons. *Journal of Responsible Innovation* 5: 100010.

Barnett C (2008) Convening publics: the parasitical spaces of public action. In: Cox KR, Low M and Robinson J (eds) *The SAGE Handbook of Political Geography*. London: SAGE, pp. 403–417.

Bennett WL (2021) Killing the golden goose? A framework for regulating disruptive technologies. *Information, Communication & Society*. Epub ahead of print 28 October. DOI: 10.1080/1369118X.2021.1994625.

Bietti E (2020) From ethics washing to ethics bashing: a view on tech ethics from within moral philosophy. In: *FAT* '20: proceedings of the 2020 conference on fairness, accountability, and transparency*, Barcelona, 27–30 January, pp. 210–219. New York: ACM.

Birch K, Chiappetta M and Artyushina A (2020) The problem of innovation in technoscientific capitalism: data rentiership and the policy implications of turning personal digital data into a private asset. *Policy Studies* 41(5): 468–487.

Birch K and Bronson K (2022) Big Tech. *Science as Culture* 31(1): 1–14.

Birch K, Cochrane DT and Ward C (2021) Data as asset? The measurement, governance, and valuation of digital personal data by big tech. *Big Data and Society* 8(1): 1–15.

Blanke T and Pybus J (2020) The material conditions of platforms: monopolization through decentralization. *Social Media and Society* 6(4): 1–13.

Bodle R (2011) Regimes of sharing: open APIs, interoperability, and Facebook. *Information, Communication, and Society* 14(3): 320–337.

Bollmer G (2017) Empathy machines. *Media International Australia* 165(1): 63–76.

Brügger N (2015) A brief history of Facebook as a media text. *First Monday* 20(5). Available at: https://firstmonday.org/ojs/index.php/fm/article/view/5423

Bucher T (2021) *Facebook*. Cambridge: Polity.

Bundeskartellamt (2019) Bundeskartellamt prohibits Facebook from combining data from different sources. Available at: https://www.bundeskartellamt.de/SharedDocs/Meldung/EN/Pressemitteilungen/2019/07_02_2019_Facebook.html

Burgess J and Baym N (2020) *Twitter: A Biography*. New York: New York University Press.

Byford S (2021) Almost a fifth of Facebook employees are now working on VR and AR: report. Available at: https://www.theverge.com/2021/3/12/22326875/facebook-reality-labs-ar-vr-headcount-report

Carmi E (2021) Facebook patent shows how you may be exploited in the metaverse. Available at: https://techpolicy.press/facebook-patent-shows-how-you-may-be-exploited-in-the-metaverse/

Carter M and Egliston B (2021) What are the risks of Virtual Reality data? Learning Analytics, Algorithmic Bias and a Fantasy of Perfect Data. *New Media and Society*. Epub ahead of print 9 May. DOI: 10.1177/14614448211012794.

Creswell J (2007) *Qualitative Inquiry and Research Design: Choosing Among Five Approaches*. Thousand Oaks, CA: SAGE.

De hoop E, Pols A and Romjin H (2016) Limits to responsible innovation. *Journal of Responsible Innovation* 3(2): 110–134.

Egliston B and Carter M (2021) Examining visions of surveillance in Oculus' data and privacy policies, 2014-2020. *Media International Australia*. Epub ahead of print 27 October. DOI: 10.1177/1329878X211041670.

Egliston B and Carter M (2022a) Oculus imaginaries: the promises and perils of Facebook's virtual reality. *New Media and Society* 24: 70–89.

Egliston B and Carter M (2022b) 'The interface of the future': Mixed reality, intimate data and imagined temporalities. *Big Data and Society* 9(1): 1–15.

Egliston B and Carter M (2022c) The material politics of mobile virtual reality: Oculus, data, and the technics of sensemaking. *Convergence: The International Journal of Research into New Media Technologies* 28: 595–610.

Elmer G (2018) Prospecting Facebook: the limits of the economy of attention. *Media, Culture and Society* 41(3): 332–346.
European Commission (n.d.) Responsible research and innovation. Available at: https://ec.europa.eu/programmes/horizon2020/en/h2020-section/responsible-research-innovation
Evans L (2019) *The Re-Emergence of Virtual Reality*. New York: Routledge.
Facebook (2020) Submission to the Australian Privacy Act Review issues paper. Available at: https://www.ag.gov.au/sites/default/files/2021-02/facebook.PDF
Foxman M (2019) United we stand: platforms, tools and innovation with the Unity game engine. *Social Media and Society* 5(4): 1–10.
Gibbs M, Meese J, Arnold M, et al. (2015) #Funeral and Instagram: death, social media, and platform vernacular. *Information, Communication and Society* 18(3): 255–268.
Goggin G (2014) Facebook's mobile career. *New Media & Society* 16(7): 1068–1086.
Hallinan B, Brubaker JR and Fiesler C (2020) Unexpected expectations: public reaction to the Facebook Emotional Contagion Study. *New Media and Society* 22(6): 1076–1094.
Harley D (2020) *The politics of consumer VR: framing contemporary virtual reality*. Unpublished Doctoral Thesis, York University, Toronto, ON, Canada. Available at: https://yorkspace.library.yorku.ca/xmlui/bitstream/handle/10315/38266/Harley_Daniel_E_2020_PhD.pdf?sequence=2&isAllowed=y
Harley D (2022) 'This would be sweet in VR': on the discursive newness of virtual reality. *New Media and Society*. Epub ahead of print 19 March. DOI: 10.1177/14614448221084655.
Haupt J (2021) Facebook futures: Mark Zuckerberg's discursive construction of a better world. *New Media and Society* 23(2): 237–257.
Helmond A, Nieborg D and Van der Vlist F (2019) Facebook's evolution: development of a platform-as-infrastructure. *Internet Histories* 3(2): 123–146.
Hesch J, Kozminski A and Linde O (2019) Powered by AI: Oculus Insight. Available at: https://ai.facebook.com/blog/powered-by-ai-oculus-insight/
Hoffmann A, Proferes N and Zimmer M (2018) 'Making the world more open and connected': Mark Zuckerberg and the discursive construction of Facebook and its users. *New Media and Society* 20(1): 199–218.
Humphreys L (2005) Cellphones in public: social interactions in a wireless era. *New Media and Society* 7(6): 810–833.
Kuchler H and Bradshaw T (2014) Facebook buys WhatsApp in $19bn deal. *Financial Times*, 20 February. Available at: https://www.ft.com/content/44d4fc72-99b2-11e3-b3a2-00144feab7de
Leaver T, Highfield T and Abidin C (2020) *Instagram: Visual Social Media Cultures*. Cambridge: Polity.
Leufer D (2021) Why you shouldn't buy Facebook Ray-Ban smart glasses. Available at: https://www.accessnow.org/facebook-ray-ban-stories-smart-glasses-privacy-review/
Mac R (2021) So the privacy experts. Available at: https://twitter.com/RMac18/status/1435998632767987714
Matney L (2018) Oculus research is now the 'Facebook Reality Lab'. Available at: https://techcrunch.com/2018/05/07/oculus-research-is-now-the-facebook-reality-lab/
Meta. (n.d.) Reality Labs. Available at: https://tech.fb.com/ar-vr/
Meta. (2019) AR/VR in Europe: build the future in Zurich, Cork, London, or Prague. Available at: https://www.metacareers.com/life/arvr-in-europe-build-the-future-in-zurich-cork-london-or-prague
Meta. (2021a) Inside Facebook Reality Labs: wrist-based interaction for the next computing platform. Available at: https://tech.fb.com/ar-vr/2021/03/inside-facebook-reality-labs-wrist-based-interaction-for-the-next-computing-platform/

Meta. (2021b) Teaching AI to view the world through your eyes. Available at: https://about.fb.com/news/2021/10/teaching-ai-to-view-the-world-through-your-eyes/
Meta. (2022) The Metaverse and how we'll build it together – connect 2021. Available at: https://www.youtube.com/watch?v=Uvufun6xer8&ab_channel=Meta
Meta. (2022a) Meta reports fourth quarter and full year 2021 results. Available at: https://investor.fb.com/investor-news/press-release-details/2022/Meta-Reports-Fourth-Quarter-and-Full-Year-2021-Results/default.aspx
Meta. (2022b) Submission to the Australian Privacy Act Review discussion paper. Available at: https://consultations.ag.gov.au/rights-and-protections/privacy-act-review-discussion-paper/consultation/view_respondent?sort=excerpt&order=ascending&_b_index=120&uuId=350227090
Meta Quest (2019a) Facebook Reality Labs: LiveMaps, Oculus Connect 6. Available at: https://www.youtube.com/watch?v=JTa8zn0RNVM&ab_channel=MetaQuest
Meta Quest (2019b) Introducing the future of virtual reality – Oculus for business, F8 2019. Available at: https://www.youtube.com/watch?v=gPvuJ5RRe08&ab_channel=MetaQuest
Murphy H, Waters R and Platt E (2022) Investors wipe more than $2020bn from value of Facebook owner Meta. *Financial Times*, 3 February. Available at: https://www.ft.com/content/51ea47e1-50c1-4b72-94d6-884017a1af4a
Nagy J and Turner F (2019) The selling of virtual reality: novelty and continuity in the cultural integration of technology. *Communication, Culture and Critique* 12(4): 535–552.
Nieborg D and Helmond A (2019) The political economy of Facebook's platformization in the mobile ecosystem: Facebook Messenger as a platform instance. *Media, Culture and Society* 41(2): 196–218.
Nix N and Gurman M (2022) Meta's Oculus unit faces FTC-led probe of competition practices. Available at: https://www.bloomberg.com/news/articles/2022-01-14/meta-s-oculus-unit-faces-ftc-led-probe-of-competition-practices
Oculus Blog (2021) Introducing App Lab. Available at: https://developer.oculus.com/blog/introducing-app-lab-a-new-way-to-distribute-oculus-quest-apps/
Phan T, Goldenfein J, Mann M, et al. (2022) Economies of virtue: the circulation of 'ethics' in Big Tech. *Science as Culture* 31: 121–135.
Plantin J, Lagoze C, Edwards P, et al. (2018) Infrastructure studies meet platform studies in the age of Google and Facebook. *New Media and Society* 20(1): 293–310.
Reality Labs (2020) Project Aria, Facebook Connect. Available at: https://www.facebook.com/watch/?v=2616922421880787
Rider K and Murakami Wood D (2019) Condemned to connection? Network communitarianism in Mark Zuckerberg's 'Facebook manifesto'. *New Media and Society* 21(3): 639–654.
Roberts M (2019) Creativity for all: Facebook's Spark AR now lets anyone build and share effects on Instagram. Available at: https://developers.facebook.com/blog/post/2019/08/13/spark-ar-publish-to-instagram/
Robertson A (2021) Facebook teases 'Project Cambria' high-end VR/AR headset. Available at: https://www.theverge.com/2021/10/28/22749008/facebook-oculus-project-cambria-pro-vr-ar-headset
Saker M and Frith J (2020) Coextensive space: virtual reality and the developing relationship between the body, the digital and physical space. *Media, Culture & Society* 41(7–8): 1427–1442.
Schreier M (2020) *Content Analysis, Qualitative*. Thousand Oaks, CA: SAGE.
Srinivasan D (2018) The antitrust case against Facebook. Available at: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3247362

Stilgoe J, Owen R and Macnaghten P (2013) Developing a framework for responsible innovation. *Research Policy* 42(9): 1568–1580.
Táíwò O (2022) *Elite Capture*. Chicago, IL: Haymarket Books.
Tech at Meta (2021) Update: a year of progress with Project Aria. Available at: https://tech.fb.com/ar-vr/2021/10/update-a-year-of-progress-with-project-aria/
Trimananda R, Le H, Cui H, et al. (2022) OVRseen: auditing network traffic and privacy policies in Oculus VR. Available at: https://arxiv.org/abs/2106.05407
Vaidhyanathan S (2021) Facebook has just suffered its most devastating PR catastrophe yet. Available at: https://www.theguardian.com/commentisfree/2021/oct/08/facebook-frances-haugen-whistleblower-pr-catastrophe-yet
Van der Vlist F and Helmond A (2019) Social media and platform historiography: challenges and opportunities. *TMG Journal for Media History* 22(1): 6–34.
Van der Vlist F and Helmond A (2021) How partners mediate platform power: mapping business and data partnerships in the social media ecosystem. *Big Data and Society* 8(1): 1–16.
Van der Vlist F, Helmond A, Burkhardt M, et al. (2022) API governance: the case of Facebook's evolution. *Social Media and Society* 8: 1–24.
Van Dijck J, Nieborg D and Poell T (2019) Reframing platform power. *Internet Policy Review* 8(2): 1–18.
Whittaker M (2021) The steep cost of capture. Available at: https://interactions.acm.org/archive/view/november-december-2021/the-steep-cost-of-capture
Wilken R (2014) Places nearby: Facebook as a location-based social media platform. *New Media and Society* 16(7): 1087–1103.
XRSI (2020) The XRSI privacy framework. Available at: https://xrsi.org/publication/the-xrsi-privacy-framework
Zuckerberg M (2015) 2015 06 22 Mark's vision. Available at: https://www.scribd.com/document/399594551/2015-06-22-MARK-S-VISION#from_embed
Zuckerberg M (2021) Founder's letter, 2021. Available at: https://about.fb.com/news/2021/10/founders-letter/

Author biographies

Dr Ben Egliston is a postdoctoral research fellow in the Digital Media Research Centre, Queensland University of Technology.

Dr Marcus Carter is a Senior Lecturer in Digital Cultures at the University of Sydney, and Director of the Sydney Games and Play Lab.

Appendix 1

References to documents cited in text.

In-text citation	Type	Reference
RLA (2019a)	Acquisition	9 February 2019, Facebook picks up retail computer vision outfit Grokstyle. https://techcrunch.com/2019/02/08/facebook-picks-up-retail-computer-vision-outfit-grokstyle/
RLA (2019b)	Acquisition	24 September 2019, Facebook buys startup building neural monitoring armband. https://techcrunch.com/2019/09/23/facebook-buys-startup-building-neural-monitoring-armband/
RLA (2019b)	Acquisition	26 November 2019, Welcoming Beat Games to Facebook. https://www.oculus.com/blog/welcoming-beat-games-to-facebook/
RLA (2020a)	Acquisition	8 February 2020, Facebook has acquired Scape technologies, the London-based computer vision startup. https://techcrunch.com/2020/02/08/scapebook/
RLA (2020b)	Acquisition	26 February 2020, Facebook acquires the VR game studio behind the Rift's best titles. https://techcrunch.com/2020/02/25/facebook-acquires-the-vr-game-studio-behind-one-of-the-rifts-best-games/
RLA (2020c)	Acquisition	19 June 2020, Mapillary, the crowdsourced database of street-level imagery, has been acquired by Facebook. https://techcrunch.com/2020/06/18/mapillary-facebook/
RLA (2020d)	Acquisition	22 June 2020, Welcoming Ready at Dawn to Facebook. https://www.oculus.com/blog/welcoming-ready-at-dawn-to-facebook/
RLA (2020e)	Acquisition	12 August 2020, Lemnis Technologies: our journey and what's next. https://medium.com/@pylaffont/lemnis-technologies-our-journey-and-whats-next-730e26ea200c
RLA (2021a)	Acquisition	30 April 2021. Welcoming Downpour interactive to Facebook. https://www.oculus.com/blog/welcoming-downpour-interactive-to-facebook/
RLA (2021b)	Acquisition	5 June, 2021, Facebook buys studio behind Roblox-like Crayta gaming platform. https://techcrunch.com/2021/06/04/facebook-buys-studio-behind-roblox-like-crayta-gaming-platform/
RLA (2021c)	Acquisition	11 June 2021. Welcoming BigBox VR to Facebook. https://www.oculus.com/blog/welcoming-bigbox-vr-to-facebook/

(Continued)

Appendix 1. (Continued)

In-text citation	Type	Reference
RLA (2021d)	Acquisition	30 October 2021, Meta (Facebook) is buying Within, creators of the 'Supernatural' VR fitness app. https://techcrunch.com/2021/10/29/meta-facebook-is-buying-within-creators-of-the-supernatural-vr-fitness-app/
RLP (2018a)	Partnership	May 2018, Call for applications: Oculus Launchpad 2018. https://www.oculus.com/blog/call-for-applications-oculus-launch-pad-2018/
RLP (2018b)	Partnership	13 June 2018, VR For Good: Introducing Our 2018 Creators Lab Participants. https://www.oculus.com/blog/vr-for-good-introducing-our-2018-creators-lab-participants/
RLP (2019)	Partnership	23 July 2019, Call for Applications: Oculus Launchpad 2019. https://www.oculus.com/blog/call-for-applications-oculus-launch-pad-2019/
RLP (2020a)	Partnership	1 August 2020, Oculus Launchpad 2020: Applications now open. https://developer.oculus.com/blog/oculus-launch-pad-2020-applications-now-open/
RLP (2020b)	Partnership	16 September 2020, Request for proposals on social experiences in VR environments. https://research.facebook.com/research-awards/request-for-proposals-on-social-experiences-in-vr-environments/
RLP (2020c)	Partnership	16 September 2020, Facebook and EssilorLuxottica Announce Collaboration for Smart Glasses. https://www.essilorluxottica.com/sites/default/files/documents/2020-09/PR-EN-FB-EL-SmartGlasses.pdf
RLP (2020d)	Partnership	25 September 2020, Responsible Innovation Principles. https://about.facebook.com/realitylabs/responsible-innovation-principles/
RLP (2020e)	Partnership	20 October 2020, Facebook relaunches Spark AR partner network. https://sparkar.facebook.com/blog/facebook-relaunches-spark-partner-network/
RLP (2021a)	Partnership	19 May 2021, Introducing the 2020 Oculus Launchpad grant recipients + 2021 applications now open. https://developer.oculus.com/blog/introducing-the-2020-oculus-launch-pad-grant-recipients-and-2021-applications-now-open/
RLP (2021b)	Partnership	7 June 2021, Towards Trustworthy Products in AR, VR, Smart devices. https://research.facebook.com/research-awards/2021-towards-trustworthy-products-in-ar-vr-and-smart-devices-request-for-proposals/

(Continued)

Appendix 1. (Continued)

In-text citation	Type	Reference
RLP (2021c)	Partnership	9 September 2021. Ray Ban Stories Privacy. https://about.facebook.com/reality-labs/ray-ban-stories/privacy
RLP (2021d)	Partnership	21 September 2021, Portal for Business. https://portal.facebook.com/au/business/
RLP (2021e)	Partnership	27 September 2021, Building the Metaverse Responsibly. https://about.fb.com/news/2021/09/building-the-metaverse-responsibly/
RLP (2021f)	Partnership	7 October 2021, Expanding horizon: new funding to support creators. https://www.oculus.com/blog/expanding-horizon-new-funding-to-support-creators/
RLP (2021g)	Partnership	29 October 2021, Oculus ISV Programme. https://business.oculus.com/isv-program/
RLP (2021h)	Partnership	7 December 2021, Announcing XR Hackathon Winners. https://developers.facebook.com/blog/post/2021/12/07/announcing-xr-hackathon-winners/
RLP (2021i)	Partnership	10 December 2021, XRSI Safety Week. https://xrsi.org/publication/virtual-worlds-real-risks-and-challenges
RLPPR (2018a)	Platform programmability	7 September 2018 Version 98. https://sparkar.facebook.com/ar-studio/learn/changelog/
RLPPR (2018b)	Platform programmability	19 October 2018, Version 98. https://sparkar.facebook.com/ar-studio/learn/changelog/
RLPPR (2019)	Platform programmability	24 December 2019, Oculus Developer Release Notes: V12. https://developer.oculus.com/blog/oculus-developer-release-notes-v12/
RLPPR (2020)	Platform programmability	8 July 2020, Version v92. https://sparkar.facebook.com/ar-studio/learn/changelog/
RLPPR (2021a)	Platform programmability	April 2021, F8 Refresh Hackathon. https://web.archive.org/web/20210420140219/https://facebookhackathons.com/
RLPPR (2021b)	Platform programmability	24 July 2021, Mixed Reality with Passthrough. https://developer.oculus.com/blog/mixed-reality-with-passthrough/
RLPPR (2021c)	Platform programmability	14 August 2021, Oculus Developer Release Notes: V31. https://developer.oculus.com/blog/oculus-developer-release-notes-v31/
RLPPR (2021d)	Platform programmability	8 November 2021, Version 126. https://sparkar.facebook.com/ar-studio/learn/changelog/