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Extended Reality Ecosystems: Innovations in Creativity & Collaboration in the Theatrical Arts

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Abstract

This article maps aspects of the current Extended Reality (XR) production ecosystem in the UK, capturing a unique industry at its moment of emergence. The last three years have seen an increase in activity by traditional theatre institutions in the UK producing and distributing VR and 360-degree video content. These projects have been made possible through interdisciplinary collaborations, which we are proposing as a ‘virtual reality production ecosystem’ in which a traditional art institution, a global technology partner and a group of creatives, artists, and technologists all join together in an innovative ‘showcase’ project. The ‘ecosystem’ notion has become somewhat of a buzz term in recent years - used to account for the organising principles of the creative industries, in this article, we adapt the descriptive and analytical value of this terminology through its application to four case-studies of VR or 360-degree video from 2015-16, produced by the National Theatre (*Fabulous.Wonderland*), English National Ballet (*Giselle*), The Royal Opera House (*Nabucco*) and Royal Shakespeare Company (*The Tempest*). We examine how each collaboration was initiated and formed, and how each project relates to government and institutional directives and policy, in the context of a technology at its point of emergence. Through interviews with a stakeholder from each of these projects, we explore the value system which emerges from within these ecosystems, including revenue generation, new artistic experimentations, audience engagement and the growth of innovation communities. Crucially, we consider how the theatrical arts in the UK is spearheading innovations and advances in Extended Reality, Virtual Reality and 360-degree video production, distribution, and audience engagement.

Introduction

Virtual Reality, and Extended Reality production is a truly inter-disciplinary domain - creative projects involve the work of theatre, film, and game practitioners alongside

journalists, psychologists, physicians, computer scientists, technologists and programmers. VR and XR projects are emerging from a number of interrelating industries – there is not a ‘virtual reality’ industry as such – they are born from a project-based mode of working, and as such, we have chosen to conceptualise them as unique forms of creative ‘ecosystems’. There are many differing views on what constitutes an ecosystem e.g. Charles Landry (1995, 1996), John Holden, Paul Jeffcut, Kevin McCarthy (all 2004), Markusen et al (2011), Holden (2015). The ecosystem notion is relevant in the particular context of VR/XR production given the nature of the collaborations which work across organisations of differing size and divergent sectors. Applying the notion of the ecosystem within this context advances current conceptualizations of the creative industries and clusters paradigms, examining collaborative projects which extend beyond the creative sector into the corporate, technology and communication domains.

We see the further and increasing legitimisation of XR, VR and 360-degree video as a resource for artistic and creative experimentation and as a valid artistic form in the range of artists who have incorporated VR into their portfolio of creative expression. These include ‘Björk Digital’¹ and the ‘Daydreaming with Stanley Kubrick’² exhibitions both included VR exhibits and both hosted at Somerset House in London during what we have described as the “summer of VR” – the moment at which the form exploded into the mainstream in 2016. The visibility, profile and credibility of VR is underscored by a specific ecosystem of exhibition and distribution which are one in the same from an audience perspective. This is predominantly through festivals that have curated a programme of new XR and VR films and have significantly contributed to the growth in the number of spaces being provided for these experiences. These include Tribeca’s Immersive Virtual Arcade and Storyscapes, the Sheffield Doc Fest where there has been an ‘Alternate Realities’ programme showcasing Virtual Reality and Interactive Documentaries since 2015, the VR suite at the Edinburgh Digital Festival, International Documentary Festival’s DocLAB in Amsterdam which is the largest documentary festival in the world, the Future of Storytelling annual conference in New York, a curated programme of VR and 360 films at Sundance Festival and the first ever VR selection at the prestigious Cannes International Film Festival in May 2016 at the Festival’s Film Market NEXT, the industry programme dedicated to the future of cinema.

¹ New Wing Somerset House, London, 1 September – 23 October 2016.

² West Wing Galleries Somerset House, London, 6 July – 4 August 2016.

From companion application to centre-stage feature

Each of the examples examined within this article (with the exception of the Royal Shakespeare Company's *The Tempest*) has been designed and launched as 'companion' experience which augments and enhances and crucially, promotes engagement in the 'main' event. It does so by providing access to additional and supplementary content for the audience to engage with before, after, or at a distance. The use of the technology in *The Tempest* is the key defining feature of their marketing and outreach campaigns which underline its accessibility and familial appeal, states the promotional summary: "In a unique partnership with Intel, the Royal Shakespeare Company will be using today's most advanced technology in a bold reimagining of Shakespeare's magical play, creating an unforgettable theatrical experience. *The Tempest* will be the perfect introduction to Shakespeare for young theatregoers and families."³

This coupling of technological innovation with artistic practices and marketing is a strategy that characterises many of the very first examples of Virtual Reality – in which some of the first mainstream, best known installations have been utilized as marketing tools prior to the release of films. These include a *Game of Thrones* "virtual elevator experience"⁴ and The *Interstellar* (2014)⁵ experience, both of which enable interactive access to some of the diegetic landscapes of the two storyworlds via Oculus Rift technology. In *Game of Thrones*, the experience also includes the use of high-powered fans, a rumble deck and jets of subzero air to emulate the elevators seven-hundred-foot ascent of the fictional location of Castle Black. In the *Interstellar* experience – audience members experience a virtual zero gravity tour of the 'Endurance' space craft which features in the film.

Drawing from the history of traditional television and film commercials and other short form content, such as car and technology advertisements, this is a space where innovation in production style, aesthetics and technique is cultivated through access to commercial sponsorship and corporate funding. There are opportunities that emerge as technology companies seek new practices through which to experiment, exploit and promote the affordances and potentials of their innovations/inventions. In many cases these commercials

³ <https://www.barbican.org.uk/the-tempest-royal-shakespeare-company/>

⁴ <http://connect.hbo.com/events/game-thrones/game-thrones-exhibit/>, It was installed in 8 cities on a worldwide tour including New York, Sydney, Belfast and Vancouver between January and August 2015 in order to promote the forthcoming Season 4 of the franchise.

⁵ This was installed at the AMC Metreon in San Francisco, in November 2014 to promote the film *Interstellar*.

or shorts have been the ‘calling cards’ that demonstrate artist prowess and help the production or individual creative practitioners to secure access to funding to develop larger scale projects. They are spectacular in their nature, redolent of Tom Gunning’s theory of the ‘Cinema of Attraction’, in which the spectacle ‘is interest in itself’ (2000, p.229). These instances follow this historical trajectory, whereby early stories foreground, lavishly deploy and privilege the possibilities of the new technologies and techniques – we see this in contemporary games and film features and now in these early stages of the evolution of VR. Moreover, these synergies create an ecosystem, where artistic and creative endeavors are facilitated by the commercial sector:

“This tendency is conflated within digital storytelling in which it is not just an unveiling for the capabilities of the technologies but also as an advertisement for an associated piece of proprietary software or hardware.” (Atkinson, 2014) *The Random Adventures of Brandon Generator* (2012), an interactive animated story, provided a showcase for the capabilities of the emergent HTML 5 standard whilst acting as a promotion for Microsoft Internet Explorer 7. The renowned *The Wilderness Downtown* (2010), produced for the Arcade Fire single ‘We Used to Wait’ directed by Chris Milk, showcased Google Street View. It is also a highly acclaimed example of a contemporary music video advancing digital production practices and modalities. In these cases, the examples are not only adverts for the music, they also function as commercial showcases for the technologies that they employ, and their core story telling mechanism is the showcase of the technological platform. They are ecosystems with very different outputs which span the purely creative and the ruthlessly commercial but they all share the same underlying structures of collaboration between cutting edge technologies/technologists and artistic production/practitioners.

The integration of virtual reality into the theatrical arts was initiated by the LA Philharmonic Orchestra’s digital initiatives team in 2015 via the ‘VAN Beethoven’ Virtual Reality Orchestra VR experience. Hempel (2015) commented on the four-minute performance: “This is the first time I’ve seen a nonprofit organisation harness this technology to bring a cultural experience to underserved communities.... [This is] the larger promise of virtual reality, realised” (2015). This quotation illustrates the frequently enthusiastic way in which many embrace the democratizing and egalitarian promise of VR, (that they enable access to previously inaccessible spaces previously limited by geographic distance or cultural exclusion) but there is yet to be any compelling evidence and data to account for these claims

of an increase in access and engagement within underserved communities. Nonetheless, this particular example presents a landmark moment as the inception of virtual reality as a mode through which to access and engage with the theatrical arts. This article presents further examples on how VR can be used as a tool for increasing access and audience engagement.

The Ecosystem approach

The 2016 ‘From Live-to-Digital Report’ commissioned by the Arts Council England grappled with the challenges of the feasibility and viability of smaller theatres and theatre production companies entering the ‘Event Cinema’ market. As the report evidences, this is now a global multi-million industry built on a significant infrastructure of international satellite broadcasts. The report stated:

“In order to enter the Event Cinema (and potentially the Virtual Reality and Augmented Reality) market(s), many suggested it would be most appropriate for small to mid-scale companies to collaborate with larger players through well-curated, high-profile collaborative initiatives – e.g. a set of performances programmed in cinemas over a short period. Many of those larger theatre players interviewed for this study, including producers and distributors, indicated an openness to discussing what form this could take.” (SOLT, 2016, p. 6.13)

Taking 2016 and 2017 as the focus to examine the extent to which this has been taken forwards, we can see that Virtual Reality is being utilised by a number of key cultural organisations in the UK as part of audience and visitor engagement strategies particularly through new types of collaborations. We propose the emergence of a particular form of “temporary collaborative ecosystem” and do so by deploying a “cultural ecosystem approach” (Hernández-Acosta, 2015, para 3). Hernández-Acosta elaborates a “concept of cultural ecosystems as a broader approach to understand diversity, interdependence, and collaboration in the cultural and creative industries” (Hernández-Acosta, 2015, para 1) which is particularly relevant to this set of case studies and at this moment of emergent practice.

We are extending this analytical approach to examine the formation of what we are proposing as ‘emergent collaborative ecosystems’. These are ecosystems which converge technology, artistic and craft practices with policy and technology infrastructure investment agendas of cultural and governmental organisations in the UK during 2016-2017.

Collaborative Virtual Reality Ecosystems are distinctive to the geo-specific phenomena known as ‘media clustering’: the agglomeration of media companies in a particular

geographic area. Landry has concluded that such a milieu ‘is a physical setting where a critical mass of entrepreneurs, intellectuals, social activists, artists, administrators, power brokers or students’ exists (2012, p.133). Borgh and Cloudt, extend the analysis to propose a ‘knowledge-based ecosystem’ in their study of a Dutch high-tech campus. A space that is “creating and sustaining an environment where collaboration between (initially) loosely interconnected companies can evolve and take place” (2012, p.151). The ecosystem notion advances clustering frameworks since within VR, the space is virtual, moves beyond the physical, and involves organisations from different sectors, clustering normally applies to individuals and organization from one sector or a group of similar sectors.

This sense of place is often particularly foregrounded in understandings of *creative clusters* (Bazalgette, 2017) . In our case studies, we observed a de-territorialised system that might be conceptualised as a virtual reality milieu that traverses geographies, cultural and disciplinary boundaries in equal measure. Indeed, as Komorowski has observed: ‘co-location does not mean collaboration’ (2016, p.186). Rather than geographical clusters – we view the ecosystems presented within this article as conceptual *constellations* (Normann and Ramirez, 1993) that cross over sector-boundaries and geographic limitations as our case studies involve global players such as Intel and Sky.

The ecosystem rhetoric has found its way into discussions around immersive technology in particular, for example, in relation to the UK’s digital economy: “Digital Catapult believes a strong ecosystem is key to developing the UK’s immersive technologies, that’s why we’re founding partners of Immerse UK.”⁶ In these instances, the notion of an ecosystem is not fully fleshed out but are certainly underpinned by an understanding of the interdependencies between the creative, the technological and the investment domains in order to drive innovation and sectoral growth. The use of this language also indicates a strong adoption of this discourse to further a particular policy and investment trajectory rather than an actual detailed consideration of what this means in practice. Hernández-Acosta claims that cultural ecosystems need to be understood “as a priority of creative industries policies” (Hernández-Acosta, 2015, para 8).

⁶ <https://www.digitalcatapultcentre.org.uk/immersive/>

Bennett presents a critique of the rhetoric of the ecosystem in which those inhabiting these types of spaces in the creative industries have “shied away from language that smacks of industrial processes and economics and describe the sector instead as an ‘ecosystem’.”

(Bennett, 2015, para 6) posing a potential:

“threat to developing effective policy and industrial strategy for the creative industries. It allows people with responsibility for the sector to imagine that it is in some ways a self-regulating and inherently resilient system. That the creative industries are somehow governed by ‘organic’ processes separate from market forces.” (Bennett, 2015, para 7)

We note Bennett’s critique and recognise the challenge that these metaphors potentially pose to arguments for economic investment, however, the language of an ecosystem affords helpful descriptive and analytical purchase at this particular early stage in the development of this emergent set of practices in 360-degree media and VR production so we will be deploying this terminology and the metaphors it affords throughout this analysis. Particularly relevant are the notions of diversity and interdependence which are particularly key in the specific collaborative structures under examination here.

This article examines four cases which collectively provide a snapshot of this area of innovation. These four case studies involve major internationally recognised cultural institutions in the UK, all situated within the theatre and performing arts sector. In the UK, the early adopters, those to most readily take VR technologies to ‘centre stage’, appear to be Live Theatre and performing arts. It is these communities who are demonstrating the greatest agility in their experimental and innovative approaches, their swift take-up and exploitation of the affordances of these technologies. The potential synergies and practices between technology and live performance have already been significantly exploited and evolved as a result of the ‘event’ cinema⁷ ecosystem which is already very established, and in which all of our cases have long successful trajectories. For example, The National Theatre Live first launched with a pilot season in 2009. The Royal Opera House pioneered cinema broadcasting in Britain, with their first transmission of Mozart’s *Don Giovanni* in 2008.⁸ The RSC began their programme of ‘Live from Stratford-upon-Avon’ in 2012. The recently

⁷ The term used to describe the live or relay broadcasts of live performances into cinema auditoria – theatre, music, dance, sport etc. It is sometimes also referred to as ‘alternative content’ – see Atkinson & Kennedy 2016 for a full definitional discussion.

⁸ ‘Exploring the market for Live to Digital Arts,’ *MTM* (2015).

commercial and economic success of the Event Cinema model is a useful touchstone for the potentials emerging from the adoption of VR in the case studies that we examine.

In this article, we look at The National Theatre's (NT) 360-degree experience of *Fabulous Wonder.Land* (December 2015), the English National Ballet's (ENB) 360-degree *Giselle* (October 2016) the Royal Opera Houses' (ROH) *Nabucco* 360-degree experience (October 2016), and Royal Shakespeare Company's (RSC) production of *The Tempest* (November 2016) in what we would refer to as 'showcase collaborations' as models of emergent production ecosystems. These collaborations all have in common that they comprise of three interdependent and diverse types of organisations:

1. Cultural Organisations
2. Technology Corporations and/or Technology Platform Providers
3. Artists, Creatives and Technologists (sole traders, freelancers or SMEs)

Collectively, these three types of organisation, each with their own stake in the arts form a collaboration that is characterised as an ecosystem. Challenging the perception of the arts as being divided into distinct and potentially agonistic fields of amateur and professional practice, Matarasso has claimed that the arts are "better understood as a complex ecosystem in which people may play different roles at different times or in different aspects of their careers." (2012: 76). In each of these examples, the traditional institutions – NT, ENB, ROH, and RSC – engage with new technologies, new technical partners and artists from beyond their own immediate familiar and comfortable cultural milieu.

Hernández-Acosta proposes a pyramid model of ecosystems – input firms at the base, competitive firms in the middle and high impact firms at the peak of the pyramid (Hernández-Acosta, 2015, para 11). Within this model, the top two tiers are commercially orientated where competitive firms "sometimes, [...] access government funds to develop specific projects, although it is not usual to sustain their operations through subsidies" (Ibid, para 11). This model does not account for the roles which larger, more significant arts and cultural organisations can play in the support and sustainability of a production ecosystem. All cases considered within this article involve a publicly-funded cultural organization. These would not fit into Hernández-Acosta's input firm tier, which is predominantly comprised of individuals and small companies.

More useful is Holden’s model of ecosystems made up by commercial, publicly-funded and home-made dimensions.

We propose the following structure, the collaborative VR ecosystem:

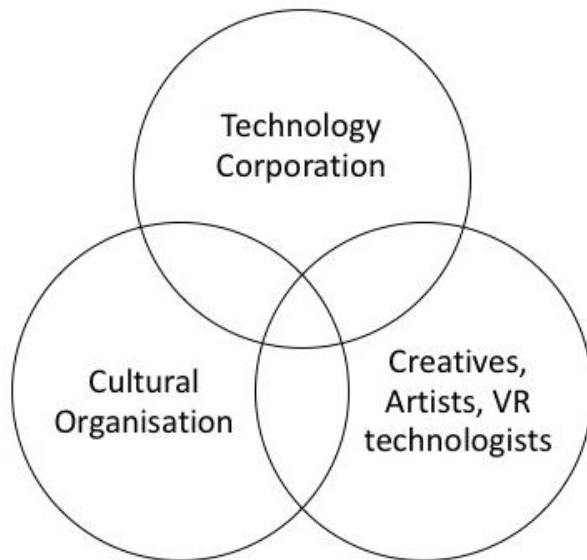


Figure 1: The collaborative VR ecosystem (Source: the author)

The technology corporation provides the platform and a source of commercial sponsorship, the cultural organization provides access to content – they rely predominantly upon public income – through arts funding and revenue generated by ticket sales. The creatives, artists and technologists are lone practitioners, or small to medium business enterprises.

The constitution of these emergent VR ecosystem is one of Technology; Arts, Culture and Innovation through research and development. “It is also vital for future growth that we build on our long history of excellence in the arts and culture and the talent it nurtures, to develop an ecosystem that brings together creativity and culture with technology, research and innovation.” (Creative Industries Council, 2014, p. 3) We see here precisely this desired convergence of the interests of a cultural institution, a corporate institution and a technology provider (for marketing, audience growth, showcase), *and* a convergence of high and low culture (through arts organisations utilisation of ‘popular’ technologies)

In this constellation – there is equality in its formation in that any one of the agents – technical, cultural or innovation can initiate collaboration, as we shall see is the case in all of

the cases discussed in this article. In their model, value creation is identified through “(1) facilitation of the innovation process for individual companies and (2) creation of an *innovation community*” (Borgh and Clodt, 2012, p. 15, emphasis added).

See the constituent players in each of our four examples in table 1.

Production	Technology Corporation	Cultural Organisation	VR Creatives & Innovators
Giselle (2016)	Sky VR	English National Ballet	Factory 42
Nabucco (2016)	Jaunt VR	Royal Opera House	V&A Sound Design
The Tempest (2016)	Intel	Royal Shakespeare Company	The Imaginarium
wonder.land (2015)	Oculus Rift	National Theatre	Play Nicely, 59 Productions
Draw Me Close (2017)	Tilt Brush (Google) and HTC Vive, IKinema	National Theatre/ National Film Board Canada	Illustrator Teva Harrison and developer All Seeing Eye
Ugly Lies The Bone (2017)	HTC Vive	National Theatre	COOL! By Firsthand Technology

Table 1: The range of key players in the various different projects indicating the leading trajectory of the National Theatre in this domain.

In the following, we will discuss our cases in depth.

Fabulous Wonder.Land

This was National Theatre’s first foray into VR. The exhibit initially formed part of a digital exhibition in the front-of-house space of the Olivier Theatre at the National Theatre South Bank, in conjunction with the Wonder.Land stage musical. It also featured in the Live Cinema Conference exhibition in May 2016 (see figure 2)



>>Figure 2: *Fabulous.Wonderland* exhibited at the Live Cinema Conference, King’s College London, May 2016. Photo: Richard Eaton.

The *Wonder.Land* exhibition included interactive and digital installations created in collaboration with 59 Productions. It was an inherently ‘digital production’ in its content, storyline, themes and design telling the story of a modern day Alice – ‘Al’ – who enters the world of *Wonder.land* through her smartphone.

The *Fabulous.Wonderland* VR App was produced by Play Nicely Bristol and 59 Productions. It is a VR music video of Damon Albarn’s track ‘Fabulous’ taken from the soundtrack of the stage play. Almost 5 minutes in length, the video comprises of Computer Generated Imagery based on the psychedelic and neon graphics of the production design in which the Cheshire Cat, played by performance artist Hal Fowler who was motion tracked as he performed the song to camera. This experience is now available for public download on the Apple App Store.

In the immediate wake of the *Fabulous.Wonderland* project , the National Theatre set up their own “Immersive Storytelling Studio” and has since gone on to produce two further productions. The National Theatre has also presented two more front-of-house installations. Firstly, The BBC’s *Easter Rising: Voice of a Rebel* VR which was shown in conjunction with

their staging of the play *Plough & The Stars*. Secondly, the VR software ('Cool!' - a VR Pain Control therapy) which features in the play *Ugly Lies the Bone* – was exhibited outside the Lyttelton theatre for audience members to experience after watching the stage play.

Giselle

Giselle VR is a short 360-degree film, accessible via the Sky VR app. It was made through a partnership between Factory 42, English National Ballet, and Sky VR. It presents an aesthetic convergence of Dance, Film and VFX. Giselle star Tamara Rojo, the ballet's artistic director and lead principal, dances around the space emitting a trail of dust and light behind her, a 2-minute experience produced by a new 'immersive content company', Factory 42.⁹ Dan Smith explains how this particular collaboration came about:

“John was commissioner for Sky Arts – he knows the people at ENB very well, we initiated the whole thing. So as a company we want to retain Intellectual Property (IP) as much as we can. Our model is to get an idea, structure it, attach an institution or a talent, and then go to a funder. Then we can structure the deal then and retain a certain amount of IP. Especially with VR, the business model isn't established, and so we need to be thinking about it, but it makes commercial sense for us to do it. It's very easy to go bust in the world that we're in where there's no proven method of income.” (Dan Smith, Factory 42)¹⁰

The English National Ballet is “Britain's only classical ballet company dedicated to touring ballets nationwide at an affordable price for audiences”¹¹ and so this project presents an opportunity to reach a wider audience through a global media distribution platform.

Nabucco

The Royal Opera House (ROH) produced Verdi's Nabucco, a chorus in 360-degrees. It presents the company rehearsing a song in the lead-up to the opening night, from rehearsal room to stage. The ROH also produced an earlier piece – The Nutcracker which follows the journey of one of the Royal Ballet's dancers onto the stage. As Tom Nelson, Head of Audience Labs, at the ROH explains:

“we've always been intrigued by what new technology can do for us, so we were one of the first to do 3D into cinema, and so it was really a piece of R&D, how might this reengage people in our art and in our brand? We've got good assets, but what could

⁹ These contemporary examples are an evolution from /departure from earlier pioneering work such as *Pina* in 3D (2011, Dir: Wim Wenders) which also placed the audience in amongst the dancers.

¹⁰ In an interview with Sarah Atkinson, 23rd June 2016.

¹¹ <https://www.ballet.org.uk>

we do with them? 360 was a new thing a couple of years ago, let's just give it go” (Tom Nelson, Royal Opera House).¹²

Nelson goes on to explain the context of the partnership with Jaunt VR:

“Jaunt VR were a partner since we didn't have the capital to invest in the huge VR rigs, what was nice about Jaunt was that they had the hardware, but they also had the production pipeline as well – pre and post – [...] so Jaunt was very attractive to us. The other factor that was important with Jaunt was at the time, they were one of the few platforms that had ambi-sonic sound which is 4 channels of sound. So in the experience, you can turn your head and get different feelings of presence through the spatial sound. For opera that was incredibly important to us, perhaps more important than the pictures that we were immersing people in a sonic world” (Tom Nelson, Royal Opera House).¹³

Nelson's account of their artistic intentions and the technological affordances is very expressive of the creative value of the collaborations underpinning the ecosystem.

The Tempest

The RSC working in partnership with Intel and The Imaginarium, a performance capture studio set up by Andy Serkis, used Shakespeare's *The Tempest* to create the world's first live motion-capture performance. Through taking real-time information from a motion-capture suit, mapping onto a digital avatar of the character of Ariel, a spirit, who accompanies the character of Prospero throughout the play, who is then projected out onto the stage through 27 projectors. The technology was developed by Imaginarium, using Epic Games' Unreal Engine and powered by Intel's processors, a project in which Seymour observes that: “So Intel got to push their tech to its limits, The Imaginarium fulfilled a long-held goal [live motion capture] and the RSC staked its claim as one of the entertainment world's leading innovators. All in all, a tidy techno hat-trick.”

This suggestion of an interdependent and mutually-beneficial partnership through which to realize the technical and creative ambitions of each of the stakeholders further underscores the proposition of our collaborative ecosystem model, which we have developed below to offer an interpretation of the various values afforded. As Sarah Ellis, Director of Digital Development at the Royal Shakespeare company explains their particular interest in the project: ‘The lens that we're looking through this is about extending the theatre making

¹² In an interview with Sarah Atkinson, 23rd June 2016.

¹³ Ibid.

toolkit. So it's not creating a sort of next step broadcast experience, it's about creating a theatrical experience.’¹⁴

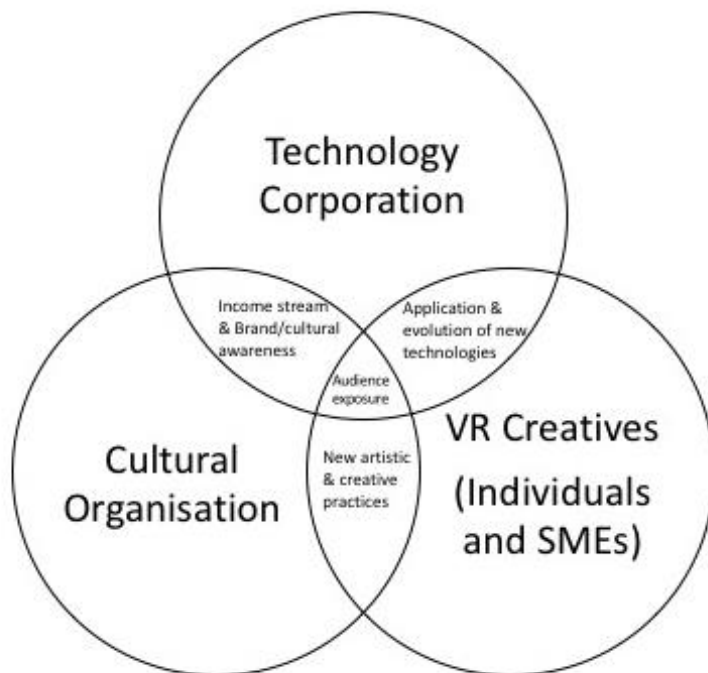


Figure 2: The outcomes and affordances of the temporary collaborative VR ecosystem

In figure 2, we highlight some of the benefits and outcomes that emerge from these collaborative projects. As Bachmann has argued: “...an overall ecosystem is viewed as a pattern of coordination amongst all the lives within it, each of which establishes a *perspective of value*” (Bachmann et al, 2012, p. 5 emphasis added). Bachman’s “perspectives of value” and Normann and Ramirez’s “value constellations” (1993) that are evidenced in these ecosystems lead to at least these five significant outcomes:

¹⁴ In an interview with Sarah Atkinson, 14th July 2017.

1. **An increased income stream** through sponsorship and support of the large technology company. The technology organization provides both a technical infrastructure and a high profile platform through which to show high-cultural and sometimes marginal works; It improves the ‘brand awareness’ of the technology company through an accessible and relatable approach to showcasing the technologies capabilities;
2. The application of new technologies and the **advancement of nascent technologies** through experimentation. The embedding of smaller organisations and their flexible, agile and iterative working practices in the context of large companies or established institutions has been referred to as ‘intra-preneurship’¹⁵;
3. The **evolution of new creative and artistic practices**. Expanding the performative palette, performing for camera and for new technologies can advance artistic exploration and discovery;
4. The **exposure of audiences to** new new entertainment experiences (VR) and also to high-cultural art forms that they would not normally experience;
5. The **creation of an “innovation community”** (Borgh and Clodt, 2012, p. 15) through bringing different artists, practitioners and skill-sets together. Whether these are long-standing and sustaining communities remains to be seen, but certainly at the point of production, the characteristic of an innovation community is its temporary and time-bound nature, focused on a particular project at a specific moment in time.

An increased income stream

This fusion of technology and arts provides further evidence of the validity of the outcomes of a recent report into the digital sector that established a terminology which captured this type of inter-disciplinary working between these sectors: “Fused businesses are those that combine creative art and design skills with technology expertise.” (Sapsed and Nightingale, 2013, p.1). They go on to describe how this fusion impacts upon the potential performance of an organization or collaboration: “when this knowledge is combined with current technological knowhow, the performance of the firm becomes ‘superfused’, achieving superior levels of innovation and growth” (Ibid, p. 5). Here, the ‘knowledge’ they refer to is that which has been gathered through audience and client response to social media.

¹⁵ The Remix Conference: Culture, Technology, Entrepreneurship, 18-19 January 2017.

The report is referring to super-fused firms, whereas I am taking the term to apply to super-fused collaborations, which are potentially distinct, however, the organisations identified as superfused are often project based SME's making use of a wide range of freelancers working in time bound collaborations . The underpinning characteristics of Superfusion are key elements of the VR/XR ecosystem.

ROH explained how they were able to leverage the strong subscriber base that they have on YouTube to garner responses and feedback. This proved to be particularly useful in taking on feedback from The Nutcracker experience to the subsequent production of Nabucco. The notion of a 'superfused' collaboration can be drawn out from Tom Nelson's account of how his particular set of partnerships worked:

“It was a good collaboration because they brought the tech and the production know-how and we brought the artists and the idea and took it from there [...] We partnered with the V&A to deliver an exhibition on opera later this autumn, and they wanted some amazing sound for their Nabucco room. So it worked for them to come on board and bring their sound designers to capture the sound in the right way. We were able to create a sound mix for the Jaunt platform and then also there is a separate sound mix for the exhibition that is audio only.” (Tom Nelson, Royal Opera House)¹⁶

Factory 42 recount what could be considered a similar 'fused' approach to their work:

“John's background in executing at a business level and a production level, very complicated advanced imaging. John was responsible for helping to introduce HD TV to Sky, and then 3D [...] and my background is more the factory floor of filmmaking, I've done a lot of CG and a lot of stereo-3D, and I was an editor for many years, so I'm half way between technical and creative. So together we make quite a good team to approach VR, and make some quality content.” (Dan Smith, Factory 42)¹⁷

Advancement of nascent technologies

As noted above, in our observations around the emergence of new technologies - the core story telling mechanism is the showcase of the technological platform, in order to communicate and aestheticize the capabilities of the technology. In the case of 360-degree media and VR, this manifests through the notable aesthetic of 'working in-the-round' – where each of the pieces require the viewer to continually pivot in their position– to see all around them in these spherical vistas. In *Giselle*, the viewer is visually guided to track the performance of the dancer as she circulates the space. In *Fabulous.Wonderland* the Cheshire

¹⁶ Ibid.

¹⁷ In an interview with Sarah Atkinson, 23rd June 2016.

cat appears above, below and behind the viewer's field of vision, no sooner has it appeared it evaporates and appears elsewhere. In *Nabucco*, the viewer is surrounded by the chorus, is positioned within them, and so can pivot around 180-degrees to study each of the performers faces. Turning full circle reveals the conductors and behind-the-scenes personnel in the rehearsal space and then the audience in the opera house, itself. In *The Tempest*, audience members perceive a holistic 3D projection of Ariel whilst simultaneously able to view the performer playing the character in a full motion capture suit. Here the behind-the-scenes production becomes part of the spectacle to deepen the audiences' engagement and experience.

The evolution of new creative and artistic practices

These examples are all at the convergence of digital production practices, many of which are used in feature films such as motion capture, green screen and visual effects (VFX). This reflects a wider trend of production convergence within the digital industries in which digital production 'shops' (formerly known as post production houses) offer a range of services which cut across film, television, games and all forms of digital media. Here we see a full integration of art forms – the artificiality of film special effects and the physicality of live performance – both used to working in either a virtual or a material 360-degree space. As our examples illuminate, it is the theatrical arts that are providing a welcome home in VR due to these characteristic and familiar three-dimensional spaces. It mirrors the aesthetic of theatrical spatialised performance providing a sense of being in amongst the production, a mingling between actor and audience that temporarily destabilises the boundaries between these subjectivities. Each of these experiences place the viewer in the performative space, as if in a promenade performance, and the conventions of immersive theatre. As Johanna Nicholls, Senior Digital Producer at the National Theatre's Storytelling Studio stated: "we bring old practices, the ancient art of storytelling: the well established process of creating spatial sound; what it is to spatialise the story [...]; what it is to create presence – all of which theatre does, and we bring all of that into the technology".¹⁸

Furthermore, the form enabled the advancement of theatrical practice in contrast to the last significant development and fusion between screen and stage in the form of the flat two-dimensionality of event cinema. Although, as we have noted this is a proven and lucrative

¹⁸ Ibid.

business model for the larger cultural players, in broadening and widening appeal, but one which does not necessarily engender innovation – the camera positions and cutting (particularly in opera and ballet) are highly conservative and formulaic – and are also limited by the buildings themselves. As Nelson stated of the engagement with the affordances of VR in terms of artistic and creative development having already “tested various production methodologies and ways of capturing sound.”¹⁹

VR is also being used as a performative tool through which to develop actors’ performances. For example, Jeremy Herrin, the director of *Plough and the Stars* took all of the cast through the *Easter Rising* VR experiences as part of the characterization process in the pre-rehearsals.

The exposure of audiences to new aesthetic and new entertainment experiences

Each of the four case studies present new mechanisms for audience engagement, both growing breadth of audience reach, and enhancing depth of audience engagement. By embedding commercial technologies in audience engagement strategies, these examples have all sought to engender immersive, meaningful engagements. Holden discusses the extent to which audience choice is indicative of a healthy ecosystem. He proposes the measurement of a number of ‘vital signs’ in order to assess the robustness of the ecosystems’ infrastructure:

“Variety is source of ecological strength: it is better for the health of the ecology, for example, that the theatre sector in a big city has a variety of sizes of venue and a wide range of different types of performance being staged, rather than offering a collection of long-running musicals, even if they attract big audiences. The health of the ecology cannot be judged in terms only of audience numbers or financial turnover.” (Holden 2015, p. 33)

The term ecosystem implies its evolutionary capacity and sustainability, it suggests that something natural and positive will emerge out of these constellations which grow from new technological opportunities. We can see evidence of the ‘health’ of the Virtual Reality ecosystem in the extent of the critical recognition being given to these projects and the number of awards that they have garnered.

The creation of an “innovation community”

Each of the four examples studied demonstrate how innovation can be nurtured in a multi-partner, cross-domain and interdisciplinary collaboration. Although, as many have noted,

¹⁹ Ibid.

aside from computer gaming, there are yet to be successfully scalable business models established for VR distribution and exhibition. As Tom Nelson commented:

“These are R&D opportunities where we don’t know if there’s a commercial model yet, we hope there might be in the future, but we need to test it first and so 360, two years ago fitted into that, now 360 is ‘business as usual’ for most organisations, which have it as part of their marketing portfolio” (Tom Nelson, Royal Opera House).²⁰

In the context of the UK there are a number of initiatives such as the Digital Catapult that provide a national infrastructure through which to support the advancement of the technologies that underpin VR and a platform for securing financial investment and support. The Digital Catapult has very recently highlighted the need for support in this area:

“The UK has a significant opportunity to repeat its successes from the related film production, visual effects and video games industries on these emerging VR, AR and mixed reality platforms. They will have closely related skillset, business and ecosystem requirements, meaning the UK starts with some advantages, but lacks investment and strong central coordination” (Digital Catapult, 2017, p. 11).

Despite this lack of investment, the examples discussed in this article have succeeded in creating the spaces that have become crucial to innovating and advancing the form, establishing new modes of production and new mechanisms for audience engagement. The National Theatre underscore the value of their approach to production and collaboration, which is “totally iterative development, open minds, open collaboration, state of discovery” (Nicholls). They also express their openness to the different forms of immersive technology: “we would as much do a single sound piece as we would a VR piece, or an emotional response piece using artificial intelligence, and algorithms around that, volumetric capture, social VR, it's immersive technology, generally. And identifying the stories that need to be told.” (Ibid.)

It is important to note that the innovation communities that I refer to within the ecosystem are temporally fleeting.

This article forms part of a wider longitudinal study in which we are mapping the evolution and integration of Virtual and Extended Reality in arts organisations over the next two years. Whether new business models will emerge for saleable VR experiences, or whether the solo VR experience will persist as the dominant model for theatre audiences is

²⁰ Ibid.

yet to be seen. Ben Lumsden from The Imaginarium identifies where the form will develop through his own proposition of the genre of “Site-specific augmented reality theatre” (in Seymour, 2017). What is currently very clear is that these are all progenitors of a type of collaboration which has successfully advanced the aesthetics, the artistic possibilities and the production techniques of the form. Furthermore, the emerging Extended Reality ecosystem that has been proposed in this article can be viewed as a microcosm of the technological evolution of the creative industries in the UK, where lessons can be learned about how technological intervention can be nurtured and advanced.

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